

**4101:8-4-01 Foundations.**

*[Comment: When a reference is made within this rule to a federal statutory provision, an industry consensus standard, or any other technical publication, the specific date and title of the publication as well as the name and address of the promulgating agency are listed in rule 4101:8-44-01 of the Administrative Code. The application of the referenced standards shall be limited and as prescribed in section 102.5 of rule 4101:8-1-01 of the Administrative Code.]*

**SECTION 401  
GENERAL**

**401.1 Application.** The provisions of this chapter shall control the design and construction of the foundation and foundation spaces for buildings. In addition to the provisions of this chapter, the design and construction of foundations in flood hazard areas as established by Table 301.2(1) shall meet the provisions of Section 322. Wood foundations shall be designed and installed in accordance with AWC PWF.

**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 not more than two floors and a roof.
2. Where interior basement and foundation walls are constructed at intervals not exceeding 50 feet (15 240 mm).

**401.2 Requirements.** Foundation construction shall be capable of accommodating all loads in accordance with 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.

**401.3 Drainage.** Surface drainage shall be diverted to a storm sewer conveyance or other approved point of collection that does not create a hazard. Lots shall be graded to drain surface water away from foundation walls. The grade shall fall not fewer than 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), drains or swales shall be constructed to ensure drainage away from the structure. Impervious surfaces within 10 feet (3048 mm) of the building foundation shall be sloped not less than 2 percent away from the building.

**401.4 Soil tests.** Where quantifiable data created by accepted soil science methodologies indicate expansive soils, compressible soils, shifting soils or other

questionable soil characteristics are likely to be present, the building official *may* determine whether to require a soil test to determine the soil's characteristics at a particular location. This test shall be done by an approved agency using an approved method.

**401.4.1 Geotechnical evaluation.** In lieu of a complete geotechnical evaluation, the load-bearing values in Table 401.4.1 shall be assumed.

**TABLE 401.4.1  
PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS <sup>a</sup>**

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, silty clay, clayey silt, silt and sandy siltclay (CL, ML, MH and CH)	1,500 <sup>b</sup>

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

- a. Where soil tests are required by Section 401.4, 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.

**401.4.2 Controlled low-strength material (CLSM).** *Where footings will bear on controlled low-strength material (CLSM), the CLSM shall comply with the provisions of an approved report. The report shall contain the following:*

1. *Specifications for the preparation of the site prior to placement of CLSM.*
2. *Specifications for the CLSM.*
3. *Laboratory or field test method(s) to be used to determine the compressive strength or bearing capacity of the CLSM.*
4. *Test methods for determining the acceptance of the CLSM in the field.*
5. *Number and frequency of field tests required to determine compliance with Item 4.*

**401.4.3 Compressible or shifting soil.** Instead of a complete geotechnical evaluation, where top or subsoils are compressible or shifting, they shall be removed to a depth and width sufficient to ensure 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 402 MATERIALS

**402.1 Wood foundations.** Wood foundation systems shall be designed and

installed in accordance with the provisions of this code.

**402.1.1 Fasteners.** Fasteners used below grade to attach plywood to the exterior side of exterior basement or crawl-space 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.

**402.1.2 Wood treatment.** Lumber and plywood shall be pressure-preservative treated and dried after treatment in accordance with AWP A U1 (Commodity Specification A, Special Requirement 4.2), and shall bear the label of an accredited agency. Where lumber or plywood is cut or drilled after treatment, the treated surface shall be field treated with copper naphthenate, the concentration of which shall contain not less than 2-percent copper metal, by repeated brushing, dipping or soaking until the wood cannot absorb more preservative.

**402.2 Concrete.** Concrete shall have a minimum specified compressive strength of  $f'_c$ , as shown in Table 402.2. Concrete subject to moderate or severe weathering as indicated in Table 301.2(1) shall be air entrained as specified in Table 402.2. 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 19.3.3.4 of ACI 318. Materials used to produce concrete and testing thereof shall comply with the applicable standards listed in Chapters 19 and 20 of ACI 318 or ACI 332.

**402.2.1 Materials for concrete.** Materials for concrete shall comply with the requirements of Section 608.5.1.

**TABLE 402.2**  
**MINIMUM SPECIFIED COMPRESSIVE STRENGTH OF CONCRETE**

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH <sup>a</sup> ( $f'_c$ )		
	Weathering Potential <sup>b</sup>		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500 <sup>c</sup>
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500 <sup>c</sup>

TYPE OR LOCATION OF CONCRETE CONSTRUCTION	MINIMUM SPECIFIED COMPRESSIVE STRENGTH <sup>a</sup> (f' <sub>c</sub> )		
	Weathering Potential <sup>b</sup>		
	Negligible	Moderate	Severe
Basement walls, foundation walls, exterior walls and other vertical concrete work exposed to the weather	2,500	3,000 <sup>d</sup>	3,000 <sup>d</sup>
Porches, carport slabs and steps exposed to the weather, and garage floor slabs	2,500	3,000 <sup>d, e, f</sup>	3,500 <sup>d, e, f</sup>

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

- Strength at 28 days psi.
- See Table 301.2(1) for weathering potential.
- Concrete in these locations that is subject to freezing and thawing during construction shall be air-entrained concrete in accordance with Footnote 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.
- See Section 402.2 for maximum cementitious materials content.
- 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.

**402.3 Precast concrete.** Precast concrete foundations shall be designed in accordance with Section 404.5 and shall be installed in accordance with the provisions of this code and the manufacturer's instructions.

**402.3.1 Precast concrete foundation materials.** Materials used to produce precast concrete foundations shall meet the following requirements.

- All concrete used in the manufacture of precast concrete foundations shall have a minimum compressive strength of 5,000 psi (34 470 kPa) at 28 days. Concrete exposed to a freezing and thawing environment shall be air entrained with a minimum total air content of 5 percent.
- Structural reinforcing steel shall meet the requirements of ASTM A615, A706 or A996. The minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa). Steel reinforcement for pre-cast concrete foundation walls shall have a minimum concrete cover of <sup>3</sup>/<sub>4</sub>-inch (19.1 mm).
- Panel-to-panel connections shall be made with Grade II steel fasteners.
- The use of nonstructural fibers shall conform to ASTM C1116.
- Grout used for bedding precast foundations placed on concrete footings shall meet ASTM C1107.

**402.4 Masonry.** Masonry systems shall be designed and installed in accordance with this chapter and shall have a minimum specified compressive strength of 1,500 psi (10.3 MPa).

## SECTION 403

## FOOTINGS

**403.1 General.** All exterior walls shall be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations, or other approved structural systems that shall be of sufficient design to accommodate all loads according to Section 301 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. Concrete footing shall be designed and constructed in accordance with the provisions of Section 403 or in accordance with ACI 332.

**403.1.1 Minimum size.** The minimum width,  $W$ , and thickness,  $T$ , for concrete footings shall be in accordance with Tables 403.1(1) through 403.1(3) and Figure 403.1(1) or 403.1.3, as applicable. The footing width shall be based on the load-bearing value of the soil in accordance with Table 401.4.1. Footing projections,  $P$ , shall be not less than 2 inches (51 mm) and shall not exceed the thickness of the footing. Footing thickness and projection for fireplaces shall be in accordance with Section 1001.2. The size of footings supporting piers and columns shall be based on the tributary load and allowable soil pressure in accordance with Table 401.4.1. Footings for wood foundations shall be in accordance with the details set forth in Section 403.2, and Figures 403.1(2) and 403.1(3). Footings for precast foundations shall be in accordance with the details set forth in Section 403.4, Table 403.4, and Figures 403.4(1) and 403.4(2).

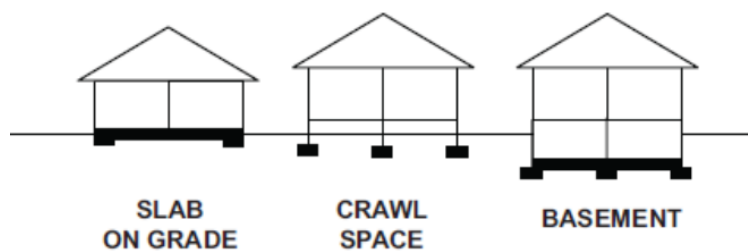
**TABLE 403.1(1)**  
**MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION (inches) <sup>a, b</sup>**

SNOW LOAD OR ROOF LIVE LOAD	STORY AND TYPE OF STRUCTURE WITH LIGHT FRAME	LOAD-BEARING VALUE OF SOIL (psf)					
		1500	2000	2500	3000	3500	4000
20 psf	1 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	16 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	22 x 6	16 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	3 story—slab-on-grade	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	19 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—plus basement	25 x 8	19 x 6	15 x 6	13 x 6	12 x 6	12 x 6
30 psf	1 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	13 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	19 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	17 x 6	13 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	23 x 6	17 x 6	14 x 6	12 x 6	12 x 6	12 x 6
	3 story—slab-on-grade	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	20 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—plus basement	26 x 8	20 x 6	16 x 6	13 x 6	12 x 6	12 x 6
50 psf	1 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	16 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	21 x 6	16 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	19 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	25 x 7	19 x 6	15 x 6	12 x 6	12 x 6	12 x 6
	3 story—slab-on-grade	17 x 6	13 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	22 x 6	17 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	3 story—plus basement	28 x 9	21 x 6	17 x 6	14 x 6	12 x 6	12 x 6
70 psf	1 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	18 x 6	13 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	24 x 7	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	16 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	21 x 6	16 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	27 x 9	20 x 6	16 x 6	14 x 6	12 x 6	12 x 6
	3 story—slab-on-grade	19 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	25 x 7	18 x 6	15 x 6	12 x 6	12 x 6	12 x 6
	3 story—plus basement	30 x 10	23 x 6	18 x 6	15 x 6	12 x 6	12 x 6

For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

a. Interpolation allowed. Extrapolation is not allowed.

b. Based on 32-foot-wide house with load-bearing center wall that carries half of the tributary attic, and floor framing. For every 2 feet of adjustment to the width of the house, add or subtract 2 inches of footing width and 1 inch of footing thickness (but not less than 6 inches thick).

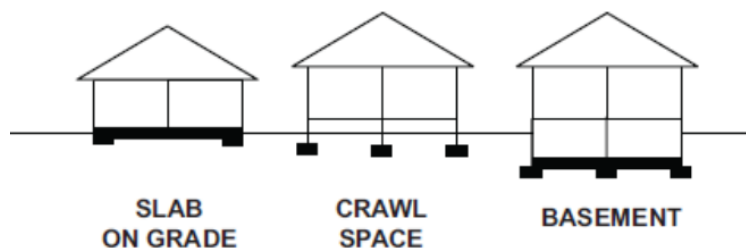


**TABLE 403.1(2)**  
**MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION**  
**WITH BRICK VENEER (inches) <sup>a, b</sup>**

SNOW LOAD OR ROOF LIVE	STORY AND TYPE OF STRUCTURE WITH BRICK VENEER	LOAD-BEARING VALUE OF SOIL (psf)					
		1500	2000	2500	3000	3500	4000
20 psf	1 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	21 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	20 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	26 x 8	20 x 6	16 x 6	13 x 6	12 x 6	12 x 6
	3 story—slab-on-grade	20 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	26 x 8	19 x 6	15 x 6	13 x 6	12 x 6	12 x 6
	3 story—plus basement	32 x 11	24 x 7	19 x 6	16 x 6	14 x 6	12 x 6
30 psf	1 story—slab-on-grade	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	16 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	22 x 6	16 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	16 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	22 x 6	16 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	27 x 9	21 x 6	16 x 6	14 x 6	12 x 6	12 x 6
	3 story—slab-on-grade	21 x 6	16 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	27 x 8	20 x 6	16 x 6	13 x 6	12 x 6	12 x 6
	3 story—plus basement	33 x 11	24 x 7	20 x 6	16 x 6	14 x 6	12 x 6
50 psf	1 story—slab-on-grade	13 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	24 x 7	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	24 x 7	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6
	2 story—plus basement	29 x 10	22 x 6	18 x 6	15 x 6	13 x 6	12 x 6
	3 story—slab-on-grade	27 x 7	18 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	3 story—with crawl space	29 x 9	22 x 6	17 x 6	14 x 6	12 x 6	12 x 6
	3 story—plus basement	35 x 12	26 x 8	21 x 6	17 x 6	15 x 6	13 x 6
70 psf	1 story—slab-on-grade	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	20 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	26 x 8	20 x 6	16 x 6	13 x 6	12 x 6	12 x 6
	2 story—slab-on grade	20 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	26 x 8	19 x 6	15 x 6	13 x 6	12 x 6	12 x 6
	2 story—plus basement	32 x 11	24 x 7	19 x 6	16 x 6	14 x 6	12 x 6
	3 story—slab-on-grade	26 x 8	19 x 6	15 x 6	13 x 6	12 x 6	12 x 6
	3 story—with crawl space	31 x 11	23 x 7	19 x 6	16 x 6	13 x 6	12 x 6
	3 story—plus basement	37 x 13	28 x 9	22 x 6	18 x 6	16 x 6	14 x 6

For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

- Interpolation allowed. Extrapolation is not allowed.
- Based on 32-foot-wide house with load-bearing center wall that carries half of the tributary attic, and floor framing. For every 2 feet of adjustment to the width of the house, add or subtract 2 inches of footing width and 1 inch of footing thickness (but not less than 6 inches thick).

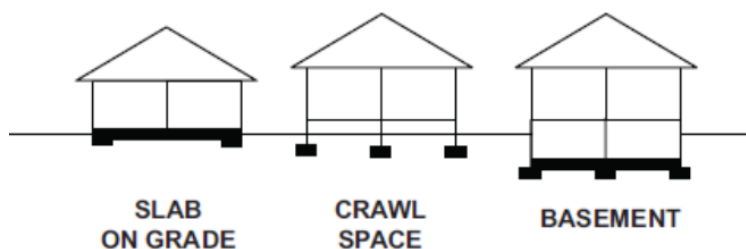


**TABLE 403.1(3)**  
**MINIMUM WIDTH AND THICKNESS FOR CONCRETE FOOTINGS**  
**WITH CAST-IN-PLACE CONCRETE OR FULLY GROUTED MASONRY WALL CONSTRUCTION (inches)<sup>a, b</sup>**

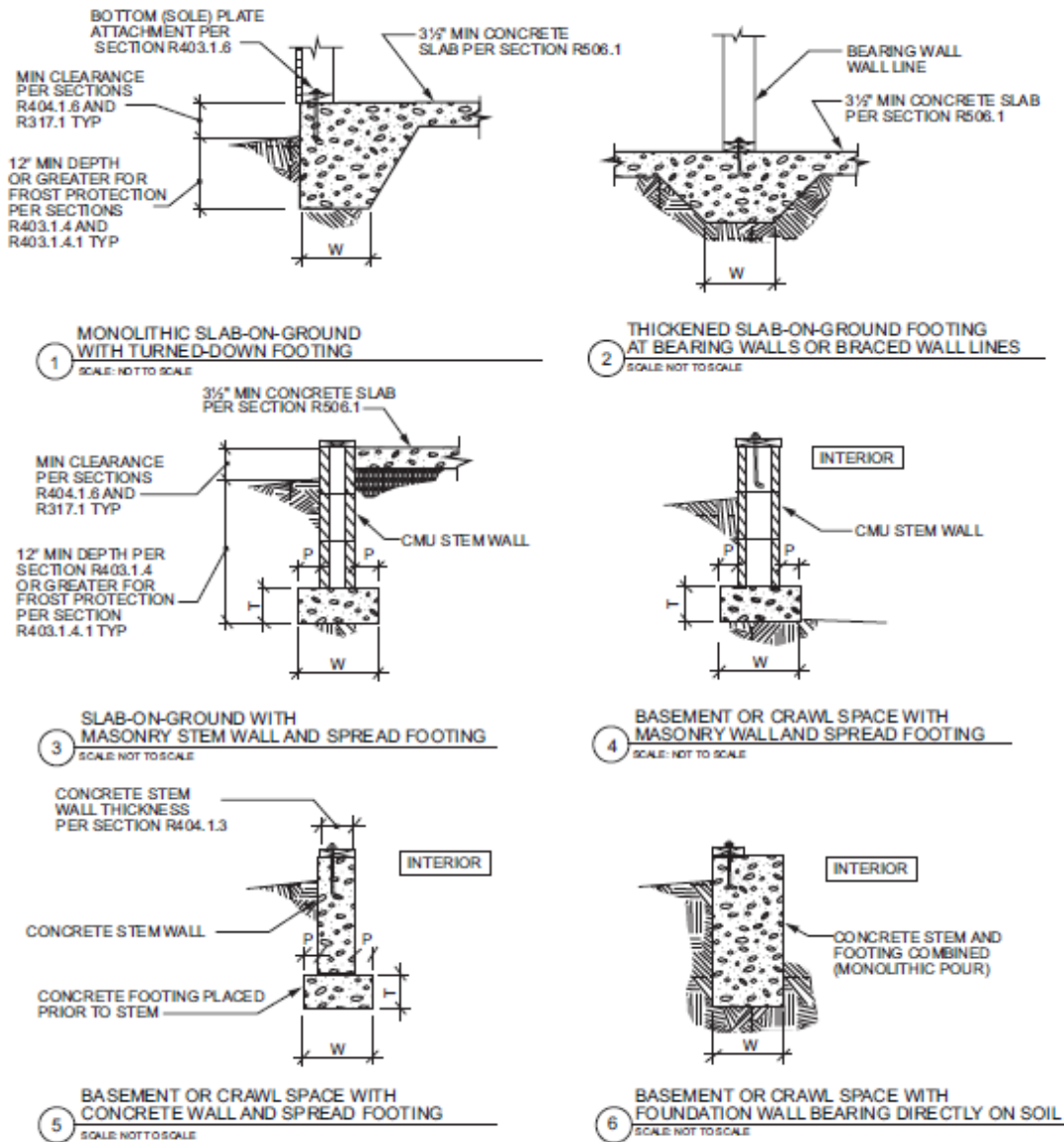
SNOW LOAD OR ROOF LIVE LOAD	STORY AND TYPE OF STRUCTURE WITH CMU	LOAD-BEARING VALUE OF SOIL (psf)					
		1500	2000	2500	3000	3500	4000
20 psf	1 story—slab-on-grade	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	19 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	25 x 8	19 x 6	15 x 6	13 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	23 x 7	18 x 6	14 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	29 x 9	22 x 6	17 x 6	14 x 6	12 x 6	12 x 6
	2 story—plus basement	35 x 12	26 x 8	21 x 6	17 x 6	15 x 6	13 x 6
	3 story—slab-on-grade	32 x 11	24 x 7	19 x 6	16 x 6	14 x 6	12 x 6
	3 story—with crawl space	38 x 14	28 x 9	23 x 6	19 x 6	16 x 6	14 x 6
	3 story—plus basement	43 x 17	33 x 11	26 x 8	22 x 6	19 x 6	16 x 6
30 psf	1 story—slab-on-grade	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	20 x 6	15 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	26 x 8	20 x 6	16 x 6	13 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	24 x 7	18 x 6	15 x 6	12 x 6	12 x 6	12 x 6
	2 story—with crawl space	30 x 10	22 x 6	18 x 6	15 x 6	13 x 6	12 x 6
	2 story—plus basement	36 x 13	27 x 8	21 x 6	18 x 6	15 x 6	13 x 6
	3 story—slab-on-grade	33 x 12	25 x 7	20 x 6	17 x 6	14 x 6	12 x 6
	3 story—with crawl space	39 x 14	29 x 9	23 x 7	19 x 6	17 x 6	14 x 6
	3 story—plus basement	44 x 17	33 x 12	27 x 8	22 x 6	19 x 6	17 x 6
50 psf	1 story—slab-on-grade	17 x 6	13 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	22 x 6	17 x 6	13 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	28 x 9	21 x 6	17 x 6	14 x 6	12 x 6	12 x 6
	2 story—slab-on-grade	27 x 8	20 x 6	16 x 6	13 x 6	12 x 6	12 x 6
	2 story—with crawl space	32 x 11	24 x 7	19 x 6	16 x 6	14 x 6	12 x 6
	2 story—plus basement	38 x 14	28 x 9	23 x 6	19 x 6	16 x 6	14 x 6
	3 story—slab-on-grade	35 x 13	27 x 8	21 x 6	18 x 6	15 x 6	13 x 6
	3 story—with crawl space	41 x 15	31 x 10	24 x 7	20 x 6	17 x 6	15 x 6
	3 story—plus basement	47 x 18	35 x 12	28 x 9	23 x 7	20 x 6	17 x 6
70 psf	1 story—slab-on-grade	19 x 6	14 x 6	12 x 6	12 x 6	12 x 6	12 x 6
	1 story—with crawl space	25 x 7	18 x 6	15 x 6	12 x 6	12 x 6	12 x 6
	1 story—plus basement	30 x 10	23 x 6	18 x 6	15 x 6	13 x 6	12 x 6
	2 story—slab-on-grade	29 x 9	22 x 6	17 x 6	14 x 6	12 x 6	12 x 6
	2 story—with crawl space	34 x 12	26 x 8	21 x 6	17 x 6	15 x 6	13 x 6
	2 story—plus basement	40 x 15	30 x 10	24 x 7	20 x 6	17 x 6	15 x 6
	3 story—slab-on-grade	38 x 14	28 x 9	23 x 6	19 x 6	16 x 6	14 x 6
	3 story—with crawl space	43 x 16	32 x 11	26 x 8	21 x 6	18 x 6	16 x 6
	3 story—plus basement	49 x 19	37 x 13	29 x 10	24 x 7	21 x 6	18 x 6

For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

- Interpolation allowed. Extrapolation is not allowed.
- Based on 32-foot-wide house with load-bearing center wall that carries half of the tributary attic, and floor framing. For every 2 feet of adjustment to the width of the house add or subtract 2 inches of footing width and 1 inch of footing thickness (but not less than 6 inches thick).







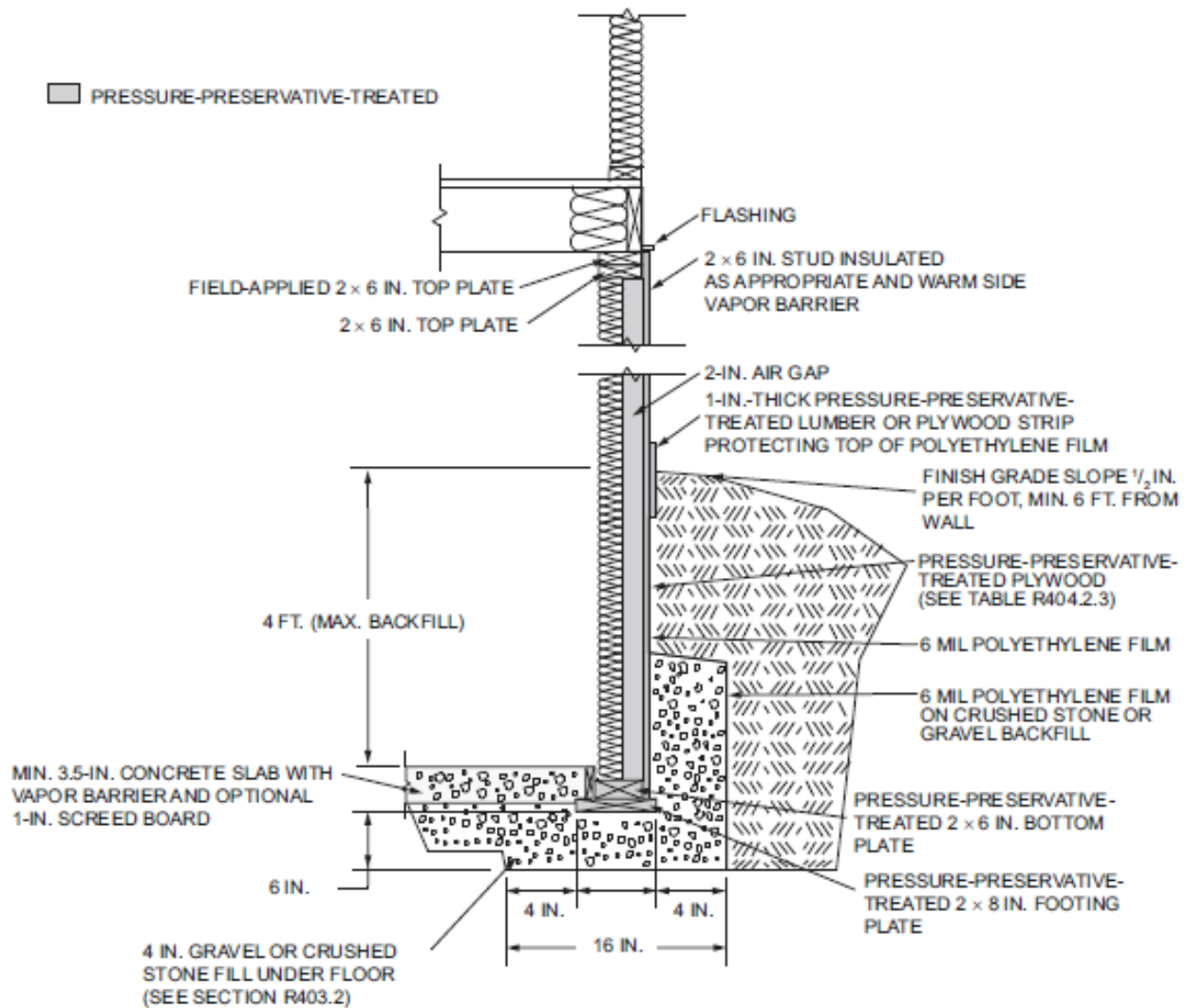
For SI: 1 inch = 25.4 mm.

$W$  = Width of footing,  $T$  = Thickness of footing and  $P$  = Projection per Section 403.1.1

**NOTES:**

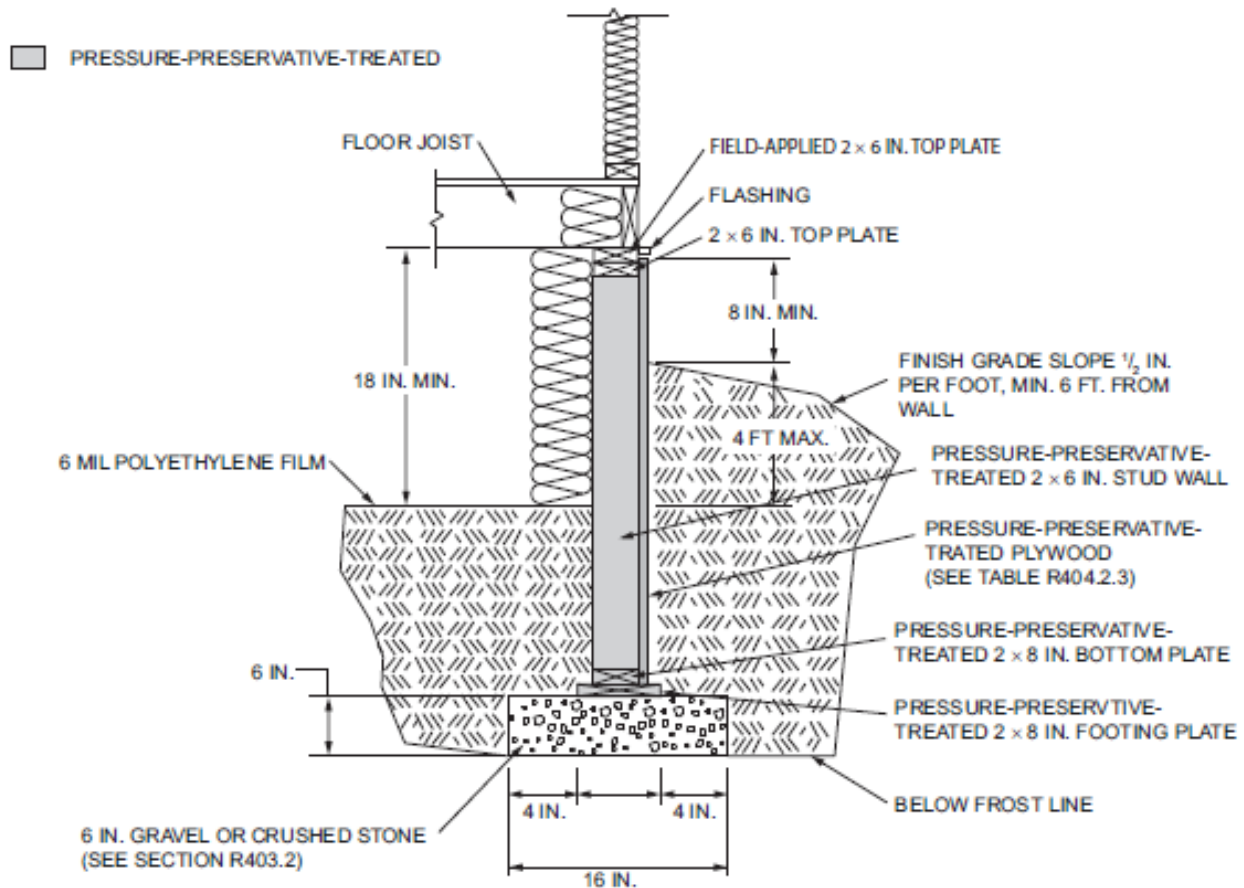
- a. See Section 404.3 for sill requirements.
- b. See Section 403.1.6 for sill attachment.
- c. See Section 506.2.3 for vapor barrier requirements.
- d. See Section 403.1 for base.
- e. Deleted
- f. See Section 408 for under-floor ventilation and access requirements.

**FIGURE 403.1(1)**  
**PLAIN CONCRETE FOOTINGS WITH MASONRY AND**  
**CONCRETE STEM WALLS IN SDC A, B and C a, b, c, d, e, f**



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

**FIGURE 403.1(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 403.1(3)**  
**PERMANENT WOOD FOUNDATION CRAWL SPACE SECTION**

**403.1.2 Continuous footing in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.**  
*Deleted*

### 403.1.3 Footing and stem wall reinforcing in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub>, and D<sub>2</sub>. Deleted

**403.1.3.1 Concrete stem walls with concrete footings.** *Deleted*

**403.1.3.2 Masonry stem walls with concrete footings.** *Deleted*

**403.1.3.3 Slabs-on-ground with turned-down footings.** *Deleted*

**403.1.3.4 Interior bearing and braced wall panel (1219 mm) footings in Seismic Design Categories D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub>.** *Deleted*

**403.1.3.5 Reinforcement.** *Deleted*

**403.1.3.5.1 Steel reinforcement.** *Deleted*

**403.1.3.5.2 Location of reinforcement in wall.** *Deleted*

**403.1.3.5.3 Support and cover.** *Deleted*

**403.1.3.5.4 Lap splices.** *Deleted*

**403.1.3.6 Isolated concrete footings.** *Deleted*

*Deleted figure*

**FIGURE 403.1.3  
REINFORCED CONCRETE FOOTINGS AND  
MASONRY AND CONCRETE STEM WALLS IN SDC D<sub>0</sub>, D<sub>1</sub> AND D<sub>2</sub><sup>a, b, c, d, e, f</sup>**

**403.1.4 Minimum depth.** Exterior footings shall be placed not less than 12 inches (305 mm) below the undisturbed ground surface. Where applicable, the depth of footings shall also conform to Sections 403.1.4.1.

**403.1.4.1 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 301.2(1).
2. Constructed in accordance with Section 403.3.
3. Constructed in accordance with ASCE 32.
4. Erected on solid rock.

Footings shall not bear on frozen soil unless the frozen condition is permanent that extend below the frost line.

**Exceptions:**

1. ~~Deleted~~ Protection of freestanding accessory structures with an area of 600 square feet (56 m<sup>2</sup>) or less, of light-frame construction, with an eave height of 10 feet (3048 mm) or less is not required.
2. ~~Deleted~~ Protection of freestanding accessory structures with an area of 400 square feet (37 m<sup>2</sup>) or less, of other than light-frame construction, with an eave height of 10 feet (3048 mm) or less is not required.
3. Decks not supported by a dwelling need not be provided with footings that extend below the frost line.

**403.1.5 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).

**403.1.6 Foundation anchorage.** Wood sill plates and wood walls supported directly on continuous foundations shall be anchored to the foundation in accordance with this section.

Cold-formed steel framing shall be anchored directly to the foundation or fastened to wood sill plates in accordance with Section 505.3.1 or 603.3.1, as applicable. Wood sill plates supporting cold-formed steel framing shall be anchored to the foundation in accordance with this section.

Wood sole plates at all exterior walls on monolithic slabs, wood sole plates of braced wall panels at building interiors on monolithic slabs and all wood sill plates shall be anchored to the foundation with minimum 1/2 -inch diameter (12.7 mm) anchor bolts spaced not greater than 6 feet (1829 mm) on center or approved anchors or anchor straps spaced as required to provide equivalent anchorage to 1/2 -inch diameter (12.7 mm) anchor bolts. Bolts shall extend not less than 7 inches (178 mm) into concrete or grouted cells of concrete masonry units. A nut and washer shall be tightened on each anchor bolt. There shall be not fewer than 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. Interior bearing wall sole plates on monolithic slab foundation that are not part of a braced wall panel shall be positively anchored with approved fasteners. Sill plates and sole plates shall be protected against decay and termites where required by Sections 317 and 318.

**Exceptions:**

1. Walls 24 inches (610 mm) total length or shorter connecting offset braced wall panels shall be anchored to the foundation with not fewer than one anchor bolt located in the center third of the plate section and shall be attached to adjacent braced wall panels at corners as shown in Item 9 of Table 602.3(1).
2. Connection of walls 12 inches (305 mm) total length or shorter connecting offset braced wall panels to the foundation without anchor bolts shall be permitted. The wall shall be attached to adjacent braced wall panels at corners as shown in Item 9 of Table 602.3(1).

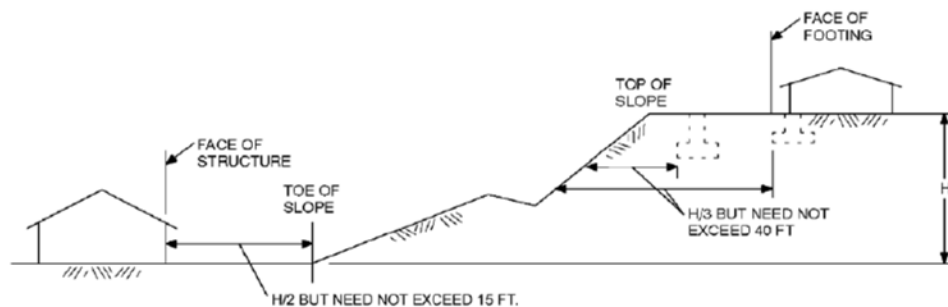
**403.1.6.1 Foundation anchorage in Seismic Design Categories C.** In addition to the requirements of Section 403.1.6, the following requirements shall apply to wood light-frame *dwelling with four or more dwelling units* in Seismic Design Categories C:

1. Plate washers conforming to Section 602.11.1 shall be provided for all anchor bolts over the full length of required braced wall lines except where approved anchor straps are used. 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 where 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 where 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 602.11.2.
6. Where continuous wood foundations in accordance with Section 404.2 are used, the force transfer shall have a capacity equal to or greater than the connections required by Section 602.11.1 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 602.3(1).

**403.1.7 Footings on or adjacent to slopes.** The placement of buildings and structures on or adjacent to slopes steeper than one unit vertical in three units horizontal (33.3-percent slope) shall conform to Sections 403.1.7.1 through

## 403.1.7.4.

**403.1.7.1 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 403.1.7.4 and Figure 403.1.7.1, 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.



For SI: 1 foot = 304.8 mm.

**FIGURE 403.1.7.1  
FOUNDATION CLEARANCE FROM SLOPES**

**403.1.7.2 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 403.1.7.4 and Figure 403.1.7.1, 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.

**403.1.7.3 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 not less than 12 inches (305 mm) plus 2 percent. Alternate elevations are permitted subject to the

approval of the building official, provided that 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.

**403.1.7.4 Alternate setbacks 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.

**403.1.8 Foundations on expansive soils.** Foundation and floor slabs for buildings located on expansive soils shall be designed in accordance with Section 1808.6 of the *Ohio building code*.

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

**403.1.8.1 Expansive soils classifications.** Soils meeting all of the following provisions shall be considered to be 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 D4318.
2. More than 10 percent of the soil particles pass a No. 200 sieve (75  $\mu$ m), determined in accordance with ASTM D422.
3. More than 10 percent of the soil particles are less than 5 micrometers in size, determined in accordance with ASTM D422.
4. Expansion Index greater than 20, determined in accordance with ASTM D4829.

**403.2 Footings for wood foundations.** Footings for wood foundations shall be in accordance with Figures 403.1(2) and 403.1(3). Gravel shall be washed and well graded. The maximum size stone shall not exceed  $\frac{3}{4}$ -inch (19.1 mm). Gravel shall be free from organic, clayey or silty soils. Sand shall be coarse, not smaller than  $\frac{1}{16}$ -inch (1.6 mm) grains and shall be free from organic, clayey or silty soils. Crushed stone shall have a maximum size of  $\frac{1}{2}$ -inch (12.7 mm)

**403.3 Frost-protected shallow foundations.** For buildings where the monthly mean temperature of the building is maintained at not less than 64°F (18°C),



footings are not required to extend below the frost line where protected from frost by insulation in accordance with Figure 403.3(1) and Table 403.3(1). Foundations protected from frost in accordance with Figure 403.3(1) and Table 403.3(1) 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 C578.

#### **403.3.1 Foundations adjoining frost-protected shallow foundations.**

Foundations that adjoin frost-protected shallow foundations shall be protected from frost in accordance with Section 403.1.4.

**403.3.1.1 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 not less than 64°F (18°C) shall be in accordance with Figure 403.3(3) and Table 403.3(1). 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 be either 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.

**403.3.1.2 Attachment to heated structure.** Where a frost-protected shallow foundation abuts a structure that has a monthly mean temperature maintained at not less than 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 403.3(4) a distance of not less than Dimension A in Table 403.3(1).

**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.

**403.3.2 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.

**403.3.3 Drainage.** Final grade shall be sloped in accordance with Section 401.3. In other than Group I Soils, as detailed in Table 405.1, gravel or crushed stone beneath horizontal insulation below ground shall drain *by gravity or mechanical means into an approved drainage system or other location that complies with the plumbing code.*

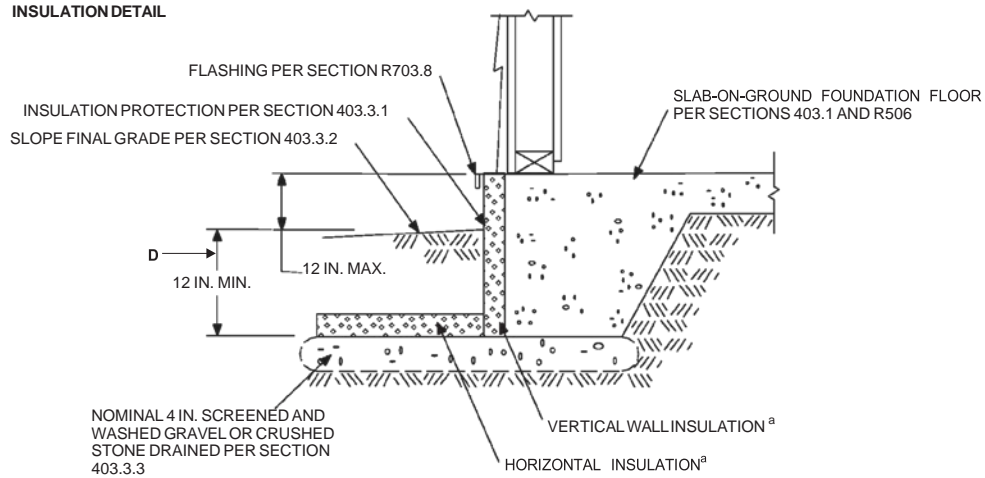
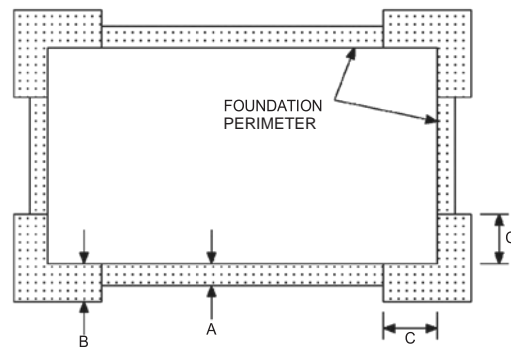
**403.3.4 Termite protection.** The use of foam plastic in areas of “very heavy” termite infestation probability shall be in accordance with Section 318.4.

**TABLE 403.3(1)**  
**MINIMUM FOOTING DEPTH AND INSULATION REQUIREMENTS FOR**  
**FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS <sup>a</sup>**

AIR FREEZING INDEX (°F-days) <sup>b</sup>	MINIMUM FOOTING DEPTH, <i>D</i>	VERTICAL INSULATION R-VALUE <sup>c,d</sup>	HORIZONTAL INSULATION R-VALUE <sup>c,e</sup>		HORIZONTAL INSULATION DIMENSIONS PER FIGURE 403.3(1) (inches)		
			Along walls	At corners	A	B	C
1,500 or less	12	4.5	Not required	Not required	Not required	Not required	Not required
2,000	14	5.6	Not required	Not required	Not required	Not required	Not required

For SI: 1 inch = 25.4 mm, °C = [(°F) - 32]/1.8.

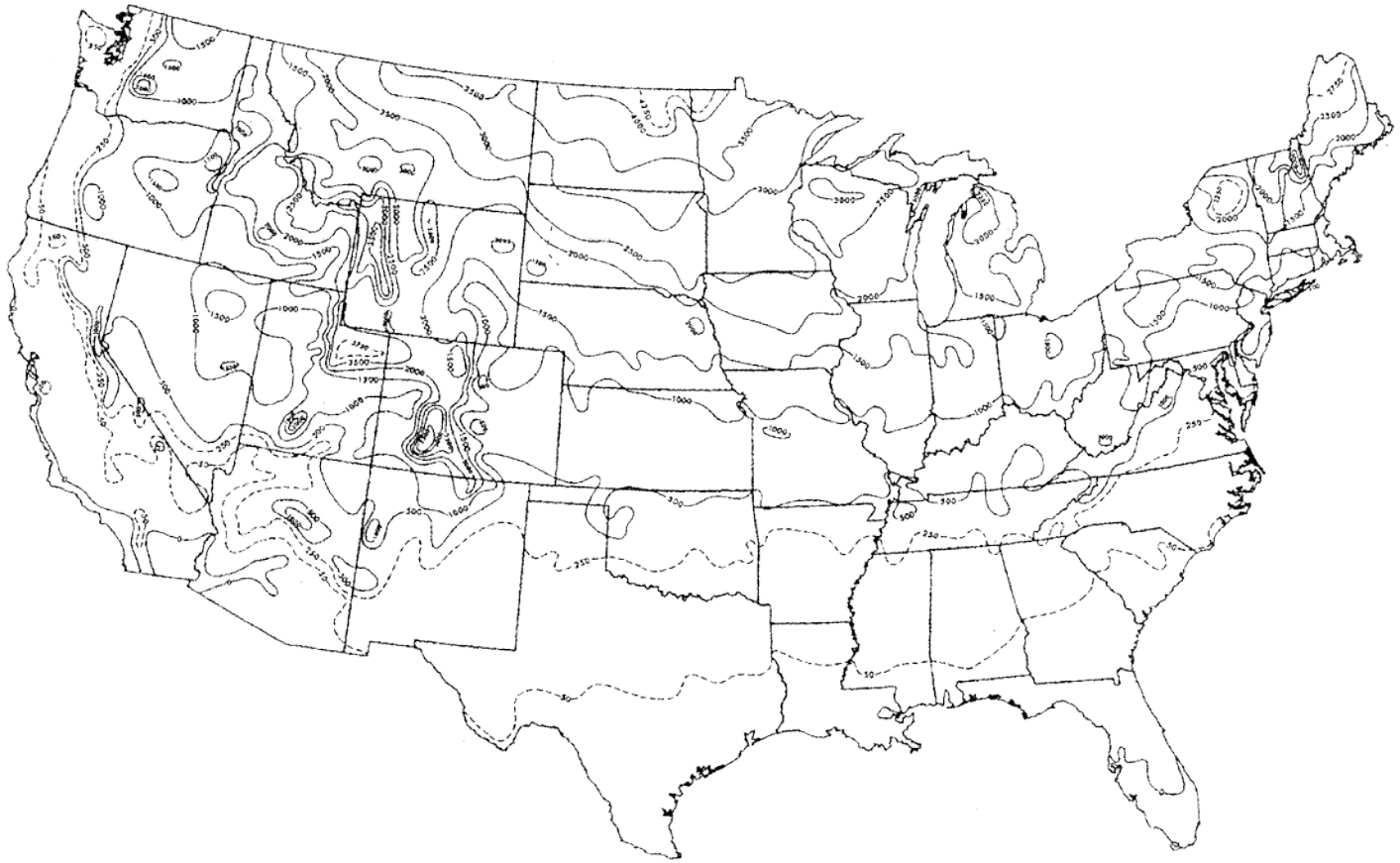
- a. Insulation requirements are for protection against frost damage in heated buildings. Greater values could be required to meet energy conservation standards.
- b. See Figure 403.3(2) or Table 403.3(2) for Air Freezing Index values.
- c. Insulation materials shall provide the stated minimum *R*-values 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 (EPS)-3.2 *R* per inch for vertical insulation and 2.6 *R* per inch for horizontal insulation; Type IX expanded polystyrene (EPS)-3.4 *R* per inch for vertical insulation and 2.8 *R* per inch for horizontal insulation; Types IV, V, VI, VII, and X extruded polystyrene (XPS)-4.5 *R* per inch for vertical insulation and 4.0 *R* per inch for horizontal insulation.
- d. Vertical insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.
- e. Horizontal insulation shall be expanded polystyrene insulation or extruded polystyrene insulation.

**INSULATION DETAIL****HORIZONTAL INSULATION PLAN**

For SI: 1 inch = 25.4 mm.

a. See Table 403.3(1) for required dimensions and *R*-values for vertical and horizontal insulation and minimum footing depth.

**FIGURE 403.3(1)**  
**INSULATION PLACEMENT FOR**  
**FROST-PROTECTED FOOTINGS IN HEATED BUILDINGS**



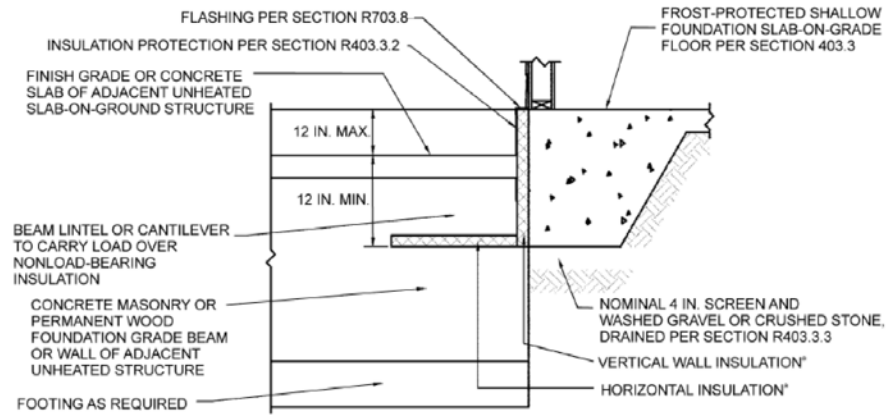
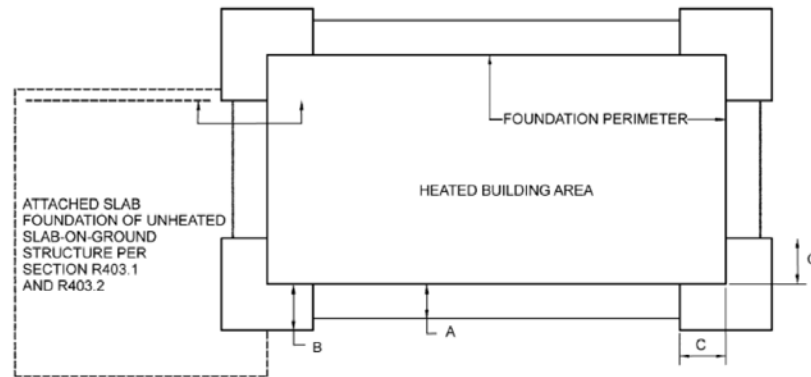
For SI:  $^{\circ}\text{C} = [(^{\circ}\text{F}) - 32]/1.8$ .

**Note:** The air-freezing index is defined as cumulative degree days below  $32^{\circ}\text{F}$ . 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. Dates from the 1951-80 period were fitted to a Weibull probability distribution to produce an estimate of the 100-year return period.

**FIGURE 403.3(2)**  
**AIR-FREEZING INDEX AN ESTIMATE OF THE 100-YEAR RETURN PERIOD**

**TABLE 403.3(2)**  
**AIR-FREEZING INDEX FOR U.S. LOCATIONS BY COUNTY**

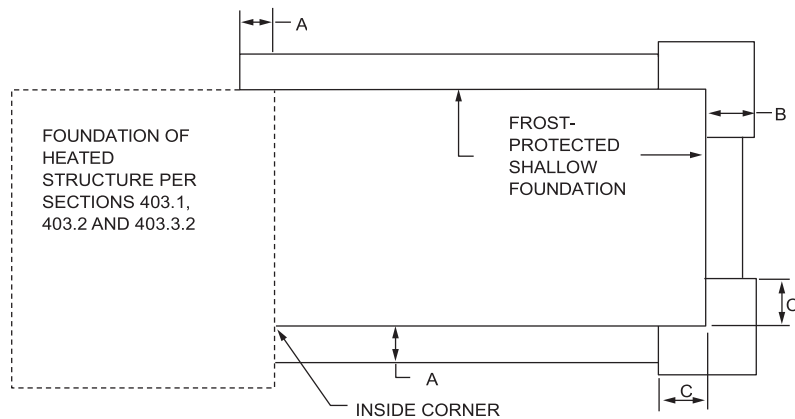
STATE	AIR-FREEZING INDEX					
	1500 or less	2000	2500	3000	3500	4000
Ohio	All counties not listed	Ashland, Crawford, Defiance, Holmes, Huron, Knox, Licking, Morrow, Paulding, Putnam, Richland, Seneca, Williams	—	—	—	—

**INSULATION DETAIL****HORIZONTAL INSULATION PLAN**

For SI: 1 inch = 25.4 mm.

1. See Table 403.3(1) for required dimensions and *R*-values for vertical and horizontal insulation.

**FIGURE 403.3(3)**  
**INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS**  
**ADJACENT TO UNHEATED SLAB-ON-GROUND STRUCTURE**



**FIGURE 403.3(4)**  
**INSULATION PLACEMENT FOR FROST-PROTECTED FOOTINGS**  
**ADJACENT TO HEATED STRUCTURE**

**TABLE 403.4**  
**MINIMUM DEPTH (D) AND WIDTH (W) OF CRUSHED STONE FOOTINGS<sup>a, b</sup> (inches)**

NUMBER OF STORIES	UNIFORM WALL LOAD	DEPTH (D) AND WIDTH (W)	LOAD-BEARING VALUE OF SOIL (psf)																	
			1500			2000			2500			3000			3500			4000		
			MH, CH, CL, ML <sup>c</sup>			SC, GC, SM, GM, SP, SW <sup>c</sup>						GP, GW <sup>c</sup>								
			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)			Wall width (inches)		
			8	10	12	8	10	12	8	10	12	8	10	12	8	10	12	8	10	12
Conventional light-frame construction																				
1-story	1100 plf	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	1800 plf	D	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	15	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
3-story	2900 plf	D	14	12	10	9	7	5	6	4	4	4	4	4	4	4	4	4	4	4
		W	25	24	24	19	19	18	15	15	17	13	15	17	13	15	17	13	15	17
4-inch brick veneer over light-frame or 8-inch hollow concrete masonry																				
1-story	1500 plf	D	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	2700 plf	D	12	11	9	8	6	4	5	4	4	4	4	4	4	4	4	4	4	4
		W	22	23	23	18	17	17	14	15	17	13	15	17	13	15	17	13	15	17
3-story	4000 plf	D	21	20	18	14	13	11	10	8	7	7	6	4	5	4	4	4	4	4
		W	33	34	33	25	26	25	20	20	21	17	17	17	14	15	17	13	15	17
8-inch solid or fully grouted masonry																				
1-story	2000 plf	D	7	6	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
		W	17	17	17	13	15	17	13	15	17	13	15	17	13	15	17	13	15	17
2-story	3600 plf	D	19	17	15	12	11	9	9	7	5	6	4	4	4	4	4	4	4	4
		W	30	30	30	22	23	23	19	19	18	15	15	17	13	15	17	13	15	17
3-story	5300 plf	D	30	29	27	21	19	18	16	14	12	12	10	8	9	8	6	7	6	4
		W	43	44	44	33	32	33	27	27	26	22	22	22	19	20	19	17	17	17

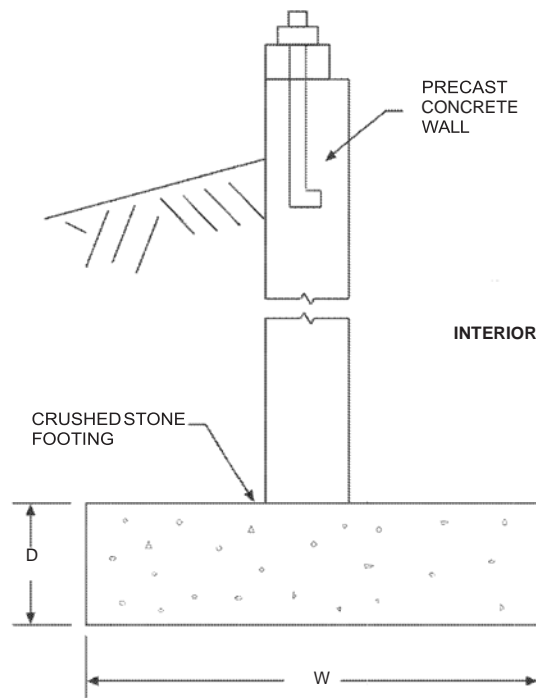
For SI: 1 inch = 25.4 mm, 1 plf = 14.6 N/m, 1 pound per square foot = 47.9 N/m<sup>2</sup>.

- Linear interpolation of stone depth between wall widths is permitted within each Load-Bearing Value of Soil (psf).
- Crushed stone must be consolidated in 8-inch lifts with a plate vibrator.
- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 4045.1.

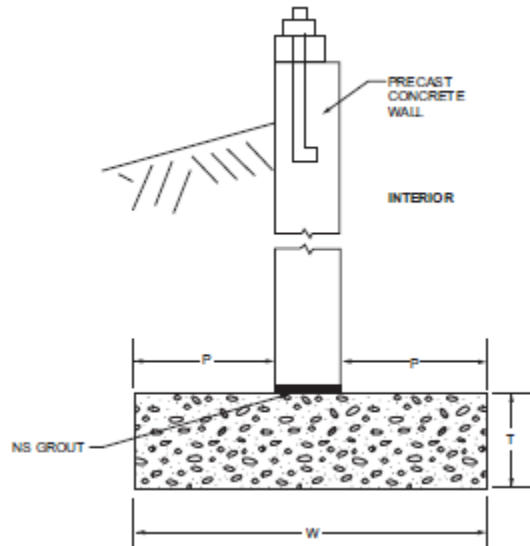
**403.4 Footings for precast concrete foundations.** Footings for precast concrete foundations shall comply with Section 403.4.

**403.4.1 Crushed stone footings.** Clean crushed stone shall be free from organic, clayey or silty soils. Crushed stone shall be angular in nature and meet ASTM C33, with the maximum size stone not to exceed  $\frac{1}{2}$  -inch (12.7 mm) and the minimum stone size not to be smaller than  $\frac{1}{16}$  -inch (1.6 mm). Crushed stone footings for precast foundations shall be installed in accordance with Figure 403.4(1) and Table 403.4. Crushed stone footings shall be consolidated using a vibratory plate in not greater than 8-inch (203 mm) lifts. Crushed stone footings shall be limited to Seismic Design Categories A, B and C.

**403.4.2 Concrete footings.** Concrete footings shall be installed in accordance with Section 403.1 and Figure 403.4(2).



**FIGURE 403.4(1)**  
**BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION**  
**WALL BEARING ON CRUSHED STONE**



**FIGURE 403.4(2)**  
**BASEMENT OR CRAWL SPACE WITH PRECAST FOUNDATION**  
**WALL ON SPREAD FOOTING**

**403.5 Exterior deck footings.** See Section 507 for exterior deck foundation requirements.

## SECTION 404 FOUNDATION AND RETAINING WALLS

**404.1 Concrete and masonry foundation walls.** Concrete foundation walls shall be selected and constructed in accordance with the provisions of Section 404.1.3. Masonry foundation walls shall be selected and constructed in accordance with the provisions of Section 404.1.2.

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

1. Walls are subject to hydrostatic pressure from ground water.
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 404.1.1(1)**  
**PLAIN MASONRY FOUNDATION WALLS <sup>f</sup>**

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

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

- 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.
- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- 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.
- Solid indicates solid masonry unit; grout indicates grouted hollow units.
- Wall construction shall be in accordance with either Table 404.1.1(2), Table 404.1.1(3), Table 404.1.1(4), or a design shall be provided.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.1(2)**  
**8-INCH MASONRY FOUNDATION WALLS WITH**  
**REINFORCING WHERE  $d \geq 5$  INCHES** <sup>a, c, f</sup>

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL <sup>e</sup>	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES) <sup>b, c</sup>		
		Soil classes and lateral soil load <sup>d</sup> (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	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet 8 inches	#4 at 48	#5 at 48	#6 at 48
7 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet 4 inches	#5 at 48	#6 at 48	#6 at 40
8 feet	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#4 at 48
	6 feet	#4 at 48	#5 at 48	#5 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#5 at 48	#6 at 48	#6 at 32
8 feet 8 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet 8 inches	#6 at 48	#6 at 32	#6 at 24
9 feet 4 inches	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 40
	8 feet	#6 at 48	#6 at 40	#6 at 24
10 feet	9 feet 4 inches	#6 at 40	#6 at 24	#6 at 16
	4 feet (or less)	#4 at 48	#4 at 48	#4 at 48
	5 feet	#4 at 48	#4 at 48	#5 at 48
	6 feet	#4 at 48	#5 at 48	#6 at 48
	7 feet	#5 at 48	#6 at 48	#6 at 32
	8 feet	#6 at 48	#6 at 32	#6 at 24
	9 feet	#6 at 40	#6 at 24	#6 at 16
	10 feet	#6 at 32	#6 at 16	#6 at 16

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

- Mortar shall be Type M or S and masonry shall be laid in running bond.
- 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 in Seismic Design Categories A, B and C.
- Vertical reinforcement shall be Grade 60 minimum. The distance,  $d$ , from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 5 inches.
- 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 405.1.
- 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.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.1(3)**  
**10-INCH MASONRY FOUNDATION WALLS WITH**  
**REINFORCING WHERE  $d \geq 6.75$  INCHES <sup>a, c, f</sup>**

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL <sup>e</sup>	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES) <sup>b, c</sup>		
		Soil classes and later soil load <sup>d</sup> (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 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet 8 inches	#4 at 56	#5 at 56	#5 at 56
7 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet 4 inches	#4 at 56	#5 at 56	#6 at 56
8 feet	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 48
8 feet 8 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#4 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet 8 inches	#5 at 56	#6 at 48	#6 at 32
9 feet 4 inches	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#4 at 56	#5 at 56	#6 at 56
	8 feet	#5 at 56	#6 at 56	#6 at 40
10 feet	9 feet 4 inches	#6 at 56	#6 at 40	#6 at 24
	4 feet (or less)	#4 at 56	#4 at 56	#4 at 56
	5 feet	#4 at 56	#4 at 56	#4 at 56
	6 feet	#4 at 56	#5 at 56	#5 at 56
	7 feet	#5 at 56	#6 at 56	#6 at 48
	8 feet	#5 at 56	#6 at 48	#6 at 40
10 feet	9 feet	#6 at 56	#6 at 40	#6 at 24
	10 feet	#6 at 48	#6 at 32	#6 at 24

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

- Mortar shall be Type M or S and masonry shall be laid in running bond.
- 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 in Seismic Design Categories A B and C.
- Vertical reinforcement shall be Grade 60 minimum. The distance,  $d$ , from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 6.75 inches.
- 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 405.1.
- 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.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.1(4)**  
**12-INCH MASONRY FOUNDATION WALLS**  
**WITH REINFORCING WHERE  $d \geq 8.75$  INCHES** <sup>a, c, f</sup>

WALL HEIGHT	HEIGHT OF UNBALANCED BACKFILL <sup>c</sup>	MINIMUM VERTICAL REINFORCEMENT AND SPACING (INCHES) <sup>b, c</sup>		
		Soil classes and lateral soil load <sup>d</sup> (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	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet 8 inches	#4 at 72	#4 at 72	#5 at 72
7 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet 4 inches	#4 at 72	#5 at 72	#6 at 72
8 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 64
8 feet 8 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#4 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet 8 inches	#5 at 72	#7 at 72	#6 at 48
9 feet 4 inches	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#5 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 56
	9 feet 4 inches	#6 at 72	#6 at 48	#6 at 40
10 feet	4 feet (or less)	#4 at 72	#4 at 72	#4 at 72
	5 feet	#4 at 72	#4 at 72	#4 at 72
	6 feet	#4 at 72	#5 at 72	#5 at 72
	7 feet	#4 at 72	#6 at 72	#6 at 72
	8 feet	#5 at 72	#6 at 72	#6 at 48
	9 feet	#6 at 72	#6 at 56	#6 at 40
	10 feet	#6 at 64	#6 at 40	#6 at 32

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

- Mortar shall be Type M or S and masonry shall be laid in running bond.
- 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 in Seismic Design Categories A, B and C.
- Vertical reinforcement shall be Grade 60 minimum. The distance,  $d$ , from the face of the soil side of the wall to the center of vertical reinforcement shall be not less than 8.75 inches.
- 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 405.1.
- 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.
- The use of this table shall be prohibited for soil classifications not shown.

**404.1.2 Design of masonry foundation walls.** Masonry foundation walls shall be designed and constructed in accordance with the provisions of this section or in accordance with the provisions of TMS 402.

**404.1.2.1 Masonry foundation walls.** Concrete masonry and clay masonry foundation walls shall be constructed as set forth in Table 404.1.1(1), 404.1.1(2), 404.1.1(3) or 404.1.1(4) and shall comply with applicable provisions of Section 606. Rubble stone masonry foundation walls shall be constructed in accordance with Sections 404.1.8 and 606.4.2.

**TABLE 404.1.2(1)**  
**MINIMUM HORIZONTAL REINFORCEMENT FOR**  
**CONCRETE BASEMENT WALLS <sup>a, b</sup>**

MAXIMUM UNSUPPORTED HEIGHT OF BASEMENT WALL (feet)	LOCATION OF HORIZONTAL REINFORCEMENT
≤ 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near mid-height of the wall story.
> 8	One No. 4 bar within 12 inches of the top of the wall story and one No. 4 bar near third points in the wall story.

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

- a. Horizontal reinforcement requirements are for reinforcing bars with a minimum yield strength of 40,000 psi and concrete with a minimum concrete compressive strength of 2,500 psi.
- b. See Section 404.1.3.2 for minimum reinforcement required for foundation walls supporting above-grade concrete walls.

**TABLE 404.1.2(2)**  
**MINIMUM VERTICAL REINFORCEMENT FOR**  
**6-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS** <sup>b, c, d, e, g, h, i, j, k</sup>

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>f</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	6 @ 39	6 @ 48
	6	5 @ 39	6 @ 48	6 @ 35
	7	6 @ 48	6 @ 34	6 @ 25
	8	6 @ 39	6 @ 25	6 @ 18
9	4	NR	NR	NR
	5	NR	5 @ 37	6 @ 48
	6	5 @ 36	6 @ 44	6 @ 32
	7	6 @ 47	6 @ 30	6 @ 22
	8	6 @ 34	6 @ 22	6 @ 16
	9	6 @ 27	6 @ 17	DR
10	4	NR	NR	NR
	5	NR	5 @ 35	6 @ 48
	6	6 @ 48	6 @ 41	6 @ 30
	7	6 @ 43	6 @ 28	6 @ 20
	8	6 @ 31	6 @ 20	DR
	9	6 @ 24	6 @ 15	DR
	10	6 @ 19	DR	DR

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m,

1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section 404.1.3.3.7.2.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- NR indicates vertical wall reinforcement is not required, except for 6-inch-nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.
- See Section 404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table 608.3 for tolerance from nominal thickness permitted for flat walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.2(3)**  
**MINIMUM VERTICAL REINFORCEMENT FOR**  
**8-INCH (203 mm) NOMINAL FLAT CONCRETE BASEMENT WALLS** <sup>b, c, d, e, f, h, i, j</sup>

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM- SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 37
	7	NR	6 @ 36	6 @ 35
	8	6 @ 41	6 @ 35	6 @ 26
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 32
	8	6 @ 36	6 @ 32	6 @ 23
	9	6 @ 35	6 @ 25	6 @ 18
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6 @ 35
	7	NR	6 @ 35	6 @ 29
	8	6 @ 35	6 @ 29	6 @ 21
	9	6 @ 34	6 @ 22	6 @ 16
	10	6 @ 27	6 @ 17	6 @ 13

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m,

1 pound per square inch = 6.895 kPa.

NR = Not Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section 404.1.3.3.7.2.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- NR indicates vertical reinforcement is not required.
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section 404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table 608.3 for tolerance from nominal thickness permitted for flat walls.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.2(4)**  
**MINIMUM VERTICAL REINFORCEMENT FOR**  
**10-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS** <sup>b, c, d, e, f, h, i, j</sup>

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	NR
	8	6 @ 48	6 @ 35	6 @ 28
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 31
	8	NR	6 @ 31	6 @ 28
	9	6 @ 37	6 @ 28	6 @ 24
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	NR
	7	NR	NR	6 @ 28
	8	NR	6 @ 28	6 @ 28
	9	6 @ 33	6 @ 28	6 @ 21
	10	6 @ 28	6 @ 23	6 @ 17

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m,  
1 pound per square inch = 6.895 kPa. NR = Not Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section 404.1.3.3.7.2.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- NR indicates vertical reinforcement is not required.
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section 404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table 608.3 for tolerance from nominal thickness permitted for flat walls.
- The use of this table shall be prohibited for soil classifications not shown.



**TABLE 404.1.2(5)**  
**MINIMUM VERTICAL WALL REINFORCEMENT FOR**  
**6-INCH WAFFLE-GRID BASEMENT WALLS** <sup>b, c, d, e, g, h, i, j</sup>

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>f</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	4 @ 48	4 @ 46	6 @ 39
	5	4 @ 45	5 @ 46	6 @ 47
	6	5 @ 45	6 @ 40	DR
	7	6 @ 44	DR	DR
	8	6 @ 32	DR	DR
9	4	4 @ 48	4 @ 46	4 @ 37
	5	4 @ 42	5 @ 43	6 @ 44
	6	5 @ 41	6 @ 37	DR
	7	6 @ 39	DR	DR
	> 8	DR <sup>i</sup>	DR	DR
10	4	4 @ 48	4 @ 46	4 @ 35
	5	4 @ 40	5 @ 40	6 @ 41
	6	5 @ 38	6 @ 34	DR
	7	6 @ 36	DR	DR
	> 8	DR	DR	DR

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m,  
1 pound per square inch = 6.895 kPa.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section 404.1.3.3.7.2.
- Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section 404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table 608.3 for thicknesses and dimensions of waffle-grid walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.2(6)**  
**MINIMUM VERTICAL REINFORCEMENT FOR**  
**8-INCH WAFFLE-GRID BASEMENT WALLS** <sup>b, c, d, e, f, h, i, j, k</sup>

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	NR	NR	NR
	5	NR	5 @ 48	5 @ 46
	6	5 @ 48	5 @ 43	6 @ 45
	7	5 @ 46	6 @ 43	6 @ 31
	8	6 @ 48	6 @ 32	6 @ 23
9	4	NR	NR	NR
	5	NR	5 @ 47	5 @ 46
	6	5 @ 46	5 @ 39	6 @ 41
	7	5 @ 42	6 @ 38	6 @ 28
	8	6 @ 44	6 @ 28	6 @ 20
	9	6 @ 34	6 @ 21	DR
10	4	NR	NR	NR
	5	NR	5 @ 46	5 @ 44
	6	5 @ 46	5 @ 37	6 @ 38
	7	5 @ 38	6 @ 35	6 @ 25
	8	6 @ 39	6 @ 25	DR
	9	6 @ 30	DR	DR
	10	6 @ 24	DR	DR

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m,

1 pound per square inch = 6.895 kPa.

NR = Not Required.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section 404.1.3.3.7.2.
- Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 (420 MPa) and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- NR indicates vertical reinforcement is not required.
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation shall not be permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Section 404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table 608.3 for thicknesses and dimensions of waffle-grid walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.2(7)**  
**MINIMUM VERTICAL REINFORCEMENT FOR**  
**6-INCH (152 mm) SCREEN-GRID BASEMENT WALLS <sup>b, c, d, e, g, h, i, j</sup>**

MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>f</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)		
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)		
		GW, GP, SW, SP 30	GM, GC, SM, SM-SC and ML 45	SC, ML-CL and inorganic CL 60
8	4	4 @ 48	4 @ 48	5 @ 43
	5	4 @ 48	5 @ 48	5 @ 37
	6	5 @ 48	6 @ 45	6 @ 32
	7	6 @ 48	DR	DR
	8	6 @ 36	DR	DR
9	4	4 @ 48	4 @ 48	4 @ 41
	5	4 @ 48	5 @ 48	6 @ 48
	6	5 @ 45	6 @ 41	DR
	7	6 @ 43	DR	DR
	> 8	DR	DR	DR
10	4	4 @ 48	4 @ 48	4 @ 39
	5	4 @ 44	5 @ 44	6 @ 46
	6	5 @ 42	6 @ 38	DR
	7	6 @ 40	DR	DR
	> 8	DR	DR	DR

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m,  
1 pound per square inch = 6.895 kPa.

DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi and vertical reinforcement being located at the centerline of the wall. See Section 404.1.3.3.7.2.
- Maximum spacings shown are the values calculated for the specified bar size. Where the bar used is Grade 60 and the size specified in the table, the actual spacing in the wall shall not exceed a whole-number multiple of 12 inches (12, 24, 36 and 48) that is less than or equal to the tabulated spacing. Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- Deflection criterion is  $L/240$ , where  $L$  is the height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- See Sections 404.1.3.2 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
- See Table 608.3 for thicknesses and dimensions of screen-grid walls.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.2(8)**  
**MINIMUM VERTICAL REINFORCEMENT FOR**  
**6-, 8-, 10- AND 12-INCH NOMINAL FLAT BASEMENT WALLS** <sup>b, c, d, e, f, h, i, k, n, o</sup>

MAXIMUM WALL HEIGHT (feet)	MAXIMUM UNBALANCED BACKFILL HEIGHT <sup>g</sup> (feet)	MINIMUM VERTICAL REINFORCEMENT-BAR SIZE AND SPACING (inches)											
		Soil classes <sup>a</sup> and design lateral soil (psf per foot of depth)											
		GW, GP, SW, SP 30				GM, GC, SM, SM-SC and ML 45				SC, ML-CL and inorganic CL 60			
		Minimum nominal wall thickness (inches)											
		6	8	10	12	6	8	10	12	6	8	10	12
5	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR <sup>1</sup>	NR	NR	4 @ 35	NR <sup>1</sup>	NR	NR
	6	NR	NR	NR	NR	5 @ 48	NR	NR	NR	5 @ 36	NR	NR	NR
7	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	5 @ 47	NR	NR	NR
	6	NR	NR	NR	NR	5 @ 42	NR	NR	NR	6 @ 43	5 @ 48	NR <sup>1</sup>	NR
	7	5 @ 46	NR	NR	NR	6 @ 42	5 @ 46	NR <sup>1</sup>	NR	6 @ 34	6 @ 48	NR	NR
8	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 38	NR <sup>1</sup>	NR	NR	5 @ 43	NR	NR	NR
	6	4 @ 37	NR <sup>1</sup>	NR	NR	5 @ 37	NR	NR	NR	6 @ 37	5 @ 43	NR <sup>1</sup>	NR
	7	5 @ 40	NR	NR	NR	6 @ 37	5 @ 41	NR <sup>1</sup>	NR	6 @ 34	6 @ 43	NR	NR
	8	6 @ 43	5 @ 47	NR <sup>1</sup>	NR	6 @ 34	6 @ 43	NR	NR	6 @ 27	6 @ 32	6 @ 44	NR
9	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 35	NR <sup>1</sup>	NR	NR	5 @ 40	NR	NR	NR
	6	4 @ 34	NR <sup>1</sup>	NR	NR	6 @ 48	NR	NR	NR	6 @ 36	6 @ 39	NR <sup>1</sup>	NR
	7	5 @ 36	NR	NR	NR	6 @ 34	5 @ 37	NR	NR	6 @ 33	6 @ 38	5 @ 37	NR <sup>1</sup>
	8	6 @ 38	5 @ 41	NR <sup>1</sup>	NR	6 @ 33	6 @ 38	5 @ 37	NR <sup>1</sup>	6 @ 24	6 @ 29	6 @ 39	4 @ 48 <sup>m</sup>
	9	6 @ 34	6 @ 46	NR	NR	6 @ 26	6 @ 30	6 @ 41	NR	6 @ 19	6 @ 23	6 @ 30	6 @ 39
10	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4 @ 33	NR <sup>1</sup>	NR	NR	5 @ 38	NR	NR	NR
	6	5 @ 48	NR <sup>1</sup>	NR	NR	6 @ 45	NR	NR	NR	6 @ 34	5 @ 37	NR	NR
	7	6 @ 47	NR	NR	NR	6 @ 34	6 @ 48	NR	NR	6 @ 30	6 @ 35	6 @ 48	NR <sup>1</sup>
	8	6 @ 34	5 @ 38	NR	NR	6 @ 30	6 @ 34	6 @ 47	NR <sup>1</sup>	6 @ 22	6 @ 26	6 @ 35	6 @ 45 <sup>m</sup>
	9	6 @ 34	6 @ 41	4 @ 48	NR <sup>1</sup>	6 @ 23	6 @ 27	6 @ 35	4 @ 48 <sup>m</sup>	DR	6 @ 22	6 @ 27	6 @ 34
	10	6 @ 28	6 @ 33	6 @ 45	NR	DR <sup>j</sup>	6 @ 23	6 @ 29	6 @ 38	DR	6 @ 22	6 @ 22	6 @ 28

For SI: 1 inch = 25.4 mm; 1 foot = 304.8 mm; 1 pound per square foot per foot = 0.1571 kPa<sup>2</sup>/m, 1 pound per square inch = 6.895 kPa.

NR = Not Required. DR = Design Required.

- Soil classes are in accordance with the Unified Soil Classification System. Refer to Table 405.1.
- Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi.
- Vertical reinforcement with a yield strength of less than 60,000 psi and bars of a different size than specified in the table are permitted in accordance with Section 404.1.3.3.7.6 and Table 404.1.2(9).
- NR indicates vertical wall reinforcement is not required, except for 6-inch nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be No. 4@48 inches on center.
- Allowable deflection criterion is  $L/240$ , where  $L$  is the unsupported height of the basement wall in inches.
- Interpolation is not permitted.
- Where walls will retain 4 feet or more of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
- Vertical reinforcement shall be located to provide a cover of  $1\frac{1}{4}$ -inches measured from the inside face of the wall. The center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness or  $\frac{3}{8}$ -inch.
- Concrete cover for reinforcement measured from the inside face of the wall shall be not less than  $\frac{3}{4}$ -inch. Concrete cover for reinforcement measured from the outside face of the wall shall be not less than  $1\frac{1}{2}$ -inches for No. 5 bars and smaller, and not less than 2 -inches for larger bars.
- DR means design is required in accordance with the applicable building code, or in the absence of a code, in accordance with ACI 318.
- Concrete shall have a specified compressive strength,  $f'_c$ , of not less than 2,500 psi at 28 days, unless a higher strength is required by Footnote l or m.
- The minimum thickness is permitted to be reduced 2 inches, provided that the minimum specified compressive strength of concrete,  $f'_c$ , is 4,000 psi.
- A plain concrete wall with a minimum nominal thickness of 12 inches is permitted, provided that the minimum specified compressive strength of concrete,  $f'_c$ , is 3,500 psi.
- See Table 608.3 for tolerance from nominal thickness permitted for flat walls.
- The use of this table shall be prohibited for soil classifications not shown.

**TABLE 404.1.2(9)**  
**MINIMUM SPACING FOR ALTERNATE BAR SIZE AND**  
**ALTERNATE GRADE OF STEEL<sup>a, b, c</sup>**

BAR SPACING FROM APPLICABLE TABLE IN SECTION 404.1.3.2 (inches)	BAR SIZE FROM APPLICABLE TABLE IN SECTION 404.1.3.2														
	#4					#5					#6				
	Alternate bar size and alternate grade of steel desired														
	Grade 60		Grade 40			Grade 60		Grade 40			Grade 60		Grade 40		
	#5	#6	#4	#5	#6	#4	#6	#4	#5	#6	#4	#5	#4	#5	#6
	Maximum spacing for alternate bar size and alternate grade of steel (inches)														
8	12	18	5	8	12	5	11	3	5	8	4	6	2	4	5
9	14	20	6	9	13	6	13	4	6	9	4	6	3	4	6
10	16	22	7	10	15	6	14	4	7	9	5	7	3	5	7
11	17	24	7	11	16	7	16	5	7	10	5	8	3	5	7
12	19	26	8	12	18	8	17	5	8	11	5	8	4	6	8
13	20	29	9	13	19	8	18	6	9	12	6	9	4	6	9
14	22	31	9	14	21	9	20	6	9	13	6	10	4	7	9
15	23	33	10	16	22	10	21	6	10	14	7	11	5	7	10
16	25	35	11	17	23	10	23	7	11	15	7	11	5	8	11
17	26	37	11	18	25	11	24	7	11	16	8	12	5	8	11
18	28	40	12	19	26	12	26	8	12	17	8	13	5	8	12
19	29	42	13	20	28	12	27	8	13	18	9	13	6	9	13
20	31	44	13	21	29	13	28	9	13	19	9	14	6	9	13
21	33	46	14	22	31	14	30	9	14	20	10	15	6	10	14
22	34	48	15	23	32	14	31	9	15	21	10	16	7	10	15
23	36	48	15	24	34	15	33	10	15	22	10	16	7	11	15
24	37	48	16	25	35	15	34	10	16	23	11	17	7	11	16
25	39	48	17	26	37	16	35	11	17	24	11	18	8	12	17
26	40	48	17	27	38	17	37	11	17	25	12	18	8	12	17
27	42	48	18	28	40	17	38	12	18	26	12	19	8	13	18
28	43	48	19	29	41	18	40	12	19	26	13	20	8	13	19
29	45	48	19	30	43	19	41	12	19	27	13	20	9	14	19
30	47	48	20	31	44	19	43	13	20	28	14	21	9	14	20
31	48	48	21	32	45	20	44	13	21	29	14	22	9	15	21
32	48	48	21	33	47	21	45	14	21	30	15	23	10	15	21
33	48	48	22	34	48	21	47	14	22	31	15	23	10	16	22
34	48	48	23	35	48	22	48	15	23	32	15	24	10	16	23
35	48	48	23	36	48	23	48	15	23	33	16	25	11	16	23
36	48	48	24	37	48	23	48	15	24	34	16	25	11	17	24
37	48	48	25	38	48	24	48	16	25	35	17	26	11	17	25
38	48	48	25	39	48	25	48	16	25	36	17	27	12	18	25
39	48	48	26	40	48	25	48	17	26	37	18	27	12	18	26
40	48	48	27	41	48	26	48	17	27	38	18	28	12	19	27
41	48	48	27	42	48	26	48	18	27	39	19	29	12	19	27
42	48	48	28	43	48	27	48	18	28	40	19	30	13	20	28
43	48	48	29	44	48	28	48	18	29	41	20	30	13	20	29
44	48	48	29	45	48	28	48	19	29	42	20	31	13	21	29
45	48	48	30	47	48	29	48	19	30	43	20	32	14	21	30
46	48	48	31	48	48	30	48	20	31	44	21	32	14	22	31
47	48	48	31	48	48	30	48	20	31	44	21	33	14	22	31
48	48	48	32	48	48	31	48	21	32	45	22	34	15	23	32

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

- This table is for use with tables in Section 404.1.3.2 that specify the minimum bar size and maximum spacing of vertical wall reinforcement for foundation walls and above-grade walls. Reinforcement specified in tables in Section 404.1.3.2 is based on Grade 60 steel reinforcement.
- Bar spacing shall not exceed 48 inches on center and shall be not less than one-half the nominal wall thickness.
- For Grade 50 steel bars (ASTM A996, Type R), use spacing for Grade 40 bars or interpolate between Grades 40 and 60.

**404.1.3 Concrete foundation walls.** Concrete foundation walls that support light-frame walls shall be designed and constructed in accordance with the provisions of this section, ACI 318, ACI 332 or PCA 100. Concrete foundation walls that support above-grade concrete walls that are within the applicability limits of Section 608.2 shall be designed and constructed in accordance with the provisions of this section, ACI 318, ACI 332 or PCA 100. Concrete foundation walls that support above-grade concrete walls that are not within the applicability limits of Section 608.2 shall be designed and constructed in accordance with the provisions of ACI 318, ACI 332 or PCA 100.

**404.1.3.1 Concrete cross-section.** Concrete walls constructed in accordance with this code shall comply with the shapes and minimum concrete cross-sectional dimensions required by Table 608.3. Other types of forming systems resulting in concrete walls not in compliance with this section and Table 608.3 shall be designed in accordance with ACI 318.

**404.1.3.2 Reinforcement for foundation walls.** Concrete foundation walls shall be laterally supported at the top and bottom. Horizontal reinforcement shall be provided in accordance with Table 404.1.2(1). Vertical reinforcement shall be provided in accordance with Table 404.1.2(2), 404.1.2(3), 404.1.2(4), 404.1.2(5), 404.1.2(6), 404.1.2(7) or 404.1.2(8). Vertical reinforcement for flat basement walls retaining 4 feet (1219 mm) or more of unbalanced backfill is permitted to be determined in accordance with Table 404.1.2(8). For basement walls supporting above-grade concrete walls, vertical reinforcement shall be the greater of that required by Tables 404.1.2(2) through 404.1.2(8) or by Section 608.6 for the above-grade wall.

**404.1.3.2.1 Concrete foundation stem walls supporting above-grade concrete walls.** Foundation stem walls that support above-grade concrete walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground shall comply with this section. Where unbalanced backfill retained by the stem wall is less than or equal to 18 inches (457 mm), the stem wall and above-grade wall it supports shall be provided with vertical reinforcement in accordance with Section 608.6 and Table 608.6(1), 608.6(2) or 608.6(3) for above-grade walls. Where unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the stem wall and above-grade wall it

supports shall be provided with vertical reinforcement in accordance with Section 608.6 and Table 608.6(4).

2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be vertically reinforced in accordance with Section 608.6 and Table 608.6(1), 608.6(2) or 608.6(3) for above-grade walls. Where the unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall shall be designed in accordance with PCA 100 or with accepted engineering practice. Where the unbalanced backfill retained by the stem wall is greater than 18 inches (457 mm), the minimum nominal thickness of the wall shall be 6 inches (152 mm).

**404.1.3.2.2 Concrete foundation stem walls supporting light-frame above-grade walls.** Concrete foundation stem walls that support light-frame, above-grade walls shall be designed and constructed in accordance with this section.

1. Stem walls not laterally supported at top. Concrete stem walls that are not monolithic with slabs-on-ground or are not otherwise laterally supported by slabs-on-ground and retain 48 inches (1219 mm) or less of unbalanced fill, measured from the top of the wall, shall be constructed in accordance with Section 404.1.3. Foundation stem walls that retain more than 48 inches (1219 mm) of unbalanced fill, measured from the top of the wall, shall be designed in accordance with Sections 404.1.4 and 404.4.
2. Stem walls laterally supported at top. Concrete stem walls that are monolithic with slabs-on-ground or are otherwise laterally supported by slabs-on-ground shall be constructed in accordance with Section 404.1.3. Where the unbalanced backfill retained by the stem wall is greater than 48 inches (1219 mm), the connection between the stem wall and the slab-on-ground, and the portion of the slab-on-ground providing lateral support for the wall, shall be designed in accordance with PCA 100 or in accordance with accepted engineering practice.

**404.1.3.3 Concrete, materials for concrete, and forms.** Materials used in concrete, the concrete itself and forms shall conform to requirements of this section or ACI 318.

**404.1.3.3.1 Compressive strength.** The minimum specified compressive strength of concrete,  $f'_c$ , shall comply with Section 402.2 and shall be not less than 2,500 psi (17.2 MPa) at 28 days in buildings assigned to Seismic Design Category A, B or C.

**404.1.3.3.2 Concrete mixing and delivery.** Mixing and delivery of concrete shall comply with ASTM C94 or ASTM C685.

**404.1.3.3.3 Maximum aggregate size.** The nominal maximum size of coarse aggregate shall not exceed one-fifth the narrowest distance between sides of forms, or three-fourths the clear spacing between reinforcing bars or between a bar and the side of the form.

**Exception:** Where approved, these limitations shall not apply where removable forms are used and workability and methods of consolidation permit concrete to be placed without honeycombs or voids.

**404.1.3.3.4 Proportioning and slump of concrete.** Proportions of materials for concrete shall be established to provide workability and consistency to permit concrete to be worked readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding. Slump of concrete placed in removable forms shall not exceed 6 inches (152 mm).

**Exception:** Where approved, the slump is permitted to exceed 6 inches (152 mm) for concrete mixtures that are resistant to segregation, and are in accordance with the form manufacturer's recommendations.

Slump of concrete placed in stay-in-place forms shall exceed 6 inches (152 mm). Slump of concrete shall be determined in accordance with ASTM C143.

**404.1.3.3.5 Consolidation of concrete.** Concrete shall be consolidated by suitable means during placement and shall be worked around embedded items and reinforcement and into corners of forms. Where stay-in-place forms are used, concrete shall be consolidated by internal vibration.

**Exception:** Where approved for concrete to be placed in stay-in-place forms, self-consolidating concrete mixtures with slumps equal to or greater than 8 inches (203 mm) that are specifically designed



for placement without internal vibration need not be internally vibrated.

**404.1.3.3.6 Form materials and form ties.** Forms shall be made of wood, steel, aluminum, plastic, a composite of cement and foam insulation, a composite of cement and wood chips, or other approved material suitable for supporting and containing concrete. Forms shall provide sufficient strength to contain concrete during the concrete placement operation.

Form ties shall be steel, solid plastic, foam plastic, a composite of cement and wood chips, a composite of cement and foam plastic, or other suitable material capable of resisting the forces created by fluid pressure of fresh concrete.

**404.1.3.3.6.1 Stay-in-place forms.** Stay-in-place concrete forms shall comply with this section.

1. Surface burning characteristics. The flame-spread index and smoke-developed index of forming material, other than foam plastic, left exposed on the interior shall comply with Section 302. The surface burning characteristics of foam plastic used in insulating concrete forms shall comply with Section 316.3.
2. Interior covering. Stay-in-place forms constructed of rigid foam plastic shall be protected on the interior of the building as required by Section 316. Where gypsum board is used to protect the foam plastic, it shall be installed with a mechanical fastening system. Use of adhesives in addition to mechanical fasteners is permitted.
3. Exterior wall covering. Stay-in-place forms constructed of rigid foam plastics shall be protected from sunlight and physical damage by the application of an approved exterior wall covering complying with this code. Exterior surfaces of other stay-in-place forming systems shall be protected in accordance with this code.
4. Termite protection. In areas where the probability of termite infestation is “very heavy” as indicated by Table 301.2(1) or Figure 301.2(7), foam plastic insulation shall be permitted below grade on foundation walls in accordance with Section 318.4.
5. Flat ICF wall system forms shall conform to ASTM E2634.

**404.1.3.3.7 Reinforcement.**

**404.1.3.3.7.1 Steel reinforcement.** Steel reinforcement shall comply with the requirements of ASTM A615, A706, or A996. ASTM A996 bars produced from rail steel shall be Type R. In buildings assigned to Seismic Design Category A, B or C, the minimum yield strength of reinforcing steel shall be 40,000 psi (Grade 40) (276 MPa).

**404.1.3.3.7.2 Location of reinforcement in wall.** The center of vertical reinforcement in basement walls determined from Tables 404.1.2(2) through 404.1.2(7) shall be located at the centerline of the wall. Vertical reinforcement in basement walls determined from Table 404.1.2(8) shall be located to provide a maximum cover of  $1\frac{1}{4}$  -inches (32 mm) measured from the inside face of the wall. Regardless of the table used to determine vertical wall reinforcement, the center of the steel shall not vary from the specified location by more than the greater of 10 percent of the wall thickness and  $\frac{3}{8}$  -inch (10 mm). Horizontal and vertical reinforcement shall be located in foundation walls to provide the minimum cover required by Section 404.1.3.3.7.4.

**404.1.3.3.7.3 Wall openings.** Vertical wall reinforcement required by Section 404.1.3.2 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.

**404.1.3.3.7.4 Support and cover.** Reinforcement shall be secured in the proper location in the forms with tie wire or other bar support system to prevent displacement during the concrete placement operation. Steel reinforcement in concrete cast against the earth shall have a minimum cover of 3 inches (75 mm). Minimum cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather shall be  $1\frac{1}{2}$  -inches (38 mm) for No. 5 bars and smaller, and 2 inches (50 mm) for No. 6 bars and larger. For concrete cast in removable forms that will not be exposed to the earth or weather, and for concrete cast in stay-in-place forms, minimum cover shall be  $\frac{3}{4}$  -inch (19 mm). The minus tolerance for cover shall not exceed the smaller of one-third the required cover or  $\frac{3}{8}$  -inch (10 mm).

**404.1.3.3.7.5 Lap splices.** Vertical and horizontal wall reinforcement shall be the longest lengths practical. Where splices are necessary in reinforcement, the length of lap splice shall be in accordance with Table 608.5.4(1) and Figure 608.5.4(1). The

maximum gap between noncontact parallel bars at a lap splice shall not exceed the smaller of one-fifth the required lap length and 6 inches (152 mm) [See Figure 608.5.4(1)].

**404.1.3.3.7.6 Alternate grade of reinforcement and spacing.**

Where tables in Section 404.1.3.2 specify vertical wall reinforcement based on minimum bar size and maximum spacing, which are based on Grade 60 (414 MPa) steel reinforcement, different size bars or bars made from a different grade of steel are permitted provided that an equivalent area of steel per linear foot of wall is provided. Use of Table 404.1.2(9) is permitted to determine the maximum bar spacing for different bar sizes than specified in the tables or bars made from a different grade of steel. Bars shall not be spaced less than one-half the wall thickness, or more than 48 inches (1219 mm) on center.

**404.1.3.3.7.7 Standard hooks.** Where reinforcement is required by this code to terminate with a standard hook, the hook shall comply with Section 608.5.4.5 and Figure 608.5.4(3).

**404.1.3.3.7.8 Construction joint reinforcement.** Construction joints in foundation walls shall be made and located to not impair the strength of the wall. Construction joints in plain concrete walls, including walls required to have not less than No. 4 bars at 48 inches (1219 mm) on center by Sections 404.1.3.2 and 404.1.4.2, shall be located at points of lateral support, and not fewer than one No. 4 bar shall extend across the construction joint at a spacing not to exceed 24 inches (610 mm) on center. Construction joint reinforcement shall have not less than 12 inches (305 mm) embedment on both sides of the joint. Construction joints in reinforced concrete walls shall be located in the middle third of the span between lateral supports, or located and constructed as required for joints in plain concrete walls.

**Exception:** Use of vertical wall reinforcement required by this code is permitted in lieu of construction joint reinforcement provided that the spacing does not exceed 24 inches (610 mm), or the combination of wall reinforcement and No. 4 bars described in this section does not exceed 24 inches (610 mm).

**404.1.3.3.8 Exterior wall coverings.** Requirements for installation of masonry veneer, stucco and other wall coverings on the exterior of concrete walls and other construction details not covered in this section

shall comply with the requirements of this code.

**404.1.3.4 Requirements for Seismic Design Category C.** Concrete foundation walls supporting above-grade concrete walls in *dwelling units with four or more dwelling units* assigned to Seismic Design Category C shall comply with ACI 318, ACI 332 or PCA 100 (see Section 404.1.3).

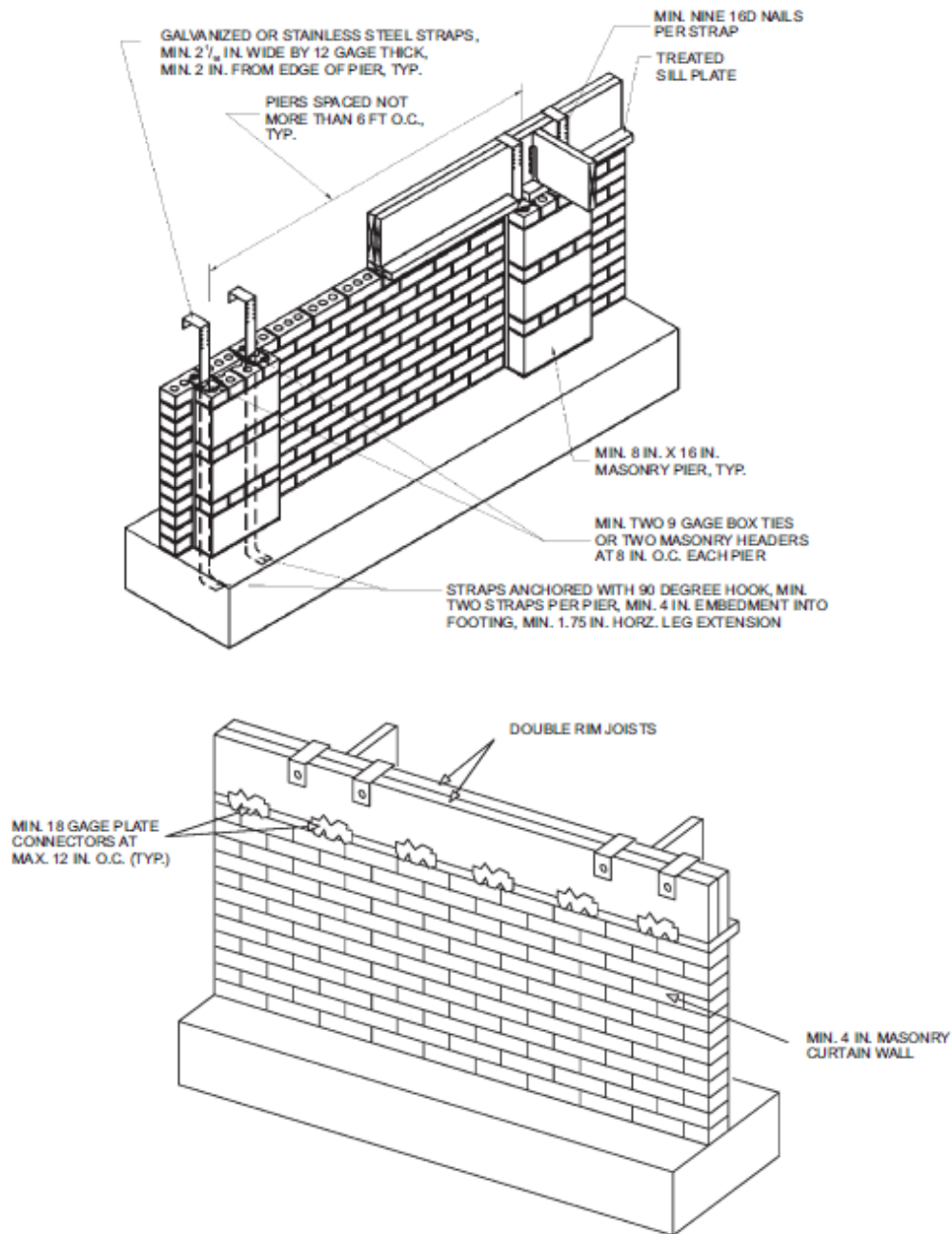
**404.1.4 Seismic Design Category D<sub>0</sub>, D<sub>1</sub> or D<sub>2</sub>.** *deleted*

**404.1.4.1 Masonry foundation walls.** *deleted*

**404.1.4.2 Concrete foundation walls.** *deleted*

**404.1.5 Foundation wall thickness based on walls supported.** The thickness of masonry or concrete foundation walls shall be not less than that required by Section 404.1.5.1 or 404.1.5.2, respectively.

**404.1.5.1 Masonry wall thickness.** Masonry foundation walls shall be not less than the thickness of the wall supported, except that masonry foundation walls of not less than 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 that the requirements of Section 404.1.1 are met.



For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 degree = 0.0175 rad

**FIGURE 404.1.5(1)**  
**FOUNDATION WALL CLAY MASONRY CURTAIN WALL WITH**  
**CONCRETE MASONRY PIERS**

**404.1.5.2 Concrete wall thickness.** The thickness of concrete foundation walls shall be equal to or greater than the thickness of the wall in the story above. Concrete foundation walls with corbels, brackets or other projections built into the wall for support of masonry veneer or other purposes are not within the scope of the tables in this section.

Where a concrete foundation wall is reduced in thickness to provide a shelf for the support of masonry veneer, the reduced thickness shall be equal to or greater than the thickness of the wall in the story above. Vertical reinforcement for the foundation wall shall be based on Table 404.1.2(8) and located in the wall as required by Section 404.1.3.3.7.2 where that table is used. Vertical reinforcement shall be based on the thickness of the thinner portion of the wall.

**Exception:** Where the height of the reduced thickness portion measured to the underside of the floor assembly or sill plate above is less than or equal to 24 inches (610 mm) and the reduction in thickness does not exceed 4 inches (102 mm), the vertical reinforcement is permitted to be based on the thicker portion of the wall.

**404.1.5.3 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 that 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  $3\frac{3}{8}$ -inches (92 mm) actual thickness, and shall be bonded integrally with piers spaced in accordance with Section 606.6.4.
3. Piers shall be constructed in accordance with Sections 606.7 and 606.7.1, and shall be bonded into the load-bearing masonry wall in accordance with Section 606.13.1 or 606.13.1.1.
4. The maximum height of a 4-inch (102 mm) load-bearing masonry foundation wall supporting wood-frame walls and floors shall be not more than 4 feet (1219 mm).
5. Anchorage shall be in accordance with Section 403.1.6, Figure 404.1.5(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. *deleted*

**404.1.6 Height above finished grade.** Concrete and masonry foundation walls shall extend above the finished grade adjacent to the foundation at all points not less than 4 inches (102 mm) where masonry veneer is used and not less than 6 inches (152 mm) elsewhere.

**404.1.7 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.

**404.1.8 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 *and* shall not support a soil pressure greater than 30 pounds per square foot per foot (4.71 kPa/m), and shall not be constructed *for dwellings with four or more dwelling units* in Seismic Design Category C, as established in Figure 301.2(2)

**404.1.9 Isolated masonry piers.** Isolated masonry piers shall be constructed in accordance with this section and the general masonry construction requirements of Section 606. Hollow masonry piers shall have a minimum nominal thickness of 8 inches (203 mm), with a nominal height not exceeding four times the nominal thickness and a nominal length not exceeding three times the nominal thickness. Where hollow masonry units are solidly filled with concrete or grout, piers shall be permitted to have a nominal height not exceeding ten times the nominal thickness. Footings for isolated masonry piers shall be sized in accordance with Section 403.1.1.

**404.1.9.1 Pier cap.** Hollow masonry piers shall be capped with 4 inches (102 mm) of solid masonry or concrete, a masonry cap block, or shall have cavities of the top course filled with concrete or grout. Where required, termite protection for the pier cap shall be provided in accordance with Section 318.

**404.1.9.2 Masonry piers supporting floor girders.** Masonry piers supporting wood girders sized in accordance with Tables 602.7(1) and 602.7(2) shall be permitted in accordance with this section. Piers supporting girders for interior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 10 feet (3048 mm) from top of footing to bottom of sill plate or girder. Piers supporting girders for

exterior bearing walls shall have a minimum nominal dimension of 12 inches (305 mm) and a maximum height of 4 feet (1220 mm) from top of footing to bottom of sill plate or girder. Girders and sill plates shall be anchored to the pier or footing in accordance with Section 403.1.6 or Figure 404.1.5(1). Floor girder bearing shall be in accordance with Section 502.6.

**404.1.9.3 Masonry piers supporting braced wall panels.** Masonry piers supporting braced wall panels shall be designed in accordance with accepted engineering practice.

**404.1.9.4 Seismic design of masonry piers.** Masonry piers in *dwelling units with four or more dwelling units* located in Seismic Design Category C, shall be designed in accordance with accepted engineering practice.

**404.1.9.5 Masonry piers in flood hazard areas.** Masonry piers for dwellings in flood hazard areas shall be designed in accordance with Section 322.

**404.2 Wood foundation walls.** Wood foundation walls shall be constructed in accordance with the provisions of Sections 404.2.1 through 404.2.6 and with the details shown in Figures 403.1(2) and 403.1(3).

**404.2.1 Identification.** Load-bearing lumber shall be identified by the grade mark of a lumber grading or inspection agency that 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.

**404.2.2 Stud size.** The studs used in foundation walls shall be 2-inch by 6-inch (51 mm by 152 mm) members. Where 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 (8619 kPa) as listed in ANSI AWC NDS shall be used. Where spaced 12 inches (305 mm) on center, an  $F_b$  of not less than 875 psi (6033 kPa) shall be required.

**404.2.3 Height of backfill.** For wood foundations that are not designed and installed in accordance with AWC PWF, the height of backfill against a foundation wall shall not exceed 4 feet (1219 mm). Where 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 404.2.3.

**TABLE 404.2.3**  
**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			FACE GRAIN PARALLEL TO STUDS		
		Grade <sup>a</sup>	Minimum thickness (inches)	Span rating	Grade <sup>a</sup>	Minimum thickness (inches) <sup>b, c</sup>	Span rating
24	12	B	15/32	32/16	A	15/32	32/16
					B	15/32 <sup>c</sup>	32/16
	16	B	15/32	32/16	A	15/32 <sup>c</sup>	32/16
					B	19/32 <sup>c</sup> (4, 5 ply)	40/20
36	12	B	15/32	32/16	A	15/32	32/16
					B	15/32 <sup>c</sup> (4, 5 ply)	32/16
					B	19/32 (4, 5 ply)	40/20
	16	B	15/32 <sup>c</sup>	32/16	A	19/32	40/20
					B	23/32	48/24
48	12	B	15/32	32/16	A	15/32 <sup>c</sup>	32/16
					B	19/32 <sup>c</sup> (4, 5 ply)	40/20
	16	B	19/32	40/20	A	19/32 <sup>c</sup>	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/m<sup>3</sup>.

- 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 <sup>15</sup>/<sub>32</sub> -inch, except crawl space sheathing shall have not less than <sup>3</sup>/<sub>8</sub> -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.

**404.2.4 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.

**404.2.5 Drainage and dampproofing.** Wood foundation basements shall be drained and dampproofed in accordance with Sections 405 and 406, respectively.

**404.2.6 Fastening.** Wood structural panel foundation wall sheathing shall be attached to framing in accordance with Table 602.3(1) and Section 402.1.1.

**404.3 Wood sill plates.** Wood sill plates shall be not less than 2-inch by 4-inch (51 mm by 102 mm) nominal lumber. Sill plate anchorage shall be in accordance with Sections 403.1.6 and 602.11.

**404.4 Retaining walls.** Retaining walls that are not laterally supported at the top and that retain in excess of 48 inches (1219 mm) of unbalanced fill, or retaining walls exceeding 24 inches (610 mm) in height that resist lateral loads in addition to soil, shall be designed in accordance with accepted engineering practice 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. This section shall not apply to foundation walls supporting buildings.

**404.5 Precast concrete foundation walls.**

**404.5.1 Design.** Precast concrete foundation walls shall be designed in accordance with accepted engineering practice. The design and manufacture of precast concrete foundation wall panels shall comply with the materials requirements of Section 402.3 or ACI 318. The panel design drawings shall be in accordance with Section 106.4.5.

**404.5.2 Precast concrete foundation design drawings.** Precast concrete foundation wall design drawings shall be submitted to the building official and approved prior to installation. Drawings shall include, at a minimum, the following information:

1. Design loading as applicable.
2. Footing design and material.
3. Concentrated loads and their points of application.
4. Soil bearing capacity.
5. Maximum allowable total uniform load.
6. Seismic design category.
7. Basic wind speed.

**404.5.3 Identification.** Precast concrete foundation wall panels shall be

identified by a certificate of inspection label issued by an approved inspection agency.

## **SECTION 405 FOUNDATION DRAINAGE**

**405.1 Concrete or masonry foundations.** Drains shall be provided around 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 top of the footing or below the bottom of the slab and shall discharge by gravity or mechanical means into an approved drainage system *or other location that complies with the plumbing code*. Gravel or crushed stone drains shall extend not less than 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. Except where otherwise recommended by the drain manufacturer, perforated drains shall be surrounded with an approved filter membrane or the filter membrane shall cover the washed gravel or crushed rock covering the drain. Drainage tiles or perforated pipe shall be placed on not less than 2 inches (51 mm) of washed gravel or crushed rock not less than 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 where 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 405.1.

**TABLE 405.1**  
**PROPERTIES OF SOILS**  
**CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM**

SOIL GROUP	UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL	SOIL DESCRIPTION	DRAINAGE CHARACTERISTICS <sup>a</sup>	FROST-HEAVE POTENTIAL	VOLUME CHANGE POTENTIAL EXPANSION <sup>b</sup>
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.

**405.1.1 Precast concrete foundation.** Precast concrete walls that retain earth and enclose habitable or useable space located below-grade that rest on crushed stone footings shall have a perforated drainage pipe installed below the base of the wall on either the interior or exterior side of the wall, not less than 1 foot (305 mm) beyond the edge of the wall. If the exterior drainage pipe is used, an approved filter membrane material shall cover the pipe. The drainage system shall discharge, *by gravity or mechanical means*, into an approved *drainage system or other location that complies with the plumbing code*.

**405.2 Wood foundations.** Wood foundations enclosing habitable or usable spaces

located below grade shall be adequately drained in accordance with Sections 405.2.1 through 405.2.3.

**405.2.1 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.

**405.2.2 Vapor retarder.** A 6-mil-thick (0.15 mm) polyethylene vapor retarder shall be applied over the porous layer with the basement floor constructed over the polyethylene.

**405.2.3 Drainage system.** In other than Group I soils, a sump shall be provided to drain the porous layer and footings. The sump shall be not less than 24 inches (610 mm) in diameter or 20 inches square (0.0129 m<sup>2</sup>), shall extend not less than 24 inches (610 mm) below the bottom of the basement floor and shall be capable of positive gravity or mechanical drainage to remove any accumulated water. The drainage system shall discharge, *by gravity or mechanical means*, into an approved *drainage system or other location that complies with the plumbing code*.

## SECTION 406 FOUNDATION WATERPROOFING AND DAMPPROOFING

**406.1 Concrete and masonry foundation dampproofing.** Except where required by Section 406.2 to be waterproofed, foundation walls that retain earth and enclose interior spaces and floors below grade shall be dampproofed from the higher of (a) the top of the footing or (b) 6 inches (152 mm) below the top of the basement floor, 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. Three pounds per square yard (1.63 kg/m<sup>2</sup>) of acrylic modified cement.
3. One-eighth-inch (3.2 mm) coat of surface bonding cement complying with ASTM C887.
4. Any material permitted for waterproofing in Section 406.2.
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 listed

dampproofing materials or any one of the waterproofing materials listed in Section 406.2 to the exterior of the wall.

**Exception:** *Existing foundations shall not be required to be dampproofed where a supplemental interior foundation drainage system is installed and connected to a sump pump.*

**406.2 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 higher of (a) the top of the footing or (b) 6 inches (152 mm) below the top of the basement floor, to the finished grade. Walls shall be water-proofed in accordance with one of the following:

1. Two-ply hot-mopped felts.
2. Fifty-five-pound (25 kg) roll roofing.
3. Six-mil (0.15 mm) polyvinyl chloride.
4. Six-mil (0.15 mm) polyethylene.
5. Forty-mil (1 mm) polymer-modified asphalt.
6. Sixty-mil (1.5 mm) flexible polymer cement.
7. One-eighth-inch (3 mm) cement-based, fiber-reinforced, waterproof coating.
8. Sixty-mil (1.5 mm) solvent-free liquid-applied synthetic rubber.

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

**Exception:**

1. 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 parings to seal ICF walls is permitted. Cold-setting asphalt or hot asphalt shall conform to Type C of ASTM D449. Hot asphalt shall be applied at a temperature of less than 200°F (93°C).
2. *Where existing exterior or interior dampproofing exists, no waterproofing shall be required.*
3. *Where an existing home has a supplemental interior foundation drainage system connected to a sump pump, no waterproofing shall be required.*

**406.3 Dampproofing for wood foundations.** Wood foundations enclosing habitable or usable spaces located below grade shall be dampproofed in accordance with Sections 406.3.1 through 406.3.4.

**406.3.1 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.

**406.3.2 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 finished 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. Where approved, other coverings appropriate to the architectural treatment shall be permitted to 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.

**406.3.3 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 backfill 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.

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

**406.4 Precast concrete foundation system dampproofing.** Except where required by Section 406.2 to be waterproofed, precast concrete foundation walls enclosing habitable or useable spaces located below grade shall be dampproofed in accordance with Section 406.1.

**406.4.1 Panel joints sealed.** Precast concrete foundation panel joints shall be sealed full height with a sealant meeting ASTM C920, Type S or M, Grade NS, Class 25, Use NT, M or A. Joint sealant shall be installed in accordance with the manufacturer's instructions.

## SECTION 407 COLUMNS

**407.1 Wood column protection.** Wood columns shall be protected against decay as set forth in Section 317.

**407.2 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.

**407.3 Structural requirements.** The columns shall be restrained to prevent lateral displacement at the bottom end. Wood columns shall be not less in nominal size than 4 inches by 4 inches (102 mm by 102 mm). Steel columns shall be not less than 3-inch-diameter (76 mm) Schedule 40 pipe manufactured in accordance with ASTM A53 Grade B or approved equivalent.

**Exception:** In Seismic Design Categories A, B and C, columns not more than 48 inches (1219 mm) in height on a pier or footing are exempt from the bottom end lateral displacement requirement within under-floor areas enclosed by a continuous foundation.

## SECTION 408 UNDER-FLOOR SPACE

**408.1 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 be not less than 1 square foot (0.0929 m<sup>2</sup>) for each 150 square feet (14 m<sup>2</sup>) of under-floor space area, unless the ground surface is covered by a Class 1 vapor retarder material. Where a Class 1 vapor retarder material is used, the minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m<sup>2</sup>) for each 1,500 square feet (140 m<sup>2</sup>) of under-floor space area. One such ventilating opening shall be within 3 feet (914 mm) of each corner of the building.

**408.2 Openings for under-floor ventilation.** The minimum net area of ventilation openings shall be not less than 1 square foot (0.0929 m<sup>2</sup>) for each 150 square feet (14 m<sup>2</sup>) of under-floor area. One ventilation opening shall be within 3 feet (915 mm) of each corner of the building. 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 ¼ -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  $\frac{1}{8}$ -inch (3.2 mm) thick.

**Exception:** The total area of ventilation openings shall be permitted to be reduced to  $\frac{1}{1,500}$  of the under-floor area where the ground surface is covered with an approved Class I vapor retarder material and the required openings are placed to provide cross ventilation of the space. The installation of operable louvers shall not be permitted.

**408.3 Unvented crawl space.** Ventilation openings in under-floor spaces specified in Sections 408.1 and 408.2 shall not be required where the following items are provided:

1. Exposed earth is covered with a continuous Class I 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 not less than 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall or insulation.
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 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m<sup>2</sup>) of crawl space 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 1102.2.11 of this code.
  - 2.2. Conditioned air supply sized to deliver at a rate equal to 1 cubic foot per minute (0.47 L/s) for each 50 square feet (4.7 m<sup>2</sup>) 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 1102.2.11 of this code.
  - 2.3. Plenum in existing structures complying with Section 1601.5, if under-floor space is used as a plenum.
  - 2.4. Dehumidification sized to provide 70 pints (33 liters) of moisture removal per day for every 1,000 square feet (93 m<sup>2</sup>) of crawl space floor area.

**408.4 Access.** Access shall be provided to all under-floor spaces. Access openings through the floor shall be not smaller than 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). Where any portion of the 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 1305.1.4 for access requirements where mechanical equipment is located under floors.

**408.5 Removal of debris.** The under-floor grade shall be cleaned of all vegetation and organic material. Wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose. Construction materials shall be removed before a building is occupied or used for any purpose.

**408.6 Finished grade.** The finished grade of under-floor surface shall be permitted to be located at the bottom of the footings; however, where there is evidence that the ground-water 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.

**408.7 Flood resistance.** For buildings located in flood hazard areas as established in Table 301.2(1) *unless otherwise approved by the local flood plain administrator:*

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section 322.2.2.
2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level on at least one side.

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

## **SECTION 409**

### **FOUNDATION INSULATION**

**409.1 Protection of exposed foundation insulation.** *Foundation walls and the edges of slab-on-grade floors with exterior applied insulation shall have a rigid, opaque and weather-resistant protective covering to prevent the degradation of thermal performance. The protective covering shall cover the exposed insulation and extend to a minimum of 6 inches (153 mm) below grade.*

Effective: 3/1/2024

Five Year Review (FYR) Dates: 7/1/2024

CERTIFIED ELECTRONICALLY

---

Certification

01/29/2024

---

Date

Promulgated Under: 119.03  
Statutory Authority: 3781.10(A)(1)  
Rule Amplifies: 3781.01, 3781.06, 3781.10, 3781.11, 3791.04, 4740.14  
Prior Effective Dates: 05/27/2006, 01/01/2013, 07/01/2014, 01/01/2016,  
07/01/2019