

CHAPTER 4

FOUNDATIONS

SECTION R401 GENERAL

R401.1 Application. The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for all buildings. In addition to the provisions of this chapter, the design and construction of foundations in areas prone to flooding as established by Table R301.2(1) shall meet the provisions of Section R324. Wood foundations shall be designed and installed in accordance with AF&PA Report No. 7.

Exception: The provisions of this chapter shall be permitted to be used for wood foundations only in the following situations:

1. In buildings that have no more than two floors and a roof.
2. When interior basement and foundation walls are constructed at intervals not exceeding 50 feet (15 240 mm).

Wood foundations in Seismic Design Category D₀, D₁ or D₂ shall be designed in accordance with accepted engineering practice.

R401.2 Requirements. Foundation construction shall be capable of accommodating all loads according to Section R301 and of transmitting the resulting loads to the supporting soil. Fill soils that support footings and foundations shall be designed, installed and tested in accordance with accepted engineering practice. Gravel fill used as footings for wood and precast concrete foundations shall comply with Section R403.

R401.3 Drainage. Surface drainage shall be diverted to a storm sewer conveyance or other approved point of collection so as to not create a hazard. Lots shall be graded to drain surface water away from foundation walls. The grade shall fall a minimum of 6 inches (152 mm) within the first 10 feet (3048 mm).

Exception: Where lot lines, walls, slopes or other physical barriers prohibit 6 inches (152 mm) of fall within 10 feet (3048 mm), the final grade shall slope away from the foundation at a minimum slope of 5 percent and the water shall be directed to drains or swales to ensure drainage away from the structure. Swales shall be sloped a minimum of 2 percent when located within 10 feet (3048 mm) of the building foundation. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped a minimum of 2 percent away from the building.

R401.4 Soil tests. Where quantifiable data created by sound soil science methodologies indicate expansive, compressible, shifting or unknown soil characteristics are likely to be present, the building official shall determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be made by an approved agency using an approved method.

R401.4.1 Geotechnical evaluation. In lieu of a complete geotechnical evaluation, the load-bearing values in Table R401.4.1 shall be assumed.

**TABLE R401.4.1
PRESUMPTIVE LOAD-BEARING VALUES OF
FOUNDATION MATERIALS^a**

CLASS OF MATERIAL	LOAD-BEARING PRESSURE (pounds per square foot)
Crystalline bedrock	12,000
Sedimentary and foliated rock	4,000
Sandy gravel and/or gravel (GW and GP)	3,000
Sand, silty sand, clayey sand, silty gravel and clayey gravel (SW, SP, SM, SC, GM and GC)	2,000
Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH and CH)	1,500 ^b

For SI: 1 pound per square foot = 0.0479 kPa.

- a. When soil tests are required by Section R401.4, the allowable bearing capacities of the soil shall be part of the recommendations.
- b. Where the building official determines that in-place soils with an allowable bearing capacity of less than 1,500 psf are likely to be present at the site, the allowable bearing capacity shall be determined by a soils investigation.

R401.4.2 Compressible or shifting soil. Instead of a complete geotechnical evaluation, when top or subsoils are compressible or shifting, they shall be removed to a depth and width sufficient to assure stable moisture content in each active zone and shall not be used as fill or stabilized within each active zone by chemical, dewatering or presaturation.

SECTION R402 MATERIALS

R402.1 Wood foundations. Wood foundation systems shall be designed and installed in accordance with the provisions of this code.

R402.1.1 Fasteners. Fasteners used below grade to attach plywood to the exterior side of exterior basement or crawlspace wall studs, or fasteners used in knee wall construction, shall be of Type 304 or 316 stainless steel. Fasteners used above grade to attach plywood and all lumber-to-lumber fasteners except those used in knee wall construction shall be of Type 304 or 316 stainless steel, silicon bronze, copper, hot-dipped galvanized (zinc coated) steel nails, or hot-tumbled galvanized (zinc coated) steel nails. Electro-galvanized steel nails and galvanized (zinc coated) steel staples shall not be permitted.

R402.1.2 Wood treatment. All lumber and plywood shall be pressure-preservative treated and dried after treatment in accordance with AWPA U1 (Commodity Specification A, Use Category 4B and Section 5.2), and shall bear the label of an accredited agency. Where lumber and/or plywood is cut

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or drilled after treatment, the treated surface shall be field treated with copper naphthenate, the concentration of which shall contain a minimum of 2 percent copper metal, by repeated brushing, dipping or soaking until the wood absorbs no more preservative.

R402.2 Concrete. Concrete shall have a minimum specified compressive strength of f'_c , as shown in Table R402.2. Concrete subject to moderate or severe weathering as indicated in Table R301.2(1) shall be air entrained as specified in Table R402.2. The maximum weight of fly ash, other pozzolans, silica fume, slag or blended cements that is included in concrete mixtures for garage floor slabs and for exterior porches, carport slabs and steps that will be exposed to deicing chemicals shall not exceed the percentages of the total weight of cementitious materials specified in Section 4.2.3 of ACI 318. Materials used to produce concrete and testing thereof shall comply with the applicable standards listed in Chapter 3 of ACI 318.

R402.3 Precast concrete. Approved precast concrete foundations shall be designed and installed in accordance with the provisions of this code and the manufacturer's installation instructions.

**SECTION R403
FOOTINGS**

R403.1 General. All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, wood foundations, or other approved structural systems which shall be of sufficient design to accommodate all loads according to Section R301 and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil. Footings shall be supported on undisturbed natural soils or engineered fill.

Exception: One-story detached accessory structures used as tool and storage sheds, playhouses and similar uses, not

exceeding 256 square feet (23 7824 m²) of building area, provided all of the following conditions are met:

1. The building eave height is 10 feet or less.
2. The maximum height from the finished floor level to grade does not exceed 18 inches.
3. The supporting structural elements in direct contact with the ground shall be placed level on firm soil and when such elements are wood they shall be approved pressure preservative treated suitable for ground contact use.
4. The structure is anchored to withstand wind loads as required by this code.
5. The structure shall be of light-frame construction with walls and roof of light weight material, not slate, tile, brick or masonry.

**TABLE R403.1
MINIMUM WIDTH OF CONCRETE OR MASONRY FOOTINGS
(inches)^a**

	LOAD-BEARING VALUE OF SOIL (psf)			
	1,500	2,000	3,000	≥4,000
Conventional light-frame construction				
1-story	12	12	12	12
2-story	15	12	12	12
3-story	23	17	12	12
4-inch brick veneer over light frame or 8-inch hollow concrete masonry				
1-story	12	12	12	12
2-story	21	16	12	12
3-story	32	24	16	12
8-inch solid or fully grouted masonry				
1-story	16	12	12	12
2-story	29	21	14	12
3-story	42	32	21	16

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

a. Where minimum footing width is 12 inches, use of a single wythe of solid or fully grouted 12-inch nominal concrete masonry units is permitted.

**TABLE R402.2
MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE**

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH ^a (f'_c)		
	Weathering Potential ^b		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500 ^c
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500 ^c
Basement walls, foundation walls, exterior walls and other vertical concrete work exposed to the weather	2,500	3,000 ^d	3,000 ^d
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000 ^{d,e,f}	3,500 ^{d,e,f}

For SI: 1 pound per square inch = 6.895 kPa.

a. Strength at 28 days psi.

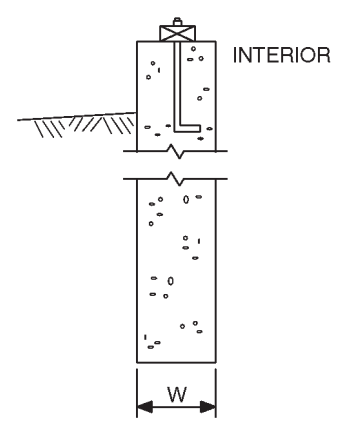
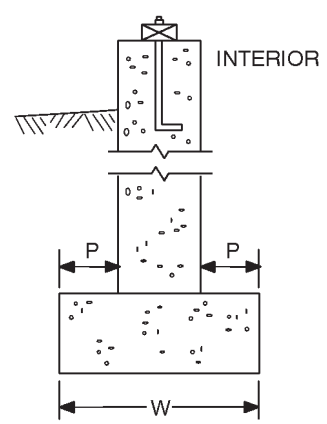
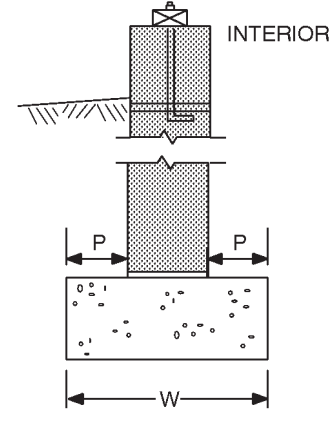
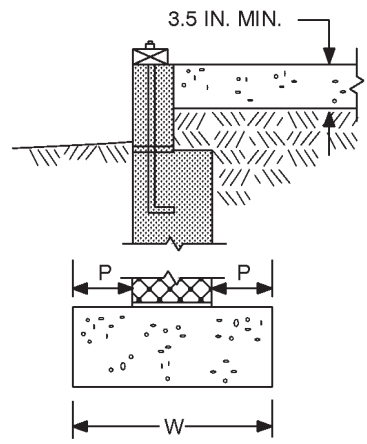
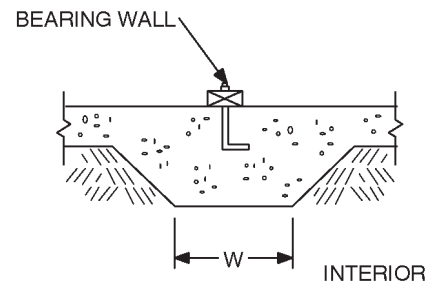
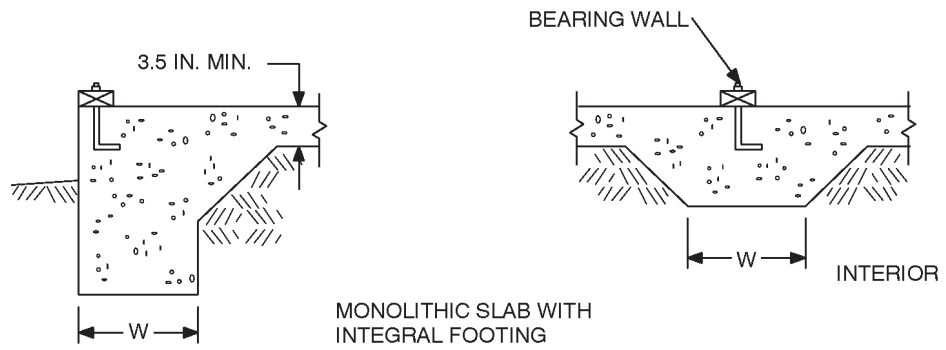
b. See Table R301.2(1) for weathering potential.

c. Concrete in these locations that may be subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Note d.

d. Concrete shall be air-entrained. Total air content (percent by volume of concrete) shall be not less than 5 percent or more than 7 percent.

e. See Section R402.2 for maximum cementitious materials content.

f. For garage floors with a steel troweled finish, reduction of the total air content (percent by volume of concrete) to not less than 3 percent is permitted if the specified compressive strength of the concrete is increased to not less than 4,000 psi.



For SI: 1 inch = 25.4 mm.

**FIGURE R403.1(1)
CONCRETE AND MASONRY FOUNDATION DETAILS**

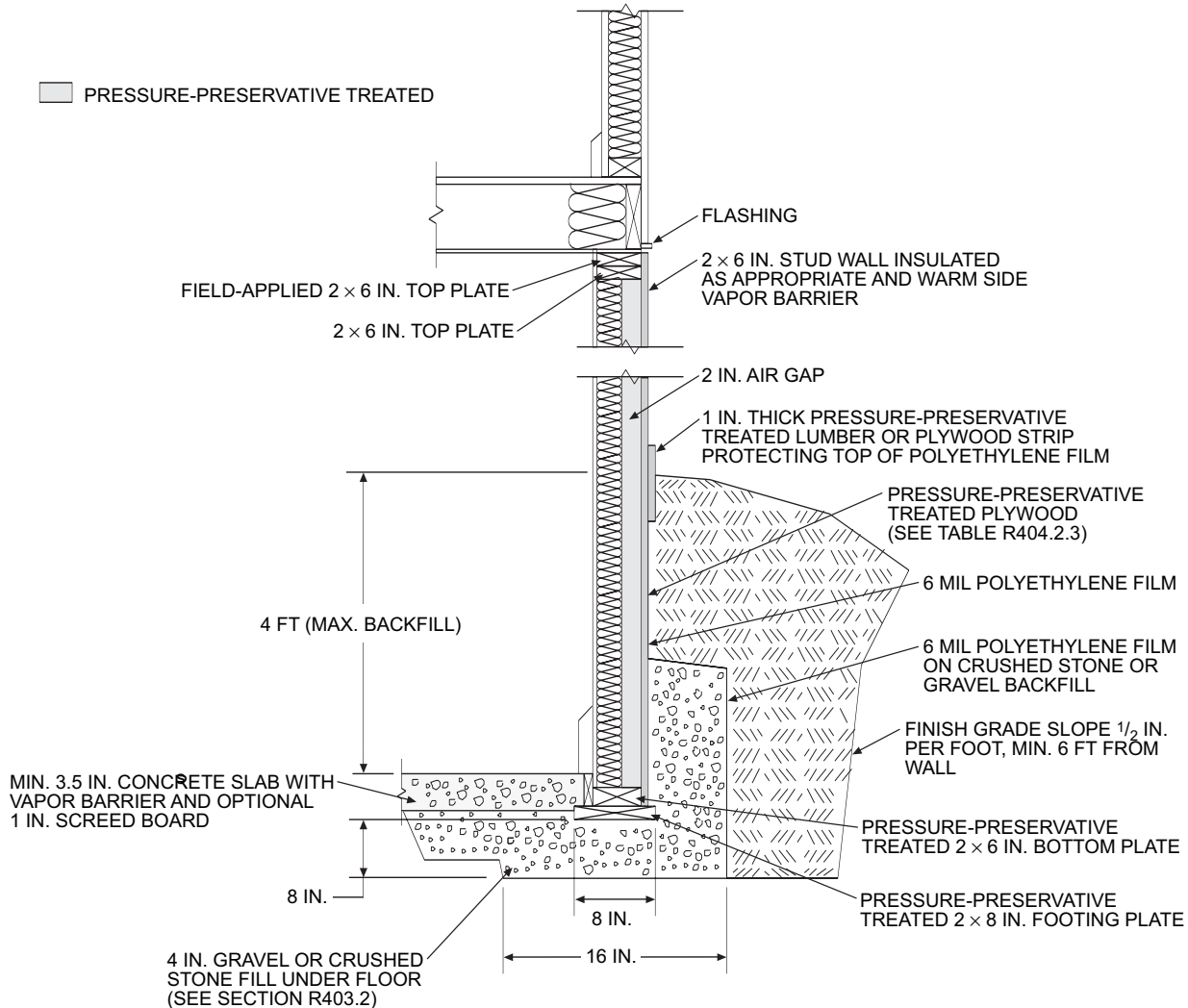
R403.1.1 Minimum size. Minimum sizes for concrete and masonry footings shall be as set forth in Table R403.1 and Figure R403.1(1). The footing width, *W*, shall be based on the load-bearing value of the soil in accordance with Table R401.4.1. Spread footings shall be at least 6 inches (152 mm) thick. Footing projections, *P*, shall be at least 2 inches (51 mm) and shall not exceed the thickness of the footing. The size of footings supporting piers and columns shall be based on the tributary load and allowable soil pressure in accordance with Table R401.4.1. Footings for wood foundations shall be in accordance with the details set forth in Section R403.2, and Figures R403.1(2) and R403.1(3).

R403.1.2 Continuous footing in Seismic Design Categories D₀, D₁ and D₂. The braced wall panels at exterior walls of buildings located in Seismic Design Categories D₀, D₁ and D₂ shall be supported by continuous footings. All required interior braced wall panels in buildings with plan dimensions greater than 50 feet (15 240 mm) shall also be supported by continuous footings.

R403.1.3 Seismic reinforcing. Concrete footings located in Seismic Design Categories D₀, D₁ and D₂, as established in Table R301.2(1), shall have minimum reinforcement. Bottom reinforcement shall be located a minimum of 3 inches (76 mm) clear from the bottom of the footing.

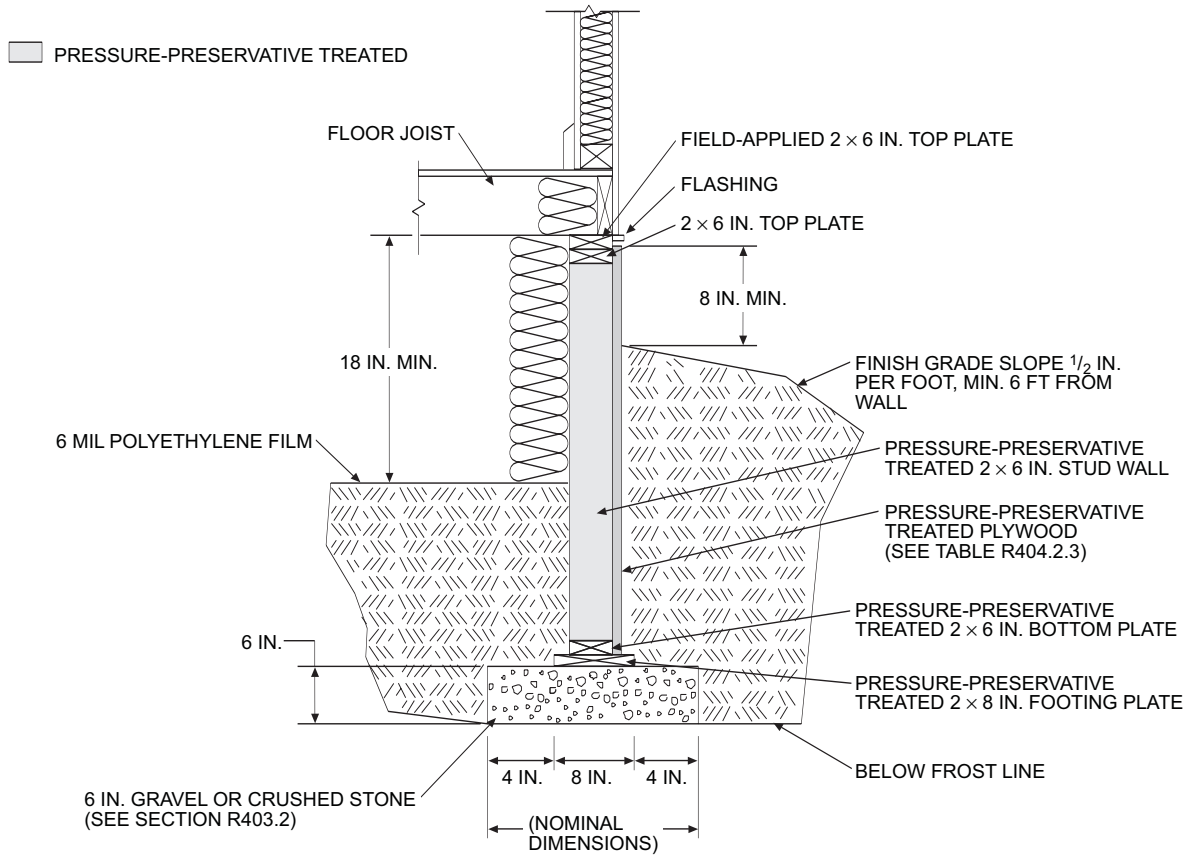
In Seismic Design Categories D₀, D₁ and D₂ where a construction joint is created between a concrete footing and a stem wall, a minimum of one No. 4 bar shall be installed at not more than 4 feet (1219 mm) on center. The vertical bar shall extend to 3 inches (76 mm) clear of the bottom of the footing, have a standard hook and extend a minimum of 14 inches (357 mm) into the stem wall.

In Seismic Design Categories D₀, D₁ and D₂ where a grouted masonry stem wall is supported on a concrete footing and stem wall, a minimum of one No. 4 bar shall be installed at not more than 4 feet on center. The vertical bar shall extend to 3 inches (76 mm) clear of the bottom of the footing and have a standard hook.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.254 mm.

FIGURE R403.1(2)
PERMANENT WOOD FOUNDATION BASEMENT WALL SECTION



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mil = 0.0254 mm.

**FIGURE R403.1(3)
PERMANENT WOOD FOUNDATION CRAWL SPACE SECTION**

In Seismic Design Categories D₀, D₁ and D₂ masonry stem walls without solid grout and vertical reinforcing are not permitted.

Exception: In detached one- and two-family dwellings which are three stories or less in height and constructed with stud bearing walls, plain concrete footings without longitudinal reinforcement supporting walls and isolated plain concrete footings supporting columns or pedestals are permitted.

R403.1.3.1 Foundations with stemwalls. Foundations with stem walls shall have installed a minimum of one No. 4 bar within 12 inches (305 mm) of the top of the wall and one No. 4 bar located 3 inches (76 mm) to 4 inches (102 mm) from the bottom of the footing.

R403.1.3.2 Slabs-on-ground with turned-down footings. Slabs-on-ground with turned-down footings shall have a minimum of one No. 4 bar at the top and bottom of the footing.

Exception: For slabs-on-ground cast monolithically with a footing, one No. 5 bar or two No. 4 bars shall be located in the middle third of the footing depth.

R403.1.4 Minimum depth. All exterior footings shall be placed at least 12 inches (305 mm) below the undisturbed ground surface. Where applicable, the depth of footings shall also conform to Sections R403.1.4.1 through R403.1.4.2.

R403.1.4.1 Frost protection. Except where otherwise protected from frost, foundation walls, piers and other permanent supports of buildings and structures shall be protected from frost by one or more of the following methods:

1. Extended below the frost line specified in Table R301.2.(1);
2. Constructing in accordance with Section R403.3;
3. Constructing in accordance with ASCE 32; or
4. Erected on solid rock.

Exceptions:

1. Protection of freestanding accessory structures with an area of 600 square feet (56 m²) or less, of light-framed construction, with an eave height of 10 feet (3048 mm) or less shall not be required.
2. Protection of freestanding accessory structures with an area of 400 square feet (37 m²) or less, of other than light-framed construction, with an eave height of 10 feet (3048 mm) or less shall not be required.

3. Decks not supported by a dwelling need not be provided with footings that extend below the frost line.

Footings shall not bear on frozen soil unless the frozen condition is permanent.

R403.1.4.2 Seismic conditions. In Seismic Design Categories D₀, D₁ and D₂, interior footings supporting bearing or bracing walls and cast monolithically with a slab on grade shall extend to a depth of not less than 12 inches (305 mm) below the top of the slab.

R403.1.5 Slope. The top surface of footings shall be level. The bottom surface of footings shall not have a slope exceeding one unit vertical in 10 units horizontal (10-percent slope). Footings shall be stepped where it is necessary to change the elevation of the top surface of the footings or where the slope of the bottom surface of the footings will exceed one unit vertical in 10 units horizontal (10-percent slope).

R403.1.6 Foundation anchorage. When braced wall panels are supported directly on continuous foundations, the wall wood sill plate or cold-formed steel bottom track shall be anchored to the foundation in accordance with this section.

The wood sole plate at exterior walls on monolithic slabs and wood sill plate shall be anchored to the foundation with anchor bolts spaced a maximum of 6 feet (1829 mm) on center. There shall be a minimum of two bolts per plate section with one bolt located not more than 12 inches (305 mm) or less than seven bolt diameters from each end of the plate section. In Seismic Design Categories D₀, D₁ and D₂, anchor bolts shall be spaced at 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section at interior braced wall lines when required by Section R602.10.9 to be supported on a continuous foundation. Bolts shall be at least 1/2 inch (13 mm) in diameter and shall extend a minimum of 7 inches (178 mm) into masonry or concrete. Interior bearing wall sole plates on monolithic slab foundation shall be positively anchored with approved fasteners. A nut and washer shall be tightened on each bolt of the plate. Sills and sole plates shall be protected against decay and termites where required by Sections R319 and R320. Cold-formed steel framing systems shall be fastened to the wood sill plates or anchored directly to the foundation as required in Section R505.3.1 or R603.1.1.

Exceptions:

1. Foundation anchorage, spaced as required to provide equivalent anchorage to 1/2-inch-diameter (13 mm) anchor bolts.
2. Walls 24 inches (610 mm) total length or shorter connecting offset braced wall panels shall be anchored to the foundation with a minimum of one anchor bolt located in the center third of the plate section and shall be attached to adjacent braced wall panels per Figure R602.10.5 at corners.
3. Walls 12 inches (305 mm) total length or shorter connecting offset braced wall panels shall be permitted to be connected to the foundation without

anchor bolts. The wall shall be attached to adjacent braced wall panels per Figure R602.10.5 at corners.

R403.1.6.1 Foundation anchorage in Seismic Design Categories C, D₀, D₁ and D₂. In addition to the requirements of Section R403.1.6, the following requirements shall apply to wood light-frame structures in Seismic Design Categories D₀, D₁ and D₂ and wood light-frame townhouses in Seismic Design Category C.

1. Plate washers conforming to Section R602.11.1 shall be provided for all anchor bolts over the full length of required braced wall lines. Properly sized cut washers shall be permitted for anchor bolts in wall lines not containing braced wall panels.
2. Interior braced wall plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section when supported on a continuous foundation.
3. Interior bearing wall sole plates shall have anchor bolts spaced at not more than 6 feet (1829 mm) on center and located within 12 inches (305 mm) of the ends of each plate section when supported on a continuous foundation.
4. The maximum anchor bolt spacing shall be 4 feet (1219 mm) for buildings over two stories in height.
5. Stepped cripple walls shall conform to Section R602.11.3.
6. Where continuous wood foundations in accordance with Section R404.2 are used, the force transfer shall have a capacity equal to or greater than the connections required by Section R602.11.1 or the braced wall panel shall be connected to the wood foundations in accordance with the braced wall panel-to-floor fastening requirements of Table R602.3(1).

R403.1.7 Footings on or adjacent to slopes. The placement of buildings and structures on or adjacent to slopes steeper than 1 unit vertical in 3 units horizontal (33.3-percent slope) shall conform to Sections R403.1.7.1 through R403.1.7.4.

R403.1.7.1 Building clearances from ascending slopes. In general, buildings below slopes shall be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures. Except as provided in Section R403.1.7.4 and Figure R403.1.7.1, the following criteria will be assumed to provide this protection. Where the existing slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the toe of the slope shall be assumed to be at the intersection of a horizontal plane drawn from the top of the foundation and a plane drawn tangent to the slope at an angle of 45 degrees (0.79 rad) to the horizontal. Where a retaining wall is constructed at the toe of the slope, the height of the slope shall be measured from the top of the wall to the top of the slope.

R403.1.7.2 Footing setback from descending slope surfaces. Footings on or adjacent to slope surfaces shall be founded in material with an embedment and setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Except as provided for in Section R403.1.7.4 and Figure R403.1.7.1, the following setback is deemed adequate to meet the criteria. Where the slope is steeper than one unit vertical in one unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degrees (0.79 rad) to the horizontal, projected upward from the toe of the slope.

R403.1.7.3 Foundation elevation. On graded sites, the top of any exterior foundation shall extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a minimum of 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the approval of the building official, provided it can be demonstrated that required drainage to the point of discharge and away from the structure is provided at all locations on the site.

R403.1.7.4 Alternate setback and clearances. Alternate setbacks and clearances are permitted, subject to the approval of the building official. The building official is permitted to require an investigation and recommendation of a qualified engineer to demonstrate that the intent of this section has been satisfied. Such an investigation shall include consideration of material, height of slope, slope gradient, load intensity and erosion characteristics of slope material.

R403.1.8 Foundations on expansive soils. Foundation and floor slabs for buildings located on expansive soils shall be designed in accordance with Section 1805.8 of the *International Building Code*.

Exception: Slab-on-ground and other foundation systems which have performed adequately in soil conditions similar to those encountered at the building site are permitted subject to the approval of the building official.

R403.1.8.1 Expansive soils classifications. Soils meeting all four of the following provisions shall be consid-

ered expansive, except that tests to show compliance with Items 1, 2 and 3 shall not be required if the test prescribed in Item 4 is conducted:

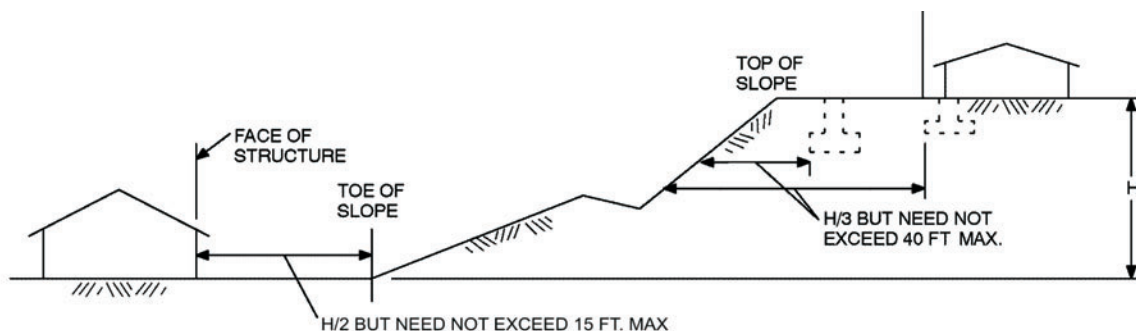
1. Plasticity Index (PI) of 15 or greater, determined in accordance with ASTM D 4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75 mm), determined in accordance with ASTM D 422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D 422.
4. Expansion Index greater than 20, determined in accordance with ASTM D 4829.

R403.2 Footings for wood foundations. Footings for wood foundations shall be in accordance with Figures R403.1(2) and R403.1(3). Gravel shall be washed and well graded. The maximum size stone shall not exceed 3/4 inch (19.1 mm). Gravel shall be free from organic, clayey or silty soils. Sand shall be coarse, not smaller than 1/16-inch (1.6 mm) grains and shall be free from organic, clayey or silty soils. Crushed stone shall have a maximum size of 1/2 inch (12.7 mm).

R403.3 Frost protected shallow foundations. For buildings where the monthly mean temperature of the building is maintained at a minimum of 64°F (18°C), footings are not required to extend below the frost line when protected from frost by insulation in accordance with Figure R403.3(1) and Table R403.3. Foundations protected from frost in accordance with Figure R403.3(1) and Table R403.3 shall not be used for unheated spaces such as porches, utility rooms, garages and carports, and shall not be attached to basements or crawl spaces that are not maintained at a minimum monthly mean temperature of 64°F (18°C).

Materials used below grade for the purpose of insulating footings against frost shall be labeled as complying with ASTM C 578.

R403.3.1 Foundations adjoining frost protected shallow foundations. Foundations that adjoin frost protected shallow foundations shall be protected from frost in accordance with Section R403.1.4.



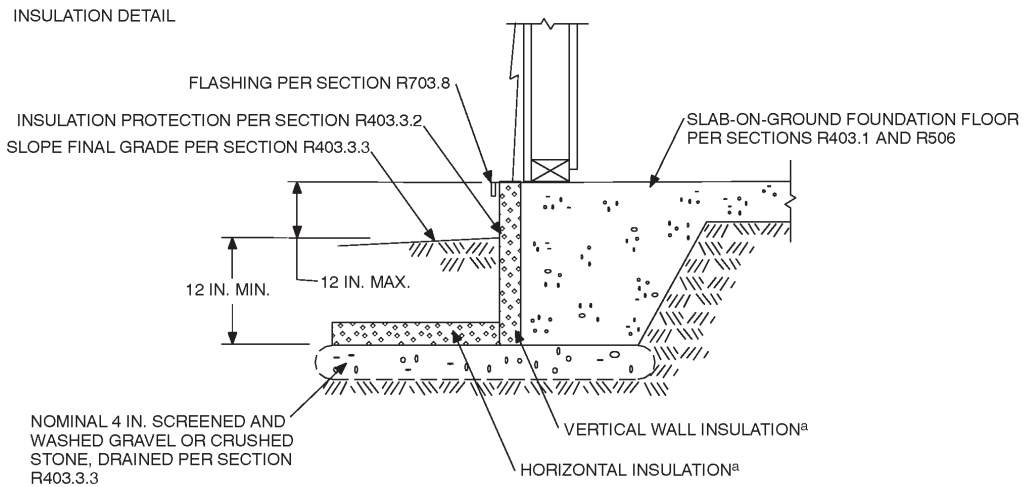
For SI: 1 foot = 304.8 mm.

FIGURE R403.1.7.1
FOUNDATION CLEARANCE FROM SLOPES

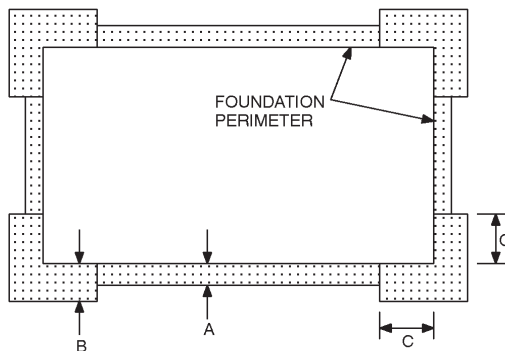
TABLE R403.3
MINIMUM INSULATION REQUIREMENTS FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS^a

AIR FREEZING INDEX (°F-days) ^b	VERTICAL INSULATION R-VALUE ^{c,d}	HORIZONTAL INSULATION R-VALUE ^{c,e}		HORIZONTAL INSULATION DIMENSIONS PER FIGURE R403.3(1) (inches)		
		Along walls	At corners	A	B	C
1,500 or less	4.5	Not required	Not required	Not required	Not required	Not required
2,000	5.6	Not required	Not required	Not required	Not required	Not required
2,500	6.7	1.7	4.9	12	24	40
3,000	7.8	6.5	8.6	12	24	40
3,500	9.0	8.0	11.2	24	30	60
4,000	10.1	10.5	13.1	24	36	60

- a. Insulation requirements are for protection against frost damage in heated buildings. Greater values may be required to meet energy conservation standards. Interpolation between values is permissible.
- b. See Figure R403.3(2) for Air Freezing Index values.
- c. Insulation materials shall provide the stated minimum R-values under long-term exposure to moist, below-ground conditions in freezing climates. The following R-values shall be used to determine insulation thicknesses required for this application: Type II expanded polystyrene—2.4R per inch; Type IV extruded polystyrene—4.5R per inch; Type VI extruded polystyrene—4.5R per inch; Type IX expanded polystyrene—3.2R per inch; Type X extruded polystyrene—4.5R per inch.
- d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.
- e. Horizontal insulation shall be extruded polystyrene insulation.



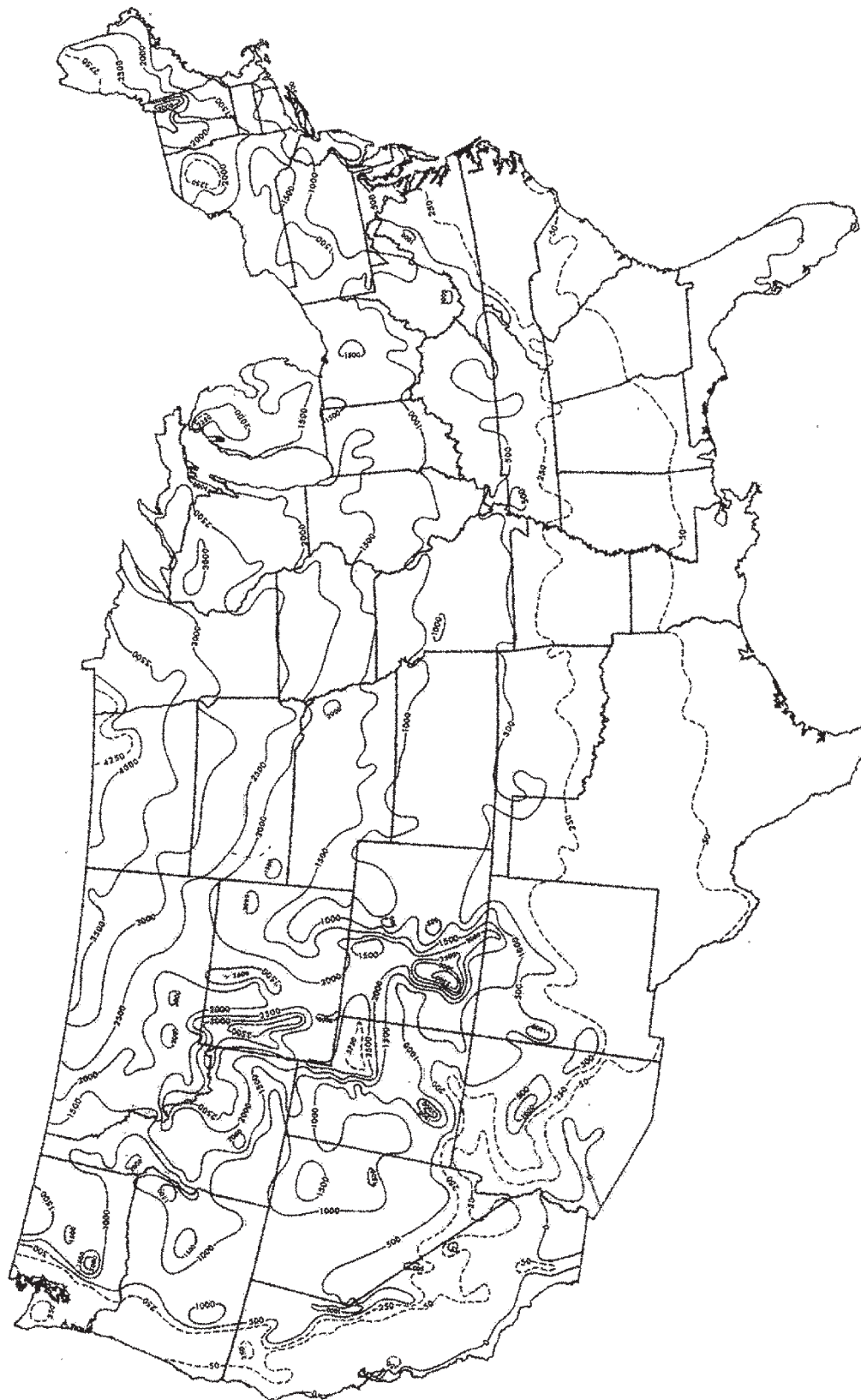
HORIZONTAL INSULATION PLAN



For SI: 1 inch = 25.4 mm.

- a. See Table R403.3 for required dimensions and R-values for vertical and horizontal insulation.

FIGURE R403.3(1)
INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS

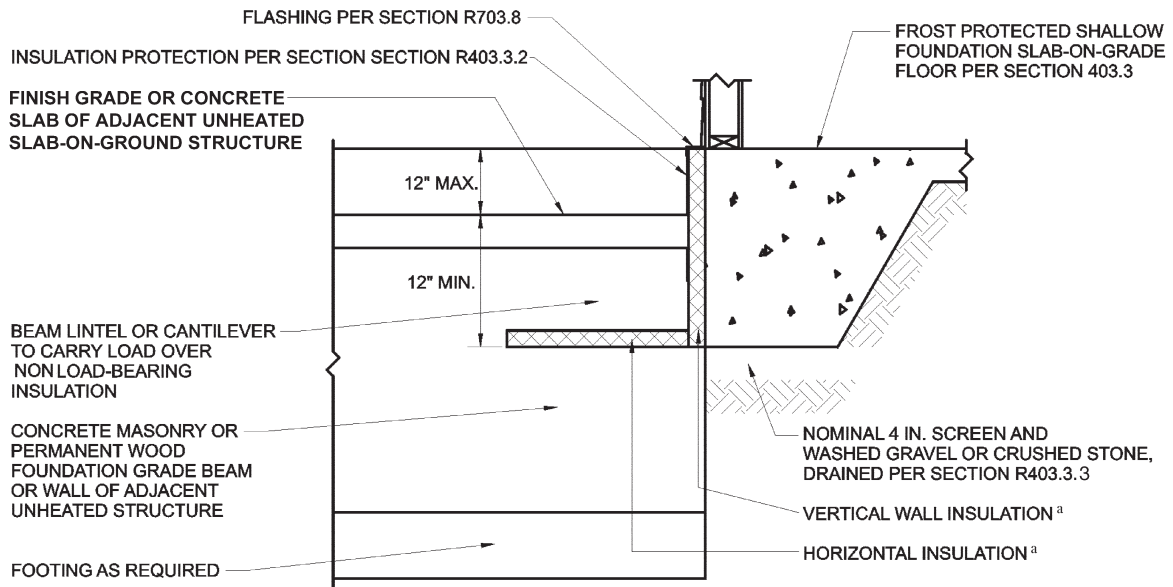


For SI: $^{\circ}\text{C} = [(^{\circ}\text{F}) - 32] / 1.8$.

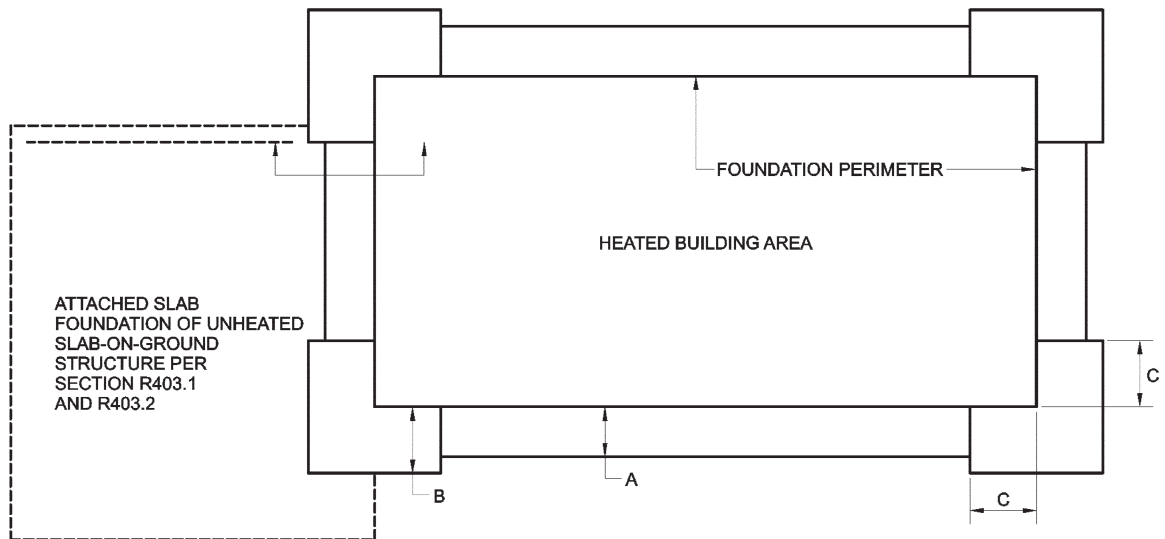
NOTE: The air-freezing index is defined as cumulative degree days below 32°F. It is used as a measure of the combined magnitude and duration of air temperature below freezing. The index was computed over a 12-month period (July-June) for each of the 3,044 stations used in the above analysis. Data from the 1951-80 period were fitted to a Weibull probability distribution to produce an estimate of the 100-year return period.

FIGURE R403.3(2)
AIR-FREEZING INDEX
AN ESTIMATE OF THE 100-YEAR RETURN PERIOD

INSULATION DETAIL



HORIZONTAL INSULATION PLAN



For SI: 1 inch = 25.4 mm.

a. See Table R403.3 for required dimensions and *R*-values for vertical and horizontal insulation.

FIGURE R403.3(3)
INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS
ADJACENT TO UNHEATED SLAB-ON-GROUND STRUCTURE

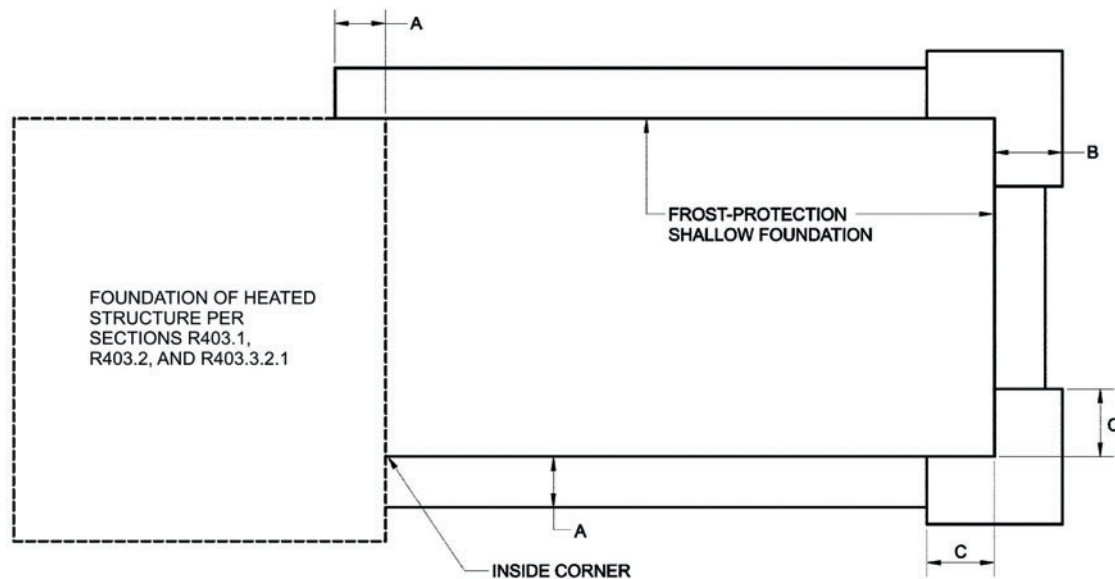


FIGURE R403.3(4)
INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS ADJACENT TO HEATED STRUCTURE

R403.3.1.1 Attachment to unheated slab-on-ground structure. Vertical wall insulation and horizontal insulation of frost protected shallow foundations that adjoin a slab-on-ground foundation that does not have a monthly mean temperature maintained at a minimum of 64°F (18°C), shall be in accordance with Figure R403.3(3) and Table R403.3. Vertical wall insulation shall extend between the frost protected shallow foundation and the adjoining slab foundation. Required horizontal insulation shall be continuous under the adjoining slab foundation and through any foundation walls adjoining the frost protected shallow foundation. Where insulation passes through a foundation wall, it shall either be of a type complying with this section and having bearing capacity equal to or greater than the structural loads imposed by the building, or the building shall be designed and constructed using beams, lintels, cantilevers or other means of transferring building loads such that the structural loads of the building do not bear on the insulation.

R403.3.1.2 Attachment to heated structure. Where a frost protected shallow foundation abuts a structure that has a monthly mean temperature maintained at a minimum of 64°F (18°C), horizontal insulation and vertical wall insulation shall not be required between the frost protected shallow foundation and the adjoining structure. Where the frost protected shallow foundation abuts the heated structure, the horizontal insulation and vertical wall insulation shall extend along the adjoining foundation in accordance with Figure R403.3(4) a distance of not less than Dimension A in Table R403.3.

Exception: Where the frost protected shallow foundation abuts the heated structure to form an inside corner, vertical insulation extending along the adjoining foundation is not required.

R403.3.2 Protection of horizontal insulation below ground. Horizontal insulation placed less than 12 inches (305 mm) below the ground surface or that portion of horizontal insulation extending outward more than 24 inches (610 mm) from the foundation edge shall be protected against damage by use of a concrete slab or asphalt paving on the ground surface directly above the insulation or by cementitious board, plywood rated for below-ground use, or other approved materials placed below ground, directly above the top surface of the insulation.

R403.3.3 Drainage. Final grade shall be sloped in accordance with Section R401.3. In other than Group I Soils, as detailed in Table R405.1, gravel or crushed stone beneath horizontal insulation below ground shall drain to daylight or into an approved sewer system.

R403.3.4 Termite damage. The use of foam plastic in areas of “very heavy” termite infestation probability shall be in accordance with Section R320.5.

SECTION R404 FOUNDATION AND RETAINING WALLS

R404.1 Concrete and masonry foundation walls. Concrete and masonry foundation walls shall be selected and constructed in accordance with Section R404 or in accordance with ACI 318, ACI 332, NCMA TR68–A or ACI 530/ASCE 5/TMS 402 or other approved structural standards.

FOUNDATIONS

TABLE R404.1(1)—TOP REACTIONS AND PRESCRIPTIVE SUPPORT FOR FOUNDATION WALLS^a (Table deleted)

TABLE R404.1(2)—MAXIMUM PLATE ANCHOR-BOLT SPACING FOR SUPPORTED FOUNDATION WALL^a (Table deleted)

TABLE R404.1(3)—MAXIMUM ASPECT RATIO, L/W FOR UNBALANCED FOUNDATIONS (Table deleted)

R404.1.1 Masonry foundation walls. Concrete masonry and clay masonry foundation walls shall be constructed as set forth in Table R404.1.1(1), R404.1.1(2), R404.1.1(3) or R404.1.1(4) and shall also comply with the provisions of Section R404 and the applicable provisions of Sections R606, R607 and R608. In Seismic Design Categories D₀, D₁ and D₂, concrete masonry and clay masonry foundation walls shall also comply with Section R404.1.4. Rubble stone masonry foundation walls shall be constructed in accordance with Sections R404.1.8 and R607.2.2. Rubble

stone masonry walls shall not be used in Seismic Design Categories D₀, D₁ and D₂.

R404.1.2 Concrete foundation walls. Concrete foundation walls shall be constructed as set forth in Table R404.1.1(5) and shall also comply with the provisions of Section R404 and the applicable provisions of Section R402.2. In Seismic Design Categories D₀, D₁ and D₂, concrete foundation walls shall also comply with Section R404.1.4.

R404.1.3 Design required. Concrete or masonry foundation walls shall be designed in accordance with accepted engineering practice when either of the following conditions exists:

1. Walls are subject to hydrostatic pressure from groundwater.
2. Walls supporting more than 48 inches (1219 mm) of unbalanced backfill that do not have permanent lateral support at the top or bottom.

**TABLE R404.1.1(1)
PLAIN MASONRY FOUNDATION WALLS**

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^c (feet)	PLAIN MASONRY ^a MINIMUM NOMINAL WALL THICKNESS (inches)		
		Soil classes ^b		
		GW, GP, SW and SP	GM, GC, SM, SM-SC and ML	SC, MH, ML-CL and inorganic CL
5	4	6 solid ^d or 8	6 solid ^d or 8	6 solid ^d or 8
	5	6 solid ^d or 8	8	10
6	4	6 solid ^d or 8	6 solid ^d or 8	6 solid ^d or 8
	5	6 solid ^d or 8	8	10
	6	8	10	12
7	4	6 solid ^d or 8	8	8
	5	6 solid ^d or 8	10	10
	6	10	12	10 solid ^d
	7	12	10 solid ^d	12 solid ^d
8	4	6 solid ^d or 8	6 solid ^d or 8	8
	5	6 solid ^d or 8	10	12
	6	10	12	12 solid ^d
	7	12	12 solid ^d	Note e
9	8	10 solid ^d	12 solid ^d	Note e
	4	6 solid ^d or 8	6 solid ^d or 8	8
	5	8	10	12
	6	10	12	12 solid ^d
	7	12	12 solid ^d	Note e
9	8	12 solid ^d	Note e	Note e
	9	Note e	Note e	Note e

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 Pa.

- a. Mortar shall be Type M or S and masonry shall be laid in running bond. UngROUTED hollow masonry units are permitted except where otherwise indicated.
- b. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.
- c. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.
- d. Solid grouted hollow units or solid masonry units.
- e. Wall construction shall be in accordance with Table R404.1.1(2) or a design shall be provided.

**TABLE R404.1.1(2)
8-INCH MASONRY FOUNDATION WALLS WITH REINFORCING
WHERE d > 5 INCHES^a**

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL ^e	MINIMUM VERTICAL REINFORCEMENT ^{b,c}		
		Soil classes and lateral soil load ^d (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5 feet	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	6 feet 8 inches	#4 at 48" o.c.	#5 at 48" o.c.	#6 at 48" o.c.
7 feet 4 inches	4 feet (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5 feet	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	6 feet	#4 at 48" o.c.	#5 at 48" o.c.	#5 at 48" o.c.
	7 feet 4 inches	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 40" o.c.
8 feet	4 feet (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5 feet	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	6 feet	#4 at 48" o.c.	#5 at 48" o.c.	#5 at 48" o.c.
	7 feet	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 40" o.c.
	8 feet	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 32" o.c.
8 feet 8 inches	4 feet (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5 feet	#4 at 48" o.c.	#4 at 48" o.c.	#5 at 48" o.c.
	6 feet	#4 at 48" o.c.	#5 at 48" o.c.	#6 at 48" o.c.
	7 feet	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 40" o.c.
	8 feet 8 inches	#6 at 48" o.c.	#6 at 32" o.c.	#6 at 24" o.c.
9 feet 4 inches	4 feet (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5 feet	#4 at 48" o.c.	#4 at 48" o.c.	#5 at 48" o.c.
	6 feet	#4 at 48" o.c.	#5 at 48" o.c.	#6 at 48" o.c.
	7 feet	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 40" o.c.
	9 feet 4 inches	#6 at 48" o.c.	#6 at 40" o.c.	#6 at 24" o.c.
10 feet	4 feet (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5 feet	#4 at 48" o.c.	#4 at 48" o.c.	#5 at 48" o.c.
	6 feet	#4 at 48" o.c.	#5 at 48" o.c.	#6 at 48" o.c.
	7 feet	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 32" o.c.
	8 feet	#6 at 48" o.c.	#6 at 32" o.c.	#6 at 24" o.c.
	9 feet	#6 at 40" o.c.	#6 at 24" o.c.	#6 at 16" o.c.
	10 feet	#6 at 32" o.c.	#6 at 16" o.c.	#6 at 16" o.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

- a. Mortar shall be Type M or S and masonry shall be laid in running bond.
- b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches.
- c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be at least 5 inches.
- d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.
- e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

TABLE R404.1.1(3)
10-INCH MASONRY FOUNDATION WALLS WITH REINFORCING
WHERE d > 6.75 INCHES^a

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL ^e	MINIMUM VERTICAL REINFORCEMENT ^{b, c}		
		Soil classes and later soil load ^d (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, MH, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5 feet	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6 feet 8 inches	#4 at 56" o.c.	#5 at 56" o.c.	#5 at 56" o.c.
7 feet 4 inches	4 feet (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5 feet	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6 feet	#4 at 56" o.c.	#4 at 56" o.c.	#5 at 56" o.c.
	7 feet 4 inches	#4 at 56" o.c.	#5 at 56" o.c.	#6 at 56" o.c.
8 feet	4 feet (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5 feet	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6 feet	#4 at 56" o.c.	#4 at 56" o.c.	#5 at 56" o.c.
	7 feet	#4 at 56" o.c.	#5 at 56" o.c.	#6 at 56" o.c.
	8 feet	#5 at 56" o.c.	#6 at 56" o.c.	#6 at 48" o.c.
8 feet 8 inches	4 feet (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5 feet	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6 feet	#4 at 56" o.c.	#4 at 56" o.c.	#5 at 56" o.c.
	8 feet 8 inches	#5 at 56" o.c.	#6 at 48" o.c.	#6 at 32" o.c.
9 feet 4 inches	4 feet (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5 feet	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6 feet	#4 at 56" o.c.	#5 at 56" o.c.	#5 at 56" o.c.
	7 feet	#4 at 56" o.c.	#5 at 56" o.c.	#6 at 56" o.c.
	9 feet 4 inches	#6 at 56" o.c.	#6 at 40" o.c.	#6 at 24" o.c.
10 feet	4 feet (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5 feet	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6 feet	#4 at 56" o.c.	#5 at 56" o.c.	#5 at 56" o.c.
	7 feet	#5 at 56" o.c.	#6 at 56" o.c.	#6 at 48" o.c.
	8 feet	#5 at 56" o.c.	#6 at 48" o.c.	#6 at 40" o.c.
	10 feet	#6 at 48" o.c.	#6 at 32" o.c.	#6 at 24" o.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

- a. Mortar shall be Type M or S and masonry shall be laid in running bond.
- b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches.
- c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be at least 6.75 inches.
- d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.
- e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab-on-grade is provided and is in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height from the exterior finish ground level to the top of the interior concrete slab is permitted.

TABLE R404.1.1(4)
12-INCH MASONRY FOUNDATION WALLS WITH REINFORCING
WHERE d > 8.75 INCHES^a

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL ^e	MINIMUM VERTICAL REINFORCEMENT ^{b, c}		
		Soil classes and lateral soil load ^d (psf per foot below grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, ML-CL and inorganic CL soils 60
6 feet 8 inches	4 feet (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5 feet	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6 feet 8 inches	#4 at 72" o.c.	#4 at 72" o.c.	#5 at 72" o.c.
7 feet 4 inches	4 feet (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5 feet	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6 feet	#4 at 72" o.c.	#4 at 72" o.c.	#5 at 72" o.c.
	7 feet 4 inches	#4 at 72" o.c.	#5 at 72" o.c.	#6 at 72" o.c.
8 feet	4 feet (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5 feet	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6 feet	#4 at 72" o.c.	#4 at 72" o.c.	#5 at 72" o.c.
	7 feet	#4 at 72" o.c.	#5 at 72" o.c.	#6 at 72" o.c.
	8 feet	#5 at 72" o.c.	#6 at 72" o.c.	#6 at 64" o.c.
8 feet 8 inches	4 feet (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5 feet	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6 feet	#4 at 72" o.c.	#4 at 72" o.c.	#5 at 72" o.c.
	7 feet	#4 at 72" o.c.	#5 at 72" o.c.	#6 at 72" o.c.
	8 feet 8 inches	#5 at 72" o.c.	#7 at 72" o.c.	#6 at 48" o.c.
9 feet 4 inches	4 feet (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5 feet	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6 feet	#4 at 72" o.c.	#5 at 72" o.c.	#5 at 72" o.c.
	7 feet	#4 at 72" o.c.	#5 at 72" o.c.	#6 at 72" o.c.
	9 feet 4 inches	#5 at 72" o.c.	#6 at 72" o.c.	#6 at 56" o.c.
10 feet	4 feet (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5 feet	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6 feet	#4 at 72" o.c.	#5 at 72" o.c.	#5 at 72" o.c.
	7 feet	#4 at 72" o.c.	#6 at 72" o.c.	#6 at 72" o.c.
	8 feet	#5 at 72" o.c.	#6 at 72" o.c.	#6 at 48" o.c.
	9 feet	#6 at 72" o.c.	#6 at 56" o.c.	#6 at 40" o.c.
	10 feet	#6 at 64" o.c.	#6 at 40" o.c.	#6 at 32" o.c.

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot per foot = 0.157 kPa/mm.

- a. Mortar shall be Type M or S and masonry shall be laid in running bond.
- b. Alternative reinforcing bar sizes and spacings having an equivalent cross-sectional area of reinforcement per lineal foot of wall shall be permitted provided the spacing of the reinforcement does not exceed 72 inches.
- c. Vertical reinforcement shall be Grade 60 minimum. The distance from the face of the soil side of the wall to the center of vertical reinforcement shall be at least 8.75 inches.
- d. Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist conditions without hydrostatic pressure. Refer to Table R405.1.
- e. Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground levels. Where an interior concrete slab-on-grade is provided and in contact with the interior surface of the foundation wall, measurement of the unbalanced backfill height is permitted to be measured from the exterior finish ground level to the top of the interior concrete slab is permitted.

**TABLE R404.1.1(5)
CONCRETE FOUNDATION WALLS^{h, i, j, k}**

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^b (feet)	MINIMUM VERTICAL REINFORCEMENT SIZE AND SPACING ^{c, d, e, f, l}											
		Soil classes ^a and design lateral soil (psf per foot of depth)											
		GW, GP, SW and SP 30				GM, GC, SM, SM-SC and ML 45				SC, ML-CL and inorganic CL 60			
		Minimum wall thickness (inches)											
		5.5	7.5	9.5	11.5	5.5	7.5	9.5	11.5	5.5	7.5	9.5	11.5
5	4	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
6	4	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC ^g	PC	PC	PC	PC	PC	PC
	6	PC	PC	PC	PC	#5@48"	PC	PC	PC	#5@36"	PC	PC	PC
7	4	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	PC	PC	PC	PC	#5@47"	PC	PC	PC
	6	PC	PC	PC	PC	#5@42"	PC	PC	PC	#6@43"	#5@48"	PC ^g	PC
	7	#5@46"	PC	PC	PC	#6@42"	#5@46"	PC ^g	PC	#6@34"	#6@48"	PC	PC
8	4	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	#4@38"	PC ^g	PC	PC	#5@43"	PC	PC	PC
	6	#4@37"	PC ^g	PC	PC	#5@37"	PC	PC	PC	#6@37"	#5@43"	PC ^g	PC
	7	#5@40"	PC	PC	PC	#6@37"	#5@41"	PC	PC	#6@34"	#6@43"	PC	PC
	8	#6@43"	#5@47"	PC ^g	PC	#6@34"	#6@43"	PC	PC	#6@27"	#6@32"	#6@44"	PC
9	4	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	#4@35"	PC ^g	PC	PC	#5@40"	PC	PC ^e	PC
	6	#4@34"	PC ^g	PC	PC	#6@48"	PC	PC	PC	#6@36"	#5@39"	PC ^g	PC
	7	#5@36"	PC	PC	PC	#6@34"	#5@37"	PC	PC	#6@33"	#6@38"	#5@37"	PC ^g
	8	#6@38"	#5@41"	PC ^g	PC	#6@33"	#6@38"	#5@37"	PC ^g	#6@24"	#7@39"	#6@39"	#4@48" ^h
	9	#6@34"	#6@46"	PC	PC	#6@26"	#7@41"	#6@41"	PC	#6@19"	#7@31"	#7@41"	#6@39"
10	4	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC	PC
	5	PC	PC	PC	PC	#4@33"	PC ^g	PC	PC	#5@38"	PC	PC	PC
	6	#5@48"	PC ^g	PC	PC	#6@45"	PC	PC	PC	#6@34"	#5@37"	PC	PC
	7	#6@47"	PC	PC	PC	#6@34"	#6@48"	PC	PC	#6@30"	#6@35"	#6@48"	PC ^g
	8	#6@34"	#5@38"	PC	PC	#6@30"	#7@47"	#6@47"	PC ^g	#6@22"	#7@35"	#7@48"	#6@45" ^h
	9	#6@34"	#6@41"	#4@48"	PC ^g	#6@23"	#7@37"	#7@48"	#4@48" ^h	DR	#6@22"	#7@37"	#7@47"
	10	#6@28"	#7@45"	#6@45"	PC	DR	#7@31"	#7@40"	#6@38"	DR	#6@22"	#7@30"	#7@38"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 kPa; 1 pound per square foot per foot = 0.157 kPa/mm.

- a. Soil classes are in accordance with the United Soil Classification System. Refer to Table R405.1
- b. Unbalanced backfill height is the difference in height of the exterior and interior finish ground levels. Where there is an interior concrete slab, the unbalanced backfill height shall be measured from the exterior finish ground level to the top of the interior concrete slab.
- c. The size and spacing of vertical reinforcement shown in the table is based on the use of reinforcement with a minimum yield strength of 60,000 psi. Vertical reinforcement with a minimum yield strength of 40,000 psi or 50,000 psi is permitted, provided the same size bar is used and the spacing shown in the table is reduced by multiplying the spacing by 0.67 or 0.83, respectively.
- d. Vertical reinforcement, when required, shall be placed nearest the inside face of the wall a distance d from the outside face (soil side) of the wall. The distance d is equal to the wall thickness, t, minus 1.25 inches plus one-half the bar diameter, db (d = t - (1.25 + db/2)). The reinforcement shall be placed within a tolerance of $\pm 3/8$ inch where d is less than or equal to 8 inches, or $\pm 1/2$ inch where d is greater than 8 inches.
- e. In lieu of the reinforcement shown, smaller reinforcing bar sizes and closer spacings resulting in an equivalent cross-sectional area of reinforcement per linear foot of wall are permitted.
- f. Concrete cover for reinforcement measured from the inside face of the wall shall not be less than $3/4$ inch. Concrete cover for reinforcement measured from the outside face of the wall shall not be less than $1 1/2$ inches for No. 5 bars and smaller, and not less than 2 inches for larger bars.
- g. The minimum thickness is permitted to be reduced 2 inches, provided the minimum specified compressive strength of concrete f'_c is 4,000 psi.

(continued)

TABLE R404.1.1(5)—continued
CONCRETE FOUNDATION WALLS^{h, l, i, k}

- h. A plain concrete wall with a minimum thickness of 11.5 inches is permitted, provided minimum specified compressive strength of concrete, f'_c , is 3,500 psi.
- i. Concrete shall have a specified compressive strength of not less than 2,500 psi at 28 days, unless a higher strength is required by note g or h.
- j. “DR” means design is required in accordance with ACI 318 or ACI 332.
- k. “PC” means plain concrete.
- l. Where vertical reinforcement is required, horizontal reinforcement shall be provided in accordance with the requirements of Section R404.4.6.2 for ICF foundation walls.

R404.1.4 Seismic Design Categories D₀, D₁ and D₂. In addition to the requirements of Tables R404.1.1(1) and R404.1.1(5), plain concrete and plain masonry foundation walls located in Seismic Design Categories D₀, D₁ and D₂, as established in Table R301.2(1), shall comply with the following.

1. Wall height shall not exceed 8 feet (2438 mm).
2. Unbalanced backfill height shall not exceed 4 feet (1219 mm).
3. Minimum reinforcement for plain concrete foundation walls shall consist of one No. 4 (No. 13) horizontal bar located in the upper 12 inches (305 mm) of the wall.
4. Minimum thickness for plain concrete foundation walls shall be 7.5 inches (191 mm) except that 6 inches (152 mm) is permitted when the maximum height is 4 feet, 6 inches (1372 mm).
5. Minimum nominal thickness for plain masonry foundation walls shall be 8 inches (203 mm).
6. Masonry stem walls shall have a minimum vertical reinforcement of one No. 3 (No. 10) bar located a maximum of 4 feet (1220 mm) on center in grouted cells. Vertical reinforcement shall be tied to the horizontal reinforcement in the footings.

Foundation walls located in Seismic Design Categories D₀, D₁ and D₂, as established in Table R301.2(1), supporting more than 4 feet (1219 mm) of unbalanced backfill or exceeding 8 feet (2438 mm) in height shall be constructed in accordance with Table R404.1.1(2), R404.1.1(3) or R404.1.1(4) for masonry, or Table R404.1.1(5) for concrete. Where Table R404.1.1(5) permits plain concrete walls, not less than No. 4 (No. 13) vertical bars at a spacing not exceeding 48 inches (1219 mm) shall be provided. Insulating concrete form foundation walls shall be reinforced as required in Table R404.4(1), R404.4(2), R404.4(3), R404.4(4) or R404.4(5). Where no vertical reinforcement is required by Table R404.4(2), R404.4(3) or R404.4(4) there shall be a minimum of one No. 4 (No. 13) bar at 48 inches (1220 mm) on center. All concrete and masonry foundation walls shall have two No. 4 (No. 13) horizontal bars located in the upper 12 inches (305 mm) of the wall.

R404.1.5 Foundation wall thickness based on walls supported. The thickness of concrete and masonry foundation walls shall not be less than the thickness of the wall supported, except that foundation walls of at least 8-inch (203 mm) nominal thickness shall be permitted under brick-veneered frame walls and under 10-inch-wide (254 mm) cavity walls where the total height of the wall supported, including gables, is not more than 20 feet (6096 mm), provided the requirements of Sections R404.1.1 and R404.1.2 are met.

R404.1.5.1 Pier and curtain wall foundations. Use of pier and curtain wall foundations shall be permitted to support light-frame construction not more than two stories in height, provided the following requirements are met:

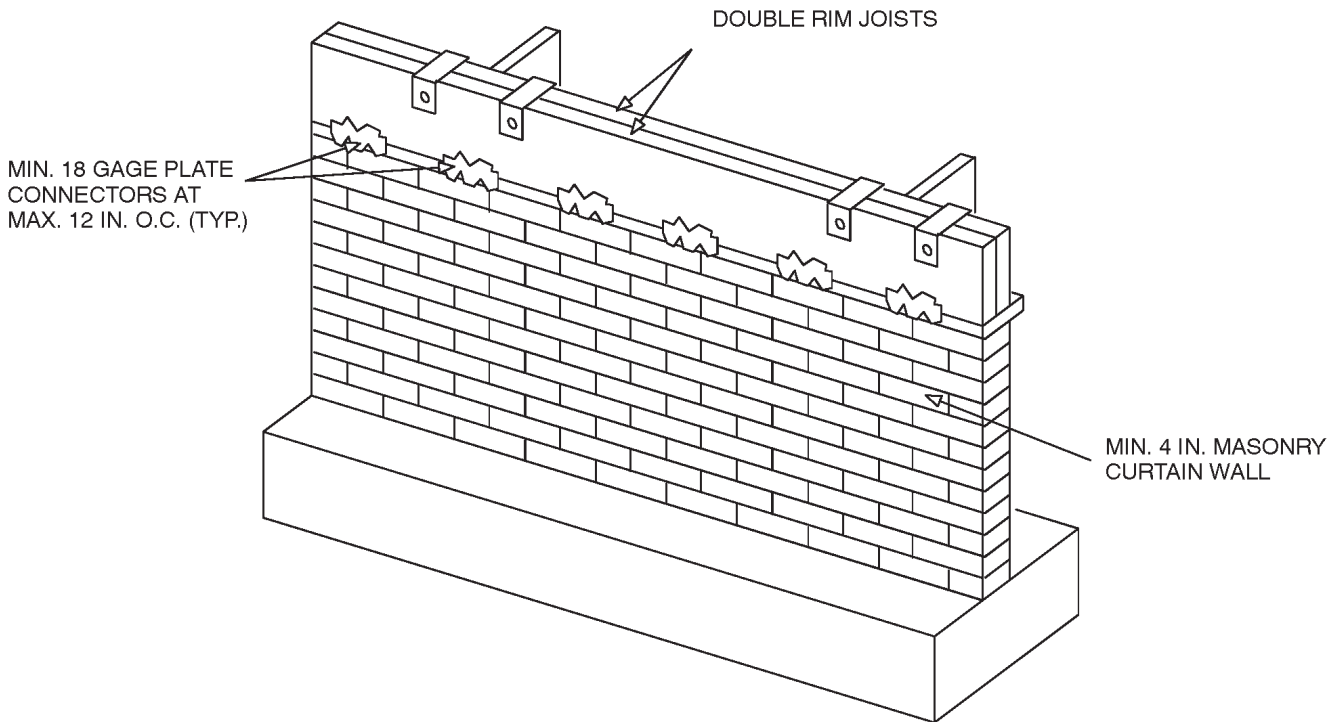
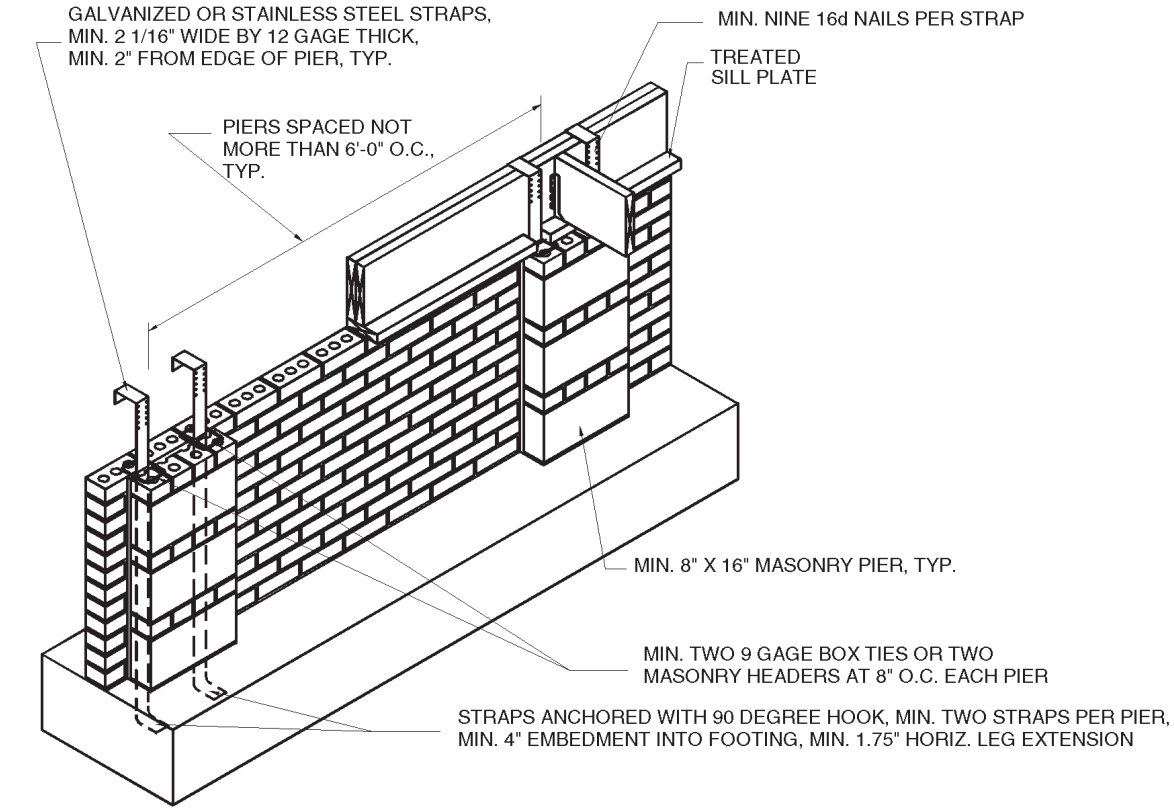
1. All load-bearing walls shall be placed on continuous concrete footings placed integrally with the exterior wall footings.
2. The minimum actual thickness of a load-bearing masonry wall shall be not less than 4 inches (102 mm) nominal or 3³/₈ inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced in accordance with Section R606.9.
3. Piers shall be constructed in accordance with Section R606.6 and Section R606.6.1, and shall be bonded into the load-bearing masonry wall in accordance with Section R608.1.1 or Section R608.1.1.2.
4. The maximum height of a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood-frame walls and floors shall not be more than 4 feet (1219 mm).
5. Anchorage shall be in accordance with Section R403.1.6, Figure R404.1.5(1), or as specified by engineered design accepted by the building official.
6. The unbalanced fill for 4-inch (102 mm) foundation walls shall not exceed 24 inches (610 mm) for solid masonry or 12 inches (305 mm) for hollow masonry.
7. In Seismic Design Categories D₀, D₁ and D₂, prescriptive reinforcement shall be provided in the horizontal and vertical direction. Provide minimum horizontal joint reinforcement of two No.9 gage wires spaced not less than 6 inches (152 mm) or one 1/4 inch (6.4 mm) diameter wire at 10 inches (254 mm) on center vertically. Provide minimum vertical reinforcement of one No. 4 bar at 48 inches (1220 mm) on center horizontally grouted in place.

R404.1.6 Height above finished grade. Concrete and masonry foundation walls shall extend above the finished grade adjacent to the foundation at all points a minimum of 4 inches (102 mm) where masonry veneer is used and a minimum of 6 inches (152 mm) elsewhere.

R404.1.7 Backfill placement. Backfill shall not be placed against the wall until the wall has sufficient strength and has been anchored to the floor above, or has been sufficiently braced to prevent damage by the backfill.

Exception: Bracing is not required for walls supporting less than 4 feet (1219 mm) of unbalanced backfill.

FOUNDATIONS



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0157 rad.

**FIGURE R404.1.5(1)
FOUNDATION WALL CLAY MASONRY CURTAIN WALL WITH CONCRETE MASONRY PIERS**

R404.1.8 Rubble stone masonry. Rubble stone masonry foundation walls shall have a minimum thickness of 16 inches (406 mm), shall not support an unbalanced backfill exceeding 8 feet (2438 mm) in height, shall not support a soil pressure greater than 30 pounds per square foot per foot (4.71 kPa/m), and shall not be constructed in Seismic Design Categories D₀, D₁, D₂ or townhouses in Seismic Design Category C, as established in Figure R301.2(2).

R404.2 Wood foundation walls. Wood foundation walls shall be constructed in accordance with the provisions of Sections R404.2.1 through R404.2.6 and with the details shown in Figures R403.1(2) and R403.1(3).

R404.2.1 Identification. All load-bearing lumber shall be identified by the grade mark of a lumber grading or inspection agency which has been approved by an accreditation body that complies with DOC PS 20. In lieu of a grade mark, a certificate of inspection issued by a lumber grading or inspection agency meeting the requirements of this section shall be accepted.

Wood structural panels shall conform to DOC PS 1 or DOC PS 2 and shall be identified by a grade mark or certificate of inspection issued by an approved agency.

R404.2.2 Stud size. The studs used in foundation walls shall be 2-inch by 6-inch (51 mm by 152 mm) members. When spaced 16 inches (406 mm) on center, a wood species with an F_b value of not less than 1,250 pounds per square inch (8612 kPa) as listed in AF&PA/NDS shall be used. When spaced 12 inches (305 mm) on center, an F_b of not less than 875 psi (6029 kPa) shall be required.

R404.2.3 Height of backfill. For wood foundations that are not designed and installed in accordance with AF&PA Report No.7, the height of backfill against a foundation wall shall not exceed 4 feet (1219 mm). When the height of fill is more than 12 inches (305 mm) above the interior grade of a crawl space or floor of a basement, the thickness of the plywood sheathing shall meet the requirements of Table R404.2.3.

**TABLE R404.2.3
PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION
(30 pcf equivalent-fluid weight soil pressure)**

HEIGHT OF FILL (inches)	STUD SPACING (inches)	FACE GRAIN ACROSS STUDS			FACE GRAIN PARALLEL TO STUDS		
		Grade ^a	Minimum thickness (inches)	Span rating	Grade ^a	Minimum thickness (inches) ^{b,c}	Span rating
24	12	B	15/32	32/16	A	15/32	32/16
					B	15/32 ^c	32/16
	16	B	15/32	32/16	A	15/32 ^c	32/16
					B	19/32 ^c (4, 5 ply)	40/20
36	12	B	15/32	32/16	A	15/32	32/16
					B	15/32 ^c (4, 5 ply)	32/16
	16	B	15/32 ^c	32/16	A	19/32	40/20
					B	23/32	48/24
48	12	B	15/32	32/16	A	15/32 ^c	32/16
					B	19/32 ^c (4, 5 ply)	40/20
	16	B	19/32	40/20	A	19/32 ^c	40/20
					A	23/32	48/24

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per cubic foot = 0.1572 kN/m³.

a. Plywood shall be of the following minimum grades in accordance with DOC PS 1 or DOC PS 2:

1. DOC PS 1 Plywood grades marked:
 - 1.1. Structural I C-D (Exposure 1)
 - 1.2. C-D (Exposure 1)
2. DOC PS 2 Plywood grades marked:
 - 2.1. Structural I Sheathing (Exposure 1)
 - 2.2. Sheathing (Exposure 1)
3. Where a major portion of the wall is exposed above ground and a better appearance is desired, the following plywood grades marked exterior are suitable:
 - 3.1. Structural I A-C, Structural I B-C or Structural I C-C (Plugged) in accordance with DOC PS 1
 - 3.2. A-C Group 1, B-C Group 1, C-C (Plugged) Group 1 or MDO Group 1 in accordance with DOC PS 1
 - 3.3. Single Floor in accordance with DOC PS 1 or DOC PS 2

b. Minimum thickness 15/32 inch, except crawl space sheathing may be 3/8 inch for face grain across studs 16 inches on center and maximum 2-foot depth of unequal fill.

c. For this fill height, thickness and grade combination, panels that are continuous over less than three spans (across less than three stud spacings) require blocking 16 inches above the bottom plate. Offset adjacent blocks and fasten through studs with two 16d corrosion-resistant nails at each end.

R404.2.4 Backfilling. Wood foundation walls shall not be backfilled until the basement floor and first floor have been constructed or the walls have been braced. For crawl space construction, backfill or bracing shall be installed on the interior of the walls prior to placing backfill on the exterior.

R404.2.5 Drainage and dampproofing. Wood foundation basements shall be drained and dampproofed in accordance with Sections R405 and R406, respectively.

R404.2.6 Fastening. Wood structural panel foundation wall sheathing shall be attached to framing in accordance with Table R602.3(1) and Section R402.1.1.

R404.3 Wood sill plates. Wood sill plates shall be a minimum of 2-inch by 4-inch (51 mm by 102 mm) nominal lumber. Sill plate anchorage shall be in accordance with Sections R403.1.6 and R602.11.

R404.4 Insulating concrete form foundation walls. Insulating concrete form (ICF) foundation walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of ACI 318. When ACI 318 or the provisions of this section are used to design insulating concrete form foundation walls, project drawings, typical details and specifications are not required to bear the seal of the architect or engineer responsible for design unless otherwise required by the state law of the jurisdiction having authority.

R404.4.1 Applicability limits. The provisions of this section shall apply to the construction of insulating concrete form foundation walls for buildings not more than 60 feet (18 288 mm) in plan dimensions, and floors not more than 32 feet (9754 mm) or roofs not more than 40 feet (12 192 mm) in clear span. Buildings shall not exceed two stories in height above grade with each story not more than 10 feet (3048 mm) high. Foundation walls constructed in accordance with the provisions of this section shall be limited to buildings subjected to a maximum ground snow load of 70 psf (3.35 kPa) and located in Seismic Design Category A, B or C. In Seismic Design Categories D₀, D₁ and D₂, foundation walls shall comply with Section R404.1.4. Insulating concrete form foundation walls supporting above-grade concrete walls shall be reinforced as required for the above-grade wall immediately above or the requirements in Tables R404.4(1), R404.4(2), R404.4(3), R404.4(4) or R404.4(5), whichever is greater.

R404.4.2 Flat insulating concrete form wall systems. Flat ICF wall systems shall comply with Figure R611.3, shall have a minimum concrete thickness of 5.5 inches (140 mm), and shall have reinforcement in accordance with Table R404.4(1), R404.4(2) or R404.4(3). Alternatively, for 7.5-inch (191 mm) and 9.5-inch (241 mm) flat ICF wall systems, use of Table R404.1.1(5) shall be permitted, provided the vertical reinforcement is of the grade and located within the wall as required by that table.

R404.4.3 Waffle-grid insulating concrete form wall systems. Waffle-grid wall systems shall have a minimum nominal concrete thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores) and shall be reinforced in accordance with Table R404.4(4). The minimum

core dimension shall comply with Table R611.2 and Figure R611.4.

R404.4.4 Screen-grid insulating concrete form wall systems. Screen-grid ICF wall systems shall have a minimum nominal concrete thickness of 6 inches (152 mm) for the horizontal and vertical concrete members (cores). The minimum core dimensions shall comply with Table R611.2 and Figure R611.5. Walls shall have reinforcement in accordance with Table R404.4(5).

R404.4.5 Concrete material. Ready-mixed concrete for insulating concrete form walls shall be in accordance with Section R402.2. Maximum slump shall not be greater than 6 inches (152 mm) as determined in accordance with ASTM C 143. Maximum aggregate size shall not be larger than 3/4 inch (19.1 mm).

Exception: Concrete mixes conforming to the ICF manufacturer's recommendations.

R404.4.6 Reinforcing steel.

R404.4.6.1 General. Reinforcing steel shall meet the requirements of ASTM A 615, A 706 or A 996. The minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). Vertical and horizontal wall reinforcements shall be placed no closer to the outside face of the wall than one-half the wall thickness. Steel reinforcement for foundation walls shall have concrete cover in accordance with ACI 318.

Exception: Where insulated concrete forms are used and the form remains in place as cover for the concrete, the minimum concrete cover for the reinforcing steel is permitted to be reduced to 3/4 inch (19.1 mm).

R404.4.6.2 Horizontal reinforcement. When vertical reinforcement is required, ICF foundation walls shall have horizontal reinforcement in accordance with this section. ICF foundation walls up to 8 feet (2438 mm) in height shall have a minimum of one continuous No. 4 horizontal reinforcing bar placed at 48 inches (1219 mm) on center with one bar located within 12 inches (305 mm) of the top of the wall story. ICF foundation walls greater than 8 feet (2438 mm) in height shall have a minimum of one continuous No. 4 horizontal reinforcing bar placed at 36 inches (914 mm) on center with one bar located within 12 inches (305 mm) of the top of the wall story.

R404.4.6.3 Wall openings. Vertical wall reinforcement required by Section R404.4.2, R404.4.3 or R404.4.4 that is interrupted by wall openings shall have additional vertical reinforcement of the same size placed within 12 inches (305 mm) of each side of the opening.

R404.4.7 Foam plastic insulation. Foam plastic insulation in insulating concrete foam construction shall comply with this section.

R404.4.7.1 Material. Insulating concrete form material shall meet the surface burning characteristics of Section R314.3. A thermal barrier shall be provided on the building interior in accordance with Section R314.4.

TABLE R404.4(1)
5.5-INCH THICK FLAT ICF FOUNDATION WALLS^{a, b, c, d}

HEIGHT OF BASEMENT WALL (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^e (feet)	MINIMUM VERTICAL REINFORCEMENT SIZE AND SPACING		
		Soil classes ^f and design lateral soil load (psf per foot of depth)		
		GW, GP, SW and SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	#4@48"	#4@48"	#4@48"
	5	#4@48"	#3@12"; #4@22"; #5@32"	#3@8"; #4@14"; #5@20"; #6@26"
	6	#3@12"; #4@22"; #5@30"	#3@8"; #4@14"; #5@20"; #6@24"	#3@6"; #4@10"; #5@14"; #6@20"
	7	#3@8"; #4@14"; #5@22"; #6@26"	#3@5"; #4@10"; #5@14"; #6@18"	#3@4"; #4@6"; #5@10"; #6@14"
9	4	#4@48"	#4@48"	#4@48"
	5	#4@48"	#3@12"; #4@20"; #5@28"; #6@36"	#3@8"; #4@14"; #5@20"; #6@22"
	6	#3@10"; #4@20"; #5@28"; #6@34"	#3@6"; #4@12"; #5@18"; #6@20"	#4@8"; #5@14"; #6@16"
	7	#3@8"; #4@14"; #5@20"; #6@22"	#4@8"; #5@12"; #6@16"	#4@6"; #5@10"; #6@12"
	8	#3@6"; #4@10"; #5@14"; #6@16"	#4@6"; #5@10"; #6@12"	#4@4"; #5@6"; #6@8"
10	4	#4@48"	#4@48"	#4@48"
	5	#4@48"	#3@10"; #4@18"; #5@26"; #6@30"	#3@6"; #4@14"; #5@18"; #6@20"
	6	#3@10"; #4@18"; #5@24"; #6@30"	#3@6"; #4@12"; #5@16"; #6@18"	#3@4"; #4@8"; #5@12"; #6@14"
	7	#3@6"; #4@12"; #5@16"; #6@18"	#3@4"; #4@8"; #5@12"	#4@6"; #5@8"; #6@10"
	8	#4@8"; #5@12"; #6@14"	#4@6"; #5@8"; #6@12"	#4@4"; #5@6"; #6@8"
	9	#4@6"; #5@10"; #6@12"	#4@4"; #5@6"; #6@8"	#5@4"; #6@6"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa.

- a. This table is based on concrete with a minimum specified concrete strength of 2500 psi, reinforcing steel with a minimum yield strength of 40,000 psi. When reinforcing steel with a minimum yield strength of 60,000 psi is used, the spacing of the reinforcement shall be increased to 1.5 times the spacing value in the table but in no case greater than 48 inches on center.
- b. This table is not intended to prohibit the use of an ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.
- c. Deflection criteria: $L/240$.
- d. Interpolation between rebar sizes and spacing is not permitted.
- e. Unbalanced backfill height is the difference in height of the exterior and interior finished ground. Where an interior concrete slab is provided, the unbalanced backfill height shall be measured from the exterior finished ground level to the top of the interior concrete slab.
- f. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

TABLE R404.4(2)
7.5-INCH-THICK FLAT ICF FOUNDATION WALLS^{a, b, c, d, e}

HEIGHT OF BASEMENT WALL (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^f (feet)	MINIMUM VERTICAL REINFORCEMENT SIZE AND SPACING		
		Soil classes ^g and design lateral soil load (psf per foot of depth)		
		GW, GP, SW and SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	6	N/R	N/R	#3@6"; #4@12"; #5@18"; #6@24"
	7	N/R	#3@8"; #4@14"; #5@20"; #6@28"	#3@6"; #4@10"; #5@16"; #6@20"
9	6	N/R	N/R	#3@8"; #4@14"; #5@20"; #6@28"
	7	N/R	#3@6"; #4@12"; #5@18"; #6@26"	#3@4"; #4@8"; #5@14"; #6@18"
	8	#3@8"; #4@14"; #5@22"; #6@28"	#3@4"; #4@8"; #5@14"; #6@18"	#3@4"; #4@6"; #5@10"; #6@14"
10	6	N/R	N/R	#3@6"; #4@12"; #5@18"; #6@26"
	7	N/R	#3@6"; #4@12"; #5@18"; #6@24"	#3@4"; #4@8"; #5@12"; #6@18"
	8	#3@6"; #4@12"; #5@20"; #6@26"	#3@4"; #4@8"; #5@12"; #6@16"	#3@4"; #4@6"; #5@8"; #6@12"
	9	#3@6"; #4@10"; #5@14"; #6@20"	#3@4"; #4@6"; #5@10"; #6@12"	#4@4"; #5@6"; #6@10"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa.

- a. This table is based on concrete with a minimum specified concrete strength of 2500 psi, reinforcing steel with a minimum yield strength of 40,000 psi. When reinforcing steel with a minimum yield strength of 60,000 psi is used, the spacing of the reinforcement shall be increased to 1.5 times the spacing value in the table.
- b. This table is not intended to prohibit the use of an ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.
- c. N/R denotes "not required."
- d. Deflection criteria: $L/240$.
- e. Interpolation between rebar sizes and spacing is not permitted.
- f. Unbalanced backfill height is the difference in height of the exterior and interior finished ground. Where an interior concrete slab is provided, the unbalanced backfill height shall be measured from the exterior finished ground level to the top of the interior concrete slab.
- g. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

TABLE R404.4(3)
9.5-INCH-THICK FLAT ICF FOUNDATION WALLS^{a, b, c, d, e}

HEIGHT OF BASEMENT WALL (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^f (feet)	MINIMUM VERTICAL REINFORCEMENT SIZE AND SPACING		
		Soil classes ^g and design lateral soil load (psf per foot of depth)		
		GW, GP, SW and SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	7	N/R	N/R	N/R
9	6	N/R	N/R	N/R
	7	N/R	N/R	#3@6"; #4@12"; #5@18"; #6@26"
	8	N/R	#3@6"; #4@12"; #5@18"; #6@26"	#3@4"; #4@8"; #5@14"; #6@18"
10	5	N/R	N/R	N/R
	6	N/R	N/R	N/R
	7	N/R	N/R	#3@6"; #4@10"; #5@18"; #6@24"
	8	N/R	#3@6"; #4@12"; #5@16"; #6@24"	#3@4"; #4@8"; #5@12"; #6@16"
	9	#3@4"; #4@10"; #5@14"; #6@20"	#3@4"; #4@8"; #5@12"; #6@18"	#3@4"; #4@6"; #5@10"; #6@12"

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa.

- a. This table is based on concrete with a minimum specified concrete strength of 2500 psi, reinforcing steel with a minimum yield strength of 40,000 psi. When reinforcing steel with a minimum yield strength of 60,000 psi is used, the spacing of the reinforcement shall be increased to 1.5 times the spacing value in the table.
- b. This table is not intended to prohibit the use of an ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.
- c. N/R denotes "not required."
- d. Deflection criteria: $L/240$.
- e. Interpolation between rebar sizes and spacing is not permitted.
- f. Unbalanced backfill height is the difference in height of the exterior and interior finished ground. Where an interior concrete slab is provided, the unbalanced backfill height shall be measured from the exterior finished ground level to the top of the interior concrete slab.
- g. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

TABLE R404.4(4)
WAFFLE GRID ICF FOUNDATION WALLS^{a, b, c, d, e}

MINIMUM NOMINAL WALL THICKNESS ^f (inches)	HEIGHT OF BASEMENT WALL (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^g (feet)	MINIMUM VERTICAL REINFORCEMENT SIZE AND SPACING		
			Soil classes ^h and design lateral soil load (psf per foot of depth)		
			GW, GP, SW and SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
6	8	4	#4@48"	#3@12"; #4@24"	#3@12"
		5	#3@12"; #5@24"	#4@12"	#7@12"
		6	#4@12"	Design required	Design required
		7	#7@12"	Design required	Design required
	9	4	#4@48"	#3@12"; #5@24"	#3@12"
		5	#3@12"	#4@12"	Design required
		6	#5@12"	Design required	Design required
		7	Design required	Design required	Design required
	10	4	#4@48"	#4@12"	#5@12"
		5	#3@12"	Design required	Design required
		6	Design required	Design required	Design required
		7	Design required	Design required	Design required
8	8	4	N/R	N/R	N/R
		5	N/R	#3@12"; #4@24"; #5@36"	#3@12"; #5@24"
		6	#3@12"; #4@24"; #5@36"	#4@12"; #5@24"	#4@12"
		7	#3@12"; #6@24"	#4@12"	#5@12"
	9	4	N/R	N/R	N/R
		5	N/R	#3@12"; #5@24"	#3@12"; #5@24"
		6	#3@12"; #4@24"	#4@12"	#4@12"
		7	#4@12"; #5@24"	#5@12"	#5@12"
	10	8	#4@12"	#5@12"	#8@12"
		4	N/R	#3@12"; #4@24"; #6@36"	#3@12"; #5@24"
		5	N/R	#3@12"; #4@24"; #6@36"	#4@12"; #5@24"
		6	#3@12"; #5@24"	#4@12"	#5@12"
		7	#4@12"	#5@12"	#6@12"
	8	#4@12"	#6@12"	Design required	
	9	#5@12"	Design required	Design required	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa.

- a. This table is based on concrete with a minimum specified concrete strength of 2500 psi, reinforcing steel with a minimum yield strength of 40,000 psi. When reinforcing steel with a minimum yield strength of 60,000 psi is used, the spacing of the reinforcement shall be increased 12 inches but in no case greater than 48 inches on center.
- b. This table is not intended to prohibit the use of an ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.
- c. N/R denotes "not required."
- d. Deflection criteria: $L/240$.
- e. Interpolation between rebar sizes and spacing is not permitted.
- f. Refer to Table R611.4(2) for wall dimensions.
- g. Unbalanced backfill height is the difference in height of the exterior and interior finished ground. Where an interior concrete slab is provided, the unbalanced backfill height shall be measured from the exterior finished ground level to the top of the interior concrete slab.
- h. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

TABLE R404.4(5)
SCREEN-GRID ICF FOUNDATION WALLS^{a, b, c, d, e}

MINIMUM NOMINAL WALL THICKNESS ^f (inches)	HEIGHT OF BASEMENT WALL (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT ^g (feet)	MINIMUM VERTICAL REINFORCEMENT SIZE AND SPACING			
			Soil classes ^h and design lateral soil load (psf per foot of depth)			
			GW, GP, SW and SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60	
6	8	4	#4@48"	#3@12"; #4@24"; #5@36"	#3@12"; #5@24"	
		5	#3@12"; #4@24"	#3@12"	#4@12"	
		6	#4@12"	#5@12"	Design required	
		7	#4@12"	Design required	Design required	
	9	4	#4@48"	#3@12"; #4@24"	#3@12"; #6@24"	
		5	#3@12"; #5@24"	#4@12"	#7@12"	
		6	#4@12"	Design required	Design required	
		7	Design required	Design required	Design required	
	10	8	Design required	Design required	Design required	
		4	#4@48"	#3@12"; #5@24"	#3@12"	
		5	#3@12"	#4@12"	#7@12"	
		6	#4@12"	Design required	Design required	
		7	Design required	Design required	Design required	
			8	Design required	Design required	Design required

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895 kPa, 1 pound per square foot = 0.0479 kPa.

- a. This table is based on concrete with a minimum specified concrete strength of 2500 psi, reinforcing steel with a minimum yield strength of 40,000 psi. When reinforcing steel with a minimum yield strength of 60,000 psi is used, the spacing of the reinforcement in the shaded cells shall be increased 12 inches.
- b. This table is not intended to prohibit the use of an ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.
- c. N/R denotes "not required."
- d. Deflection criteria: *L/240*.
- e. Interpolation between rebar sizes and spacing is not permitted.
- f. Refer to Table R611.4(2) for wall dimensions.
- g. Unbalanced backfill height is the difference in height of the exterior and interior finished ground. Where an interior concrete slab is provided, the unbalanced backfill height shall be measured from the exterior finished ground level to the top of the interior concrete slab.
- h. Soil classes are in accordance with the Unified Soil Classification System. Refer to Table R405.1.

R404.4.7.2 Termite hazards. In areas where hazard of termite damage is very heavy in accordance with Figure R301.2(6), foam plastic insulation shall be permitted below grade on foundation walls in accordance with one of the following conditions:

1. When in addition to the requirements in Section R320.1, an approved method of protecting the foam plastic and structure from subterranean termite damage is provided.
2. The structural members of walls, floors, ceilings and roofs are entirely of noncombustible materials or pressure preservatively treated wood.
3. On the interior side of basement walls.

R404.4.8 Foundation wall thickness based on walls supported. The thickness of ICF foundation walls shall not be less than the thickness of the wall supported above.

R404.4.9 Height above finished ground. ICF foundation walls shall extend above the finished ground adjacent to the foundation at all points a minimum of 4 inches (102 mm) where masonry veneer is used and a minimum of 6 inches (152 mm) elsewhere.

R404.4.10 Backfill placement. Backfill shall be placed in accordance with Section R404.1.7.

R404.4.11 Drainage and dampproofing/waterproofing. ICF foundation basements shall be drained and dampproofed/waterproofed in accordance with Sections R405 and R406.

R404.5 Retaining walls. Retaining walls that are not laterally supported at the top and that retain in excess of 24 inches (610 mm) of unbalanced fill shall be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. Retaining walls shall be designed for a safety factor of 1.5 against lateral sliding and overturning.

SECTION R405
FOUNDATION DRAINAGE

R405.1 Concrete or masonry foundations. Drains shall be provided around all concrete or masonry foundations that retain earth and enclose habitable or usable spaces located below grade. Drainage tiles, gravel or crushed stone drains, perforated pipe or other approved systems or materials shall be installed at or below the area to be protected and shall discharge by gravity

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or mechanical means into an approved drainage system. Gravel or crushed stone drains shall extend at least 1 foot (305 mm) beyond the outside edge of the footing and 6 inches (152 mm) above the top of the footing and be covered with an approved filter membrane material. The top of open joints of drain tiles shall be protected with strips of building paper, and the drainage tiles or perforated pipe shall be placed on a minimum of 2 inches (51 mm) of washed gravel or crushed rock at least one sieve size larger than the tile joint opening or perforation and covered with not less than 6 inches (152 mm) of the same material.

Exception: A drainage system is not required when the foundation is installed on well-drained ground or sand-gravel mixture soils according to the Unified Soil Classification System, Group I Soils, as detailed in Table R405.1.

R405.2 Wood foundations. Wood foundations enclosing habitable or usable spaces located below grade shall be adequately

drained in accordance with Sections R405.2.1 through R405.2.3.

R405.2.1 Base. A porous layer of gravel, crushed stone or coarse sand shall be placed to a minimum thickness of 4 inches (102 mm) under the basement floor. Provision shall be made for automatic draining of this layer and the gravel or crushed stone wall footings.

R405.2.2 Moisture barrier. A 6-mil-thick (0.15 mm) polyethylene moisture barrier shall be applied over the porous layer with the basement floor constructed over the polyethylene.

R405.2.3 Drainage system. In other than Group I soils, a sump shall be provided to drain the porous layer and footings. The sump shall be at least 24 inches (610 mm) in diameter or 20 inches square (0.0129 m²), shall extend at least 24 inches (610 mm) below the bottom of the basement floor and shall be capable of positive gravity or mechanical drainage to

TABLE R405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS ^a	FROST HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION ^b
Group I	GW	Well-graded gravels, gravel sand mixtures, little or no fines	Good	Low	Low
	GP	Poorly graded gravels or gravel sand mixtures, little or no fines	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines	Good	Low	Low
	SP	Poorly graded sands or gravelly sands, little or no fines	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures	Good	Medium	Low
Group II	GC	Clayey gravels, gravel-sand-clay mixtures	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixture	Medium	Medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium	Medium	Medium to Low
Group III	CH	Inorganic clays of high plasticity, fat clays	Poor	Medium	High
	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Poor	High	High
Group IV	OL	Organic silts and organic silty clays of low plasticity	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts	Unsatisfactory	Medium	High
	Pt	Peat and other highly organic soils	Unsatisfactory	Medium	High

For SI: 1 inch = 25.4 mm.

- a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.
b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

remove any accumulated water. The drainage system shall discharge into an approved sewer system or to daylight.

SECTION R406 FOUNDATION WATERPROOFING AND DAMPPROOFING

R406.1 Concrete and masonry foundation dampproofing.

Except where required by Section R406.2 to be waterproofed, foundation walls that retain earth and enclose interior spaces and floors below grade shall be dampproofed from the top of the footing to the finished grade. Masonry walls shall have not less than $\frac{3}{8}$ inch (9.5 mm) portland cement parging applied to the exterior of the wall. The parging shall be dampproofed in accordance with one of the following:

1. Bituminous coating.
2. 3 pounds per square yard (1.63 kg/m²) of acrylic modified cement.
3. $\frac{1}{8}$ -inch (3.2 mm) coat of surface-bonding cement complying with ASTM C 887.
4. Any material permitted for waterproofing in Section R406.2.
5. Other approved methods or materials.

Exception: Parging of unit masonry walls is not required where a material is approved for direct application to the masonry.

Concrete walls shall be dampproofed by applying any one of the above listed dampproofing materials or any one of the waterproofing materials listed in Section R406.2 to the exterior of the wall.

R406.2 Concrete and masonry foundation waterproofing.

In areas where a high water table or other severe soil-water conditions are known to exist, exterior foundation walls that retain earth and enclose interior spaces and floors below grade shall be waterproofed from the top of the footing to the finished grade. Walls shall be waterproofed in accordance with one of the following:

1. 2-ply hot-mopped felts.
2. 55 pound (25 kg) roll roofing.
3. 6-mil (0.15 mm) polyvinyl chloride.
4. 6-mil (0.15 mm) polyethylene.
5. 40-mil (1 mm) polymer-modified asphalt.
6. 60-mil (1.5 mm) flexible polymer cement.
7. $\frac{1}{8}$ inch (3 mm) cement-based, fiber-reinforced, water-proof coating.
8. 60-mil (0.22 mm) solvent-free liquid-applied synthetic rubber.

Exception: Organic-solvent-based products such as hydrocarbons, chlorinated hydrocarbons, ketones and esters shall not be used for ICF walls with expanded polystyrene form material. Use of plastic roofing cements, acrylic coatings, latex coatings, mortars and pargings to seal ICF walls is

permitted. Cold-setting asphalt or hot asphalt shall conform to type C of ASTM D 449. Hot asphalt shall be applied at a temperature of less than 200°F (93°C).

All joints in membrane waterproofing shall be lapped and sealed with an adhesive compatible with the membrane.

R406.3 Dampproofing for wood foundations. Wood foundations enclosing habitable or usable spaces located below grade shall be dampproofed in accordance with Sections R406.3.1 through R406.3.4.

R406.3.1 Panel joint sealed. Plywood panel joints in the foundation walls shall be sealed full length with a caulking compound capable of producing a moisture-proof seal under the conditions of temperature and moisture content at which it will be applied and used.

R406.3.2 Below-grade moisture barrier. A 6-mil-thick (0.15 mm) polyethylene film shall be applied over the below-grade portion of exterior foundation walls prior to backfilling. Joints in the polyethylene film shall be lapped 6 inches (152 mm) and sealed with adhesive. The top edge of the polyethylene film shall be bonded to the sheathing to form a seal. Film areas at grade level shall be protected from mechanical damage and exposure by a pressure preservative treated lumber or plywood strip attached to the wall several inches above finish grade level and extending approximately 9 inches (229 mm) below grade. The joint between the strip and the wall shall be caulked full length prior to fastening the strip to the wall. Other coverings appropriate to the architectural treatment may also be used. The polyethylene film shall extend down to the bottom of the wood footing plate but shall not overlap or extend into the gravel or crushed stone footing.

R406.3.3 Porous fill. The space between the excavation and the foundation wall shall be backfilled with the same material used for footings, up to a height of 1 foot (305 mm) above the footing for well-drained sites, or one-half the total back-fill height for poorly drained sites. The porous fill shall be covered with strips of 30-pound (13.6 kg) asphalt paper or 6-mil (0.15 mm) polyethylene to permit water seepage while avoiding infiltration of fine soils.

R406.3.4 Backfill. The remainder of the excavated area shall be backfilled with the same type of soil as was removed during the excavation.

SECTION R407 COLUMNS

R407.1 Wood column protection. Wood columns shall be protected against decay as set forth in Section R319.

R407.2 Steel column protection. All surfaces (inside and outside) of steel columns shall be given a shop coat of rust-inhibitive paint, except for corrosion-resistant steel and steel treated with coatings to provide corrosion resistance.

R407.3 Structural requirements. The columns shall be restrained to prevent lateral displacement at the bottom end. Wood columns shall not be less in nominal size than 4 inches by

4 inches (102 mm by 102 mm) and steel columns shall not be less than 3-inch-diameter (76 mm) standard pipe or approved equivalent.

Exception: In Seismic Design Categories A, B and C columns no more than 48 inches (1219 mm) in height on a pier or footing are exempt from the bottom end lateral displacement requirement within underfloor areas enclosed by a continuous foundation.

SECTION R408 UNDER-FLOOR SPACE

R408.1 Ventilation. The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a basement) shall have ventilation openings through foundation walls or exterior walls. The minimum net area of ventilation openings shall not be less than 1 square foot (0.0929 m²) for each 150 square feet (14 m²) of under-floor space area. One such ventilating opening shall be within 3 feet (914 mm) of each corner of the building.

Exception: When the exposed earth is covered with a continuous vapor barrier, the minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m²) for each 1500 square feet (139 m²) of under-floor space area. Joints of the vapor retarder shall overlap by 6 inches (152 mm).

R408.2 Openings for under-floor ventilation. Ventilation openings shall be covered for their height and width with any of the following materials provided that the least dimension of the covering shall not exceed 1/4 inch (6.4 mm):

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.
3. Cast-iron grill or grating.
4. Extruded load-bearing brick vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant wire mesh, with the least dimension being 1/8 inch (3.2 mm).

R408.3 Unvented crawl space. Ventilation openings in under-floor spaces specified in Sections R408.1 and R408.2 shall not be required where:

1. Exposed earth is covered with a continuous vapor retarder. Joints of the vapor retarder shall overlap by 6 inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall; and
2. One of the following is provided for the under-floor space:
 - 2.1. Continuously operated mechanical exhaust ventilation at a rate equal to 1 cfm (0.47 L/s) for each 50 ft² (4.7 m²) of crawlspace floor area, including an air pathway to the common area (such as a

duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.8;

- 2.2. Conditioned air supply sized to deliver at a rate equal to 1 cfm (0.47 L/s) for each 50 ft² (4.7 m²) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.8;

- 2.3. Plenum complying with Section M1601.4, if under-floor space is used as a plenum.

R408.4 Access. Access shall be provided to all under-floor spaces. Access openings through the floor shall be a minimum of 18 inches by 24 inches (457 mm by 610 mm). Openings through a perimeter wall shall be not less than 16 inches by 24 inches (407 mm by 610 mm). When any portion of the through-wall access is below grade, an areaway not less than 16 inches by 24 inches (407 mm by 610 mm) shall be provided. The bottom of the areaway shall be below the threshold of the access opening. Through wall access openings shall not be located under a door to the residence. See Section M1305.1.4 for access requirements where mechanical equipment is located under floors.

R408.5 Removal of debris. The under-floor grade shall be cleaned of all vegetation and organic material. All wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose. All construction materials shall be removed before a building is occupied or used for any purpose.

R408.6 Finished grade. The finished grade of under-floor surface may be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished floor at the building perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the under-floor space shall be as high as the outside finished grade, unless an approved drainage system is provided.

R408.7 Flood resistance. For buildings located in areas prone to flooding as established in Table R301.2(1):

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section R324.2.2.
2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level.

Exception: Under-floor spaces that meet the requirements of FEMA/FIA TB 11-1.