

**FOUNDATION SITE & SOIL**

**FOUNDATION CONSTRUCTION REQUIREMENTS** (Based on IRC R401.2)

- Foundation construction must be capable of accommodating all loads and of transmitting the resulting loads to the supporting soil.
- Fill soils that support footings and foundations must be designed, installed and tested.

**DRAINAGE** (Based on IRC R401.3)

- Surface drainage must be diverted to a storm sewer conveyance or other approved point of collection that does not create a hazard.
- Lots must be graded to drain surface water away from foundation walls.
- Grade: must fall a min. of 6" within the first 10 ft.

**SOIL TESTS** (Based on IRC R401.4)

- Where quantifiable data indicate expansive soils, compressible soils, shifting soils or other questionable soil characteristics, the building official must determine whether to require a soil test.
- In lieu of a complete geotechnical evaluation, assume the values in Table R401.4.1.

**FOUNDATION ELEVATION** (Based on IRC R403.1.7.3)

- On graded sites, the top of any exterior foundation must extend above the elevation of the street gutter at point of discharge or the inlet of an approved drainage device a min. of 12" plus 2%.
- 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.

**FOUNDATION TYPES**

Applicable to all foundation types.

- All 3 foundation types rely on perimeter foundation.
- Grade is the finished ground level adjoining the building at all exterior walls.

**Slab on Grade Foundations**

- Used mostly in warm-climates, where living is close to the ground and the frost line is close to the surface.
- In this system the footing is shallow and the ground floor is a concrete slab.
- Many slab-on-grade systems allow the concrete footing, foundation and subfloor to be poured at the same time.

**Crawl Spaces**

- Crawl Space: an underfloor space that is not a basement.
- Found in all climates but predominate in temperate regions.
- In this system, the insulated wooden ground floor is supported above grade on a foundation wall made of concrete or concrete block.

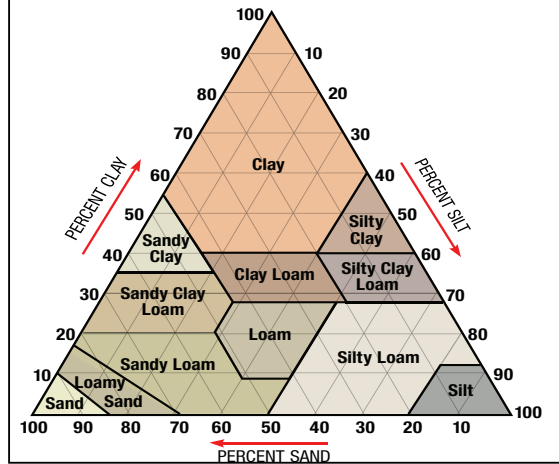
**Basements**

- Basement: a story that is not a story above grade plane.
- Used in the coldest part of the country, where frost lines mandate deep footings.
- Foundation systems are usually constructed of concrete or concrete block foundation walls.
- Drainage and waterproofing are critical in basement systems.

**SOILS DESCRIPTIONS** (Based on IRC Definitions)

Soil	Description
Collapsible Soils	Soils that exhibit volumetric reduction in response to partial or full wetting under load.
Compressible Soils	Soils that exhibit volumetric reduction in response to the application of load even in the absence of wetting or drying.
Expansive Soils	Soils that exhibit volumetric increase or decrease (swelling or shrinking) in response to partial or full wetting or drying under load.

**SOIL CLASSIFICATIONS**



**PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS<sup>a</sup>** (Based on IRC Table R401.4.1)

Class of Materials	Load-Bearing Pressure (lbs./ft <sup>2</sup> )
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>

a. Where soil tests are required by Section R401.4, the allowable bearing capacities of the soil must 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 must be determined by a soils investigation.

**PROPERTIES OF SOILS – UNIFIED SOIL CLASSIFICATION SYSTEM** (Based on IRC Table R405.1)

Soil Group	System Symbol	Soil Description	Drainage Characteristics	Frost Heave Potential	Volume Change Potential Expansion
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

a. The percolation rate for good drainage is over 4" per hour, medium drainage is 2" to 4" per hour and poor is less than 2" 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.

**SOIL TYPES** (Based on OSHA)

Type	Characteristics	Examples
Type A	cohesive soils with an unconfined, compressive strength of 1.5 tons per square foot (tsf) or greater.	<ul style="list-style-type: none"> <li>• clay, silty clay, sandy clay, clay loam</li> <li>• silty clay loam and sandy clay loam</li> </ul>
Type B	cohesive soils with an unconfined compressive strength greater than 0.5 tsf but less than 1.5 tsf.	<ul style="list-style-type: none"> <li>• angular gravel; silt; silt loam;</li> <li>• previously disturbed soils unless otherwise classified as Type C;</li> <li>• soils that meet the unconfined compressive strength or cementation requirements of Type A soils but are fissured or subject to vibration;</li> <li>• dry unstable rock;</li> <li>• layered systems sloping into the trench at a slope less than 4H:1V (only if the material would be classified as a Type B soil).</li> </ul>
Type C	cohesive soils with an unconfined compressive strength of 0.5 tsf or less.	<ul style="list-style-type: none"> <li>• granular soils such as gravel, sand and loamy sand, submerged soil, soil from which water is freely seeping and submerged rock that is not stable.</li> <li>• material in a sloped, layered system where the layers dip into the excavation or have a slope of four horizontal to one vertical (4H:1V) or greater.</li> </ul>

# FOOTINGS

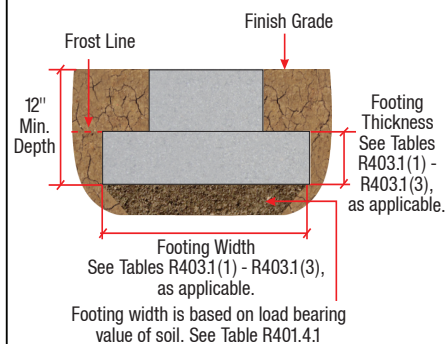
## FOOTINGS *(Based on IRC R403.1)*

- All exterior walls must be supported on continuous solid or fully grouted masonry or concrete footings, crushed stone footings, wood foundations or other approved structural systems.
- The footings must be of sufficient design to accommodate all loads and to transmit the resulting loads to the soil within the limitations as determined from the character of the soil.
- Footings must be supported on undisturbed natural soils or engineered fill.

## PRESUMPTIVE LOAD-BEARING VALUES OF FOUNDATION MATERIALS *(Based on IRC Table R401.4.1)*

Class of Materials	Load-Bearing Pressure (lbs./ft <sup>2</sup> )
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

## FOOTINGS



## FOOTINGS – MINIMUM SIZE *(Based on IRC R403.1.1)*

- The minimum width (W) and thickness (T) for concrete footings must be in accordance with Tables R403.1(1) through R403.1(3) and Figure R403.1(1) or R403.1.3, as applicable.
- The footing width must be based on the load bearing value of the soil in accordance with Table R401.4.1.
- Footing projections (P) must be not less than 2\"/>

## FOOTINGS – MINIMUM DEPTH *(Based on IRC R403.1.4)*

- Exterior footings must be placed at least 12\"/>

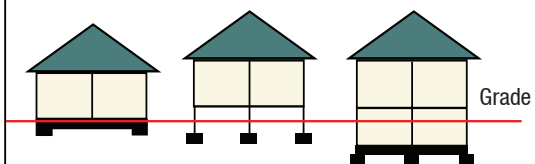
## FOOTINGS – FROST PROTECTION *(Based on IRC R403.1.4.1)*

- Except where otherwise protected from frost, foundation walls, piers and other permanent supports of buildings and structures must be protected from frost by one or more of the following methods:
  - Extended below the frost line specified in Table R301.2.(1).
  - Constructed in accordance with Section R403.3.
  - Constructed in accordance with ASCE 32.
  - Erected on solid rock.
- Footings must not bear on frozen soil unless the frozen condition is permanent.

## FOOTINGS – SLOPE *(Based on IRC R403.1.5)*

- The top surface of footings must be level.
- The bottom surface of footings must not have a slope exceeding 1 unit vertical in 10 units horizontal (10% slope).
- Footings must 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 1 unit vertical in 10 units horizontal (10% slope).

## 3 FOUNDATION TYPES



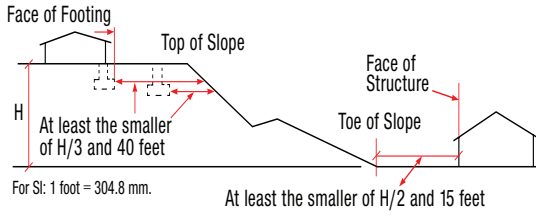
## MINIMUM WIDTH & THICKNESS FOR CONCRETE FOOTINGS FOR LIGHT-FRAME CONSTRUCTION (inches) *(Based on IRC Table R403.1(1))*

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 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	22 × 6	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	25 × 8	19 × 6	15 × 6	13 × 6	12 × 6	12 × 6
30 psf	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	23 × 6	17 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	20 × 6	15 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	26 × 8	20 × 6	16 × 6	13 × 6	12 × 6	12 × 6
50 psf	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	21 × 6	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	25 × 7	19 × 6	15 × 6	12 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	22 × 6	17 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	28 × 9	21 × 6	17 × 6	14 × 6	12 × 6	12 × 6
70 psf	1 story—slab-on-grade	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—with crawl space	18 × 6	13 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	1 story—plus basement	24 × 7	18 × 6	14 × 6	12 × 6	12 × 6	12 × 6
	2 story—slab-on-grade	16 × 6	12 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	2 story—with crawl space	21 × 6	16 × 6	13 × 6	12 × 6	12 × 6	12 × 6
	2 story—plus basement	27 × 9	20 × 6	16 × 6	14 × 6	12 × 6	12 × 6
	3 story—slab-on-grade	19 × 6	14 × 6	12 × 6	12 × 6	12 × 6	12 × 6
	3 story—with crawl space	25 × 7	18 × 6	15 × 6	12 × 6	12 × 6	12 × 6
	3 story—plus basement	30 × 10	23 × 6	18 × 6	15 × 6	13 × 6	12 × 6

- 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 ft. of adjustment to the width of the house, add or subtract 2\"/>

# FOOTINGS (Continued)

## FOUNDATION CLEARANCE FROM SLOPES



## FOOTINGS ON OR ADJACENT TO SLOPES

(Based on IRC R403.1.7)

- The placement of buildings and structures on or adjacent to slopes steeper than 1 unit vertical in 3 units horizontal (33.3% slope) must conform to the following:

### Building Clearances from Ascending Slopes

- Buildings below slopes must be set a sufficient distance from the slope to provide protection from slope drainage, erosion and shallow failures.
- Where the existing slope is steeper than 1 unit vertical in 1 unit horizontal (100% slope), the toe of the slope must 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° (0.79 rad) to the horizontal.
- Where a retaining wall is constructed at the toe of the slope, the height of the slope must be measured from the top of the wall to the top of the slope.

### Footing Setback from Descending Slope Surfaces

- Footings on or adjacent to slope surfaces must be founded in material with an embedment and set-back from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement.
- Where the slope is steeper than 1 unit vertical in 1 unit horizontal (100% slope), the required setback must be measured from an imaginary plane 45° (0.79 rad) to the horizontal, projected upward from the toe of the slope.

## FOOTING REINFORCEMENT

(Based on IRC R403.1.3.5.2 - R403.1.3.5.4 & R403.1.3.6)

### Location of Reinforcement in Wall

- The center of vertical reinforcement in stem walls must be located at the centerline of the wall.

### Support and Cover

- Horizontal and vertical reinforcement must be located in footings and stem walls to provide the minimum cover requirements below:
- Reinforcement must 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 must have a minimum cover of 3".
- Min. cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather: 1 1/2" for No. 5 bars or smaller.
- Min. cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather: 2" for No. 6 bars and larger.
- Min. cover for concrete cast in removable forms that will not be exposed to the earth or weather and concrete cast in stay-in-place forms: 3/4" Min.

### Lap Splices

- Horizontal and vertical reinforcements must be the longest lengths practical.
- Where splices are necessary in reinforcement, the length of lap splice must be in accordance with Table R608.5.4.(1) and Fig. R608.5.4(1).
- The maximum gap between non-contact parallel bars at a lap splice must not exceed the smaller of 1/5" the required lap length and 6".

### Isolated Concrete Footings

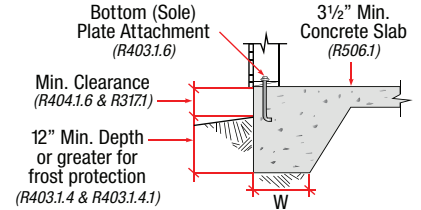
- Isolated plain concrete footings supporting columns or pedestals are permitted in detached one- and two-family dwellings that are 3-stories or less in height and constructed with stud bearing walls.

## CONTINUOUS FOOTING IN SDC

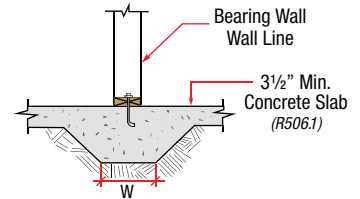
D<sub>0</sub>, D<sub>1</sub> & D<sub>2</sub> (Based on IRC R403.1.2; 403.1.3.4)

- Exterior walls of buildings located in Seismic Design Categories (SDC) D<sub>0</sub>, D<sub>1</sub> and D<sub>2</sub> must be supported by continuous solid or fully grouted masonry or concrete footings.
- Required interior braced wall panels in buildings located in SDC D<sub>0</sub>, D<sub>1</sub> & D<sub>2</sub> with plan dimensions greater than 50 ft. must be supported by continuous solid or fully grouted masonry or concrete footings.  
Note: In two-story buildings in SDC D<sub>0</sub>, D<sub>1</sub> & D<sub>2</sub> all braced wall panels, interior and exterior, must be supported on continuous foundations.
- Interior footings supporting bearing walls or braced wall panels and cast monolithically with slab on grade, must extend to a depth of not less than 12" below the top of the slab.
- Concrete footings in SDC D<sub>0</sub>, D<sub>1</sub> & D<sub>2</sub> must have minimum reinforcement in accordance with this section and Figure R403.1.3.
- Reinforcement must be installed with support and cover in accordance with Section R403.1.3.5.

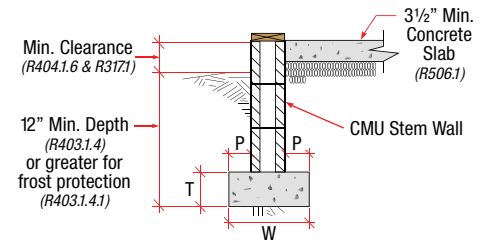
## PLAIN CONCRETE FOOTINGS WITH MASONRY & CONCRETE STEM WALLS IN SDC A, B & C



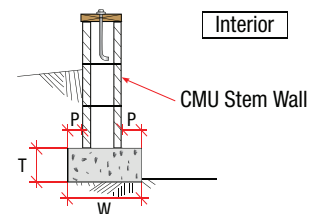
### Monolithic Slab-On-Ground with Turned-Down Footings



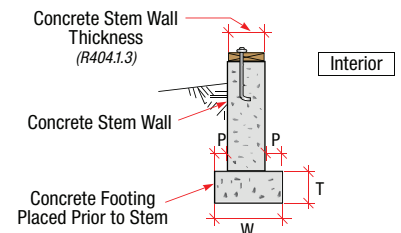
### Thickened Slab-On-Ground Footing At Bearing Walls or Braced Wall Lines



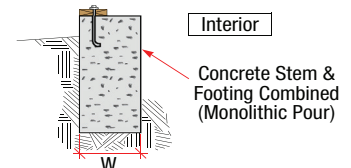
### Slab-On-Ground with Masonry Stem Wall & Spread Footing



### Basement or Crawl Space with Masonry Wall & Spread Footing



### Basement or Crawl Space with Concrete Wall & Spread Footing

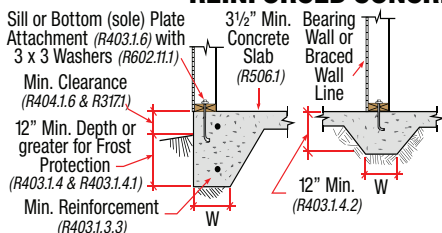


### Basement or Crawl Space with Foundation Wall Bearing Directly on Soil

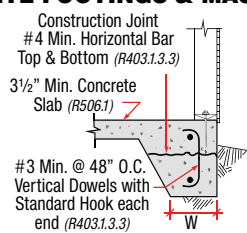
## FOUNDATION ANCHORAGE (Based on IRC R403.1.6)

- Wood sill plates and wood walls supported directly on continuous foundations must be anchored to the foundation.
- 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 must be anchored to the foundation with min. 1/2" diameter anchor bolts spaced not greater than 6 ft. on center or approved anchors or anchor straps spaced as required to provide equivalent anchorage to 1/2" diameter anchor bolts.
- Bolts must extend not less than 7" into concrete or grouted cells of concrete masonry units.
- The bolts must be located in the middle third of the width of the plate.
- A nut and washer must be tightened on each anchor bolt.
- There must be not fewer than 2 bolts per plate section with 1 bolt located not more than 12" or less than 7 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 must be positively anchored with approved fasteners.
- Sill plates and sole plates must be protected against decay and termites where required by Sections R317 and R318.

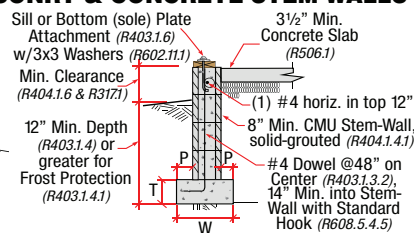
## REINFORCED CONCRETE FOOTINGS & MASONRY & CONCRETE STEM WALLS IN SDC D<sub>0</sub>, D<sub>1</sub> & D<sub>2</sub>



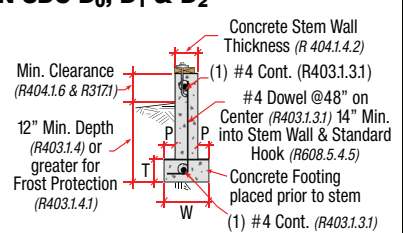
Slab-on-Ground With Monolithic Turned-Down Footing



Dowels for Slab-on-Ground With Turned-Down Footings



Slab-On-Ground With Masonry Stem Wall & Spread Footing



Basement or Crawl Space Concrete Stem Wall & Spread Footing

# FOUNDATION & RETAINING WALLS

## FOUNDATION WALL THICKNESS BASED ON WALLS SUPPORTED (Based on IRC R404.1.5)

### Masonry Wall Thickness

- Masonry foundation walls must not be less than the thickness of the wall supported.
- Masonry foundation walls of not less than 8" in nominal thickness must be permitted under brick veneered frame walls and under 10" wide cavity walls where the total height of the wall supported, including gables, is 20 ft. max., provided requirements of Sec. R404.1.1 are met.

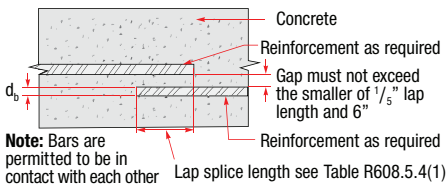
### Concrete Wall Thickness

- The thickness of concrete foundation walls must be equal to or greater than the thickness of the wall in the story above.
- Where a concrete foundation wall is reduced in thickness to provide a shelf for the support of masonry veneer, the reduced thickness must be equal to or greater than the thickness of the wall in the story above.
- Vertical reinforcement for the foundation wall must be based on Table R404.1.2(8) and located in the wall as required where that table is used.
- Vertical reinforcement must be based on the thickness of the thinner portion of the wall.

## HEIGHT ABOVE FINISHED GRADE (Based on IRC R404.1.6)

Concrete and masonry foundation walls must extend above the finished grade adjacent to the foundation at all points not less than 4" where masonry veneer is used and not less than 6" elsewhere.

### LAP SPLICES



## REINFORCEMENT (Based on IRC R404.1.3.3.7.2 - R404.1.3.3.7.5)

### Location

- The center of vertical reinforcement in basement walls must be located at the centerline of the wall.
- Vertical reinforcement in basement walls must be located to provide a max. cover of 1 1/4" measured from the inside face of the wall.
- The center of the steel must not vary from the specified location by more than the greater of 10% of the wall thickness and 3/8".

### Support & Cover

- Reinforcement must 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 must have a min. cover of 3".
- Min. cover for reinforcement in concrete cast in removable forms that will be exposed to the earth or weather must be 1 1/2" for No. 5 bars and smaller and 2" 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 must be 3/4".
- The minus tolerance for cover must not exceed the smaller of 1/3" the required cover or 3/8".

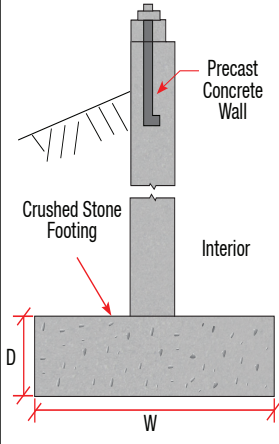
### Lap Splices

- Vertical and horizontal wall reinforcement must be the longest lengths practical.
- Where splices are necessary in reinforcement, the length of lap splice must comply with Table R608.5.4.(1) and Figure R608.5.4(1).
- The max. gap between noncontact parallel bars at a lap splice must not exceed the smaller of 1/5 the required lap length and 6".

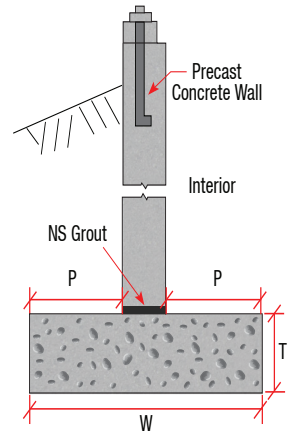
### Wall Openings

- Vertical wall reinforcement that is interrupted by wall openings must have additional vertical reinforcement of the same size placed within 12" of each side of the opening.

## PRECAST BEARING ON CRUSHED STONE



## PRECAST ON SPREAD FOOTING



## COMPRESSIVE STRENGTH OF CONCRETE (Based on IRC Table R402.2)

Type or Location of Concrete Construction	Min. Specified Compressive Strength ( $f'_c$ )		
	Weathering Potential		
	Negligible	Moderate	Severe
Basement walls, foundations and other concrete not exposed to the weather	2,500	2,500	2,500
Basement slabs and interior slabs on grade, except garage floor slabs	2,500	2,500	2,500
Basement walls, foundation walls, exterior walls and other vertical concrete work posed to the weather	2,500	3,000	3,000
Porches, carport slabs and steps exposed to the weather and garage floor slabs	2,500	3,000	3,500

## MIN. HORIZONTAL REINFORCEMENT FOR CONCRETE BASEMENT WALLS (Based on IRC Table R404.1.2(1))

Max. Unsupported Height of Basement Wall (feet)	Location of Horizontal Reinforcement
≤ 8	One No. 4 bar within 12" 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" of the top of the wall story and one No. 4 bar near third points in the wall story.

## PLAIN MASONRY FOUNDATION WALLS (Based on IRC Table R404.1.1(1))

Max. Wall Height (feet)	Max. Unbalanced Backfill Height (feet)	Plain Masonry Minimum Nominal Wall Thickness (inches)		
		Soil Classes		
		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	6	8	10	12
	7	10	12	12 solid <sup>d</sup>
7	4	6 solid <sup>d</sup> or 8	8	8
	5	6 solid <sup>d</sup> or 8	10	10
7	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
8	6	10	12	12 solid <sup>d</sup>
	7	12	12 solid <sup>d</sup>	Footnote e
8	8	10 grout <sup>d</sup>	12 grout <sup>d</sup>	Footnote e
	9	12	Footnote e	Footnote e
9	4	6 grout <sup>d</sup> or 8 solid <sup>d</sup> or 12	6 grout <sup>d</sup> or 8 solid <sup>d</sup>	8 grout <sup>d</sup> or 10 solid <sup>d</sup>
	5	6 grout <sup>d</sup> or 10 solid <sup>d</sup>	8 grout <sup>d</sup> or 12 solid <sup>d</sup>	8 grout <sup>d</sup>
	6	8 grout <sup>d</sup> or 12 solid <sup>d</sup>	10 grout <sup>d</sup>	10 grout <sup>d</sup>
	7	10 grout <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	

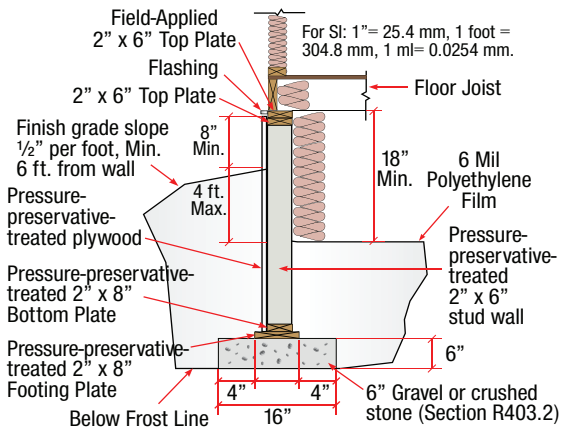
d. Solid indicates solid masonry unit; grout indicates grouted hollow units.

## LAP SPLICE & TENSION DEVELOPMENT LENGTHS (Based on IRC Table R608.5.4(1))

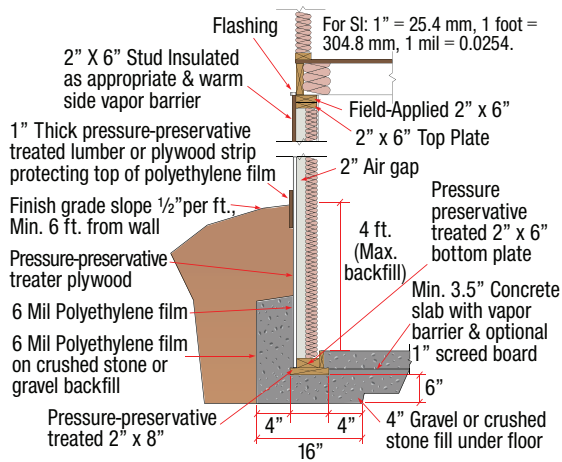
	Bar Size No.	Yield Strength of Steel, $f_y$ - psi	
		40,000 (280)	60,000 (420)
		Splice length or tension development length (inches)	
Lap splice length-tension	4	20	30
	5	25	38
	6	30	45
Tension development length for straight bar	4	15	23
	5	19	28
	6	23	34
Tension development length for: a. 90° and 180° standard hooks with not less than 2 1/2" of side cover perpendicular to plane of hook and b. 90° standard hooks with not less than 2" of cover on the bar extension beyond the hook.	4	6	9
	5	7	11
	6	8	13
Tension development length for bar with 90° or 180° standard hook having less cover than required in items a and b.	4	8	12
	5	10	15
	6	12	18

# WOOD FOUNDATION WALLS

## PERMANENT WOOD FOUNDATION CRAWL SPACE SECTION



## PERMANENT WOOD FOUNDATION BASEMENT WALL SECTION



## FASTENERS (Based on IRC R402.1.1)

- Fasteners used below grade to attach plywood to the exterior side of exterior basement or crawlspace wall studs or fasteners used in knee wall construction, must 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 must 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 are not permitted.

## WOOD SILL PLATES (Based on IRC R404.3)

- Wood sill plates must be a min. of 2" by 4" nominal lumber.
- Sill plate anchorage, see with Sections R403.1.6 and R602.11.

## FOOTINGS FOR WOOD FOUNDATIONS

(Based on IRC R403.2)

- Footings for wood foundations must be in accordance with the figures on this page.
- Gravel must be washed and well graded.
- The maximum size stone must not exceed 3/4".
- Gravel must be free from organic, clayey or silty soils.
- Sand must be coarse, not smaller than 1/16" grains and must be free from organic, clayey or silty soils.
- Crushed stone must have a maximum size of 1/2".

## FOUNDATION ANCHORAGE (Based on IRC R403.1.6)

- Wood sill plates and wood walls supported directly on continuous foundations must be anchored to the foundation.
- 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 must be anchored to the foundation with min. 1/2" dia. anchor bolts spaced not greater than 6 ft. on center or approved anchors or anchor straps spaced as required to provide equivalent anchorage to 1/2" dia. anchor bolts.
- Bolts must extend not less than 7" into concrete or grouted cells of concrete masonry units.
- Bolts location: middle third of the width of the plate.
- A nut and washer must be tightened on each anchor bolt.
- There must be not fewer than 2 bolts per plate section with 1 bolt located not more than 12" or less than 7 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 must be positively anchored with approved fasteners.
- Sill plates and sole plates must be protected against decay and termites, see Sections R317 and R318.

## WOOD FOUNDATION WALLS

(Based on IRC R404.2)

### Stud Size

- The studs used in foundation walls must be 2-inch by 6-inch members.
- Where spaced 16" on center, a wood species with an Fb value of not less than 1,250 psi as listed in ANSI AWC NDS must be used.
- Where spaced 12" on center, an Fb of not less than 875 psi must be required.

### 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 must not exceed 4 ft.
- Where the height of fill is more than 12" above the interior grade of a crawl space or floor of a basement, the thickness of the plywood sheathing must meet the requirements of Table R404.2.3.

### Backfilling

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

### Drainage and Dampproofing

- Wood foundation basements must be drained and dampproofed. See Section R405 and R406, respectively.

### Fastening

- Wood structural panel foundation wall sheathing must be attached to framing, see Table R602.3(1) and Section R402.1.1.

## PLYWOOD GRADE AND THICKNESS FOR WOOD FOUNDATION CONSTRUCTION (30 pcf equivalent-fluid weight soil pressure) (Based on IRC Table R404.2.3)

Height of Fill (inches)	Stud Spacing (inches)	Face Grain Across Studs			Face Grain Parallel to Studs		
		Grade	Min. Thickness (inches)	Span Rating	Grade	Min. Thickness (inches)	Span Rating
24	12	B	15/32	32/16	A	15/32	32/16
		B	15/32	32/16	B	15/32	32/16
	16	B	15/32	32/16	A	15/32	32/16
		B	15/32	32/16	B	19/32 (4, 5 ply)	40/20
36	12	B	15/32	32/16	A	15/32	32/16
		B	15/32	32/16	B	15/32 (4, 5 ply)	32/16
	16	B	15/32	32/16	A	19/32	40/20
		B	15/32	32/16	B	23/32	48/24
48	12	B	15/32	32/16	A	15/32	32/16
		B	15/32	32/16	B	19/32 (4, 5 ply)	40/20
	16	B	19/32	40/20	A	19/32	40/20
		B	19/32	40/20	A	23/32	48/24

## UNDER-FLOOR SPACE

### VENTILATION (Based on IRC R408.1)

- The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a basement) must have ventilation openings through foundation walls or exterior walls.
- Min. net area of ventilation openings: 1 square foot for each 150 square feet of under floor space area.
- Min. net area of ventilation openings where a Class 1 vapor retarder material is used: 1 square foot for each 1,500 square feet of under space area.
- One ventilation opening must be within 3 ft. of each corner of the building.

### OPENINGS FOR UNDER-FLOOR VENTILATION

(Based on IRC R408.2)

- Ventilation openings must be covered for their height and width with any of the following materials provided that the least dimension of the covering does not exceed 1/4":
- Perforated sheet metal plates not less than 0.070" thick.
  - Expanded sheet metal plates not less than 0.047" thick.
  - Cast-iron grill or grating.
  - Extruded load-bearing brick vents.
  - Hardware cloth of 0.035" wire or heavier.
  - Corrosion-resistant wire mesh, with the least dimension being 1/8" thick.

### ACCESS (Based on IRC R408.4)

- Access must be provided to all under-floor spaces.
- Size of access openings through the floor: 18" Min. x 24" Min.
- Size of openings through the perimeter wall: 16" Min. x 24" Min.
- Where any portion of the through-wall access is below grade, provide an areaway a min. of 16" x 24".
- The bottom of the areaway must be below the threshold of the access opening.
- Through wall access opening must not be located under a door to the residence.

# FOUNDATION DRAINAGE

## CONCRETE OR MASONRY FOUNDATIONS *(Based on IRC R405.1)*

- Drains must 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 must be installed at or below the top of the footing or below the bottom of the slab and must discharge by gravity or mechanical means into an approved drainage system.
- Gravel or crushed stone drains must extend not less than 1 ft. beyond the outside edge of the footing and 6" above the top of the footing and be covered with an approved filter membrane material.
- The top of open joints of drain tiles must be protected with strips of building paper.
- Perforated drains must be surrounded with an approved filter membrane or the filter membrane must cover the washed gravel or crushed rock covering the drain.
- Drainage tiles or perforated pipe must be placed on not less than 2" 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" of the same material.

Note: A drainage system is not required where the foundation is installed on well-drained ground or sand gravel mixture soils, Group I soils, see Table R405.1.

## WOOD FOUNDATIONS *(Based on IRC R405.2)*

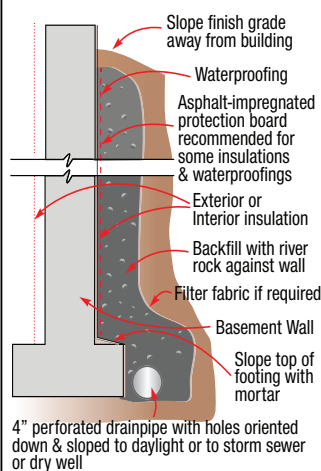
Wood foundations enclosing habitable or usable space located below-grade must be adequately drained:

- A porous layer of gravel, crushed stone or coarse sand must be placed to a min. thickness of 4" under the basement floor.
- Provision must be made for automatic draining of this layer and the gravel or crushed stone wall footings.
- A 6-mil thick polyethylene vapor retarder must be applied over the porous layer with the basement floor constructed over the polyethylene.
- In other than Group I soils, a sump must be provided to drain the porous layer and footings.
- Sump must be not less than 24" in dia. or 20 in<sup>2</sup>, must extend not less than 24" below the bottom of the basement floor and must be capable of positive gravity or mechanical drainage to remove accumulated water.
- The drainage system must discharge into an approved sewer system or to daylight.

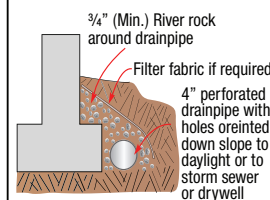
## PRECAST CONCRETE FOUNDATIONS *(Based on IRC R405.1.1)*

- Precast concrete walls that retain earth and enclose habitable or usable space located below-grade that rest on crushed stone footings must have a perforated drainage pipe installed below the base of the wall on either the interior or the exterior side of the wall, not less than 1 ft. beyond the edge of the wall.
- If the exterior drainage pipe is used, an approved filter membrane material must cover the pipe.
- The drainage system must discharge into an approved sewer system or to daylight.

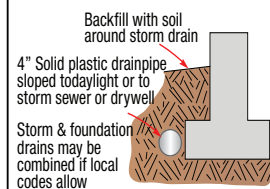
## BASEMENT DRAINAGE



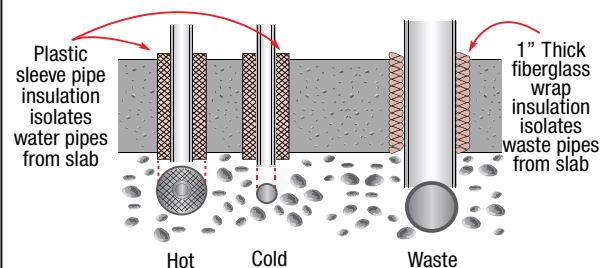
## FOUNDATION DRAIN



## STORM DRAIN



## BASEMENT DRAINAGE



# DAMP-PROOFING & WATERPROOFING

## DAMP-PROOFING - CONCRETE & MASONRY FOUNDATION

*(Based on IRC R406.1)*

Foundation walls that retain earth and enclose interior spaces and floors below grade must be dampproofed from the top of the footing or 6" below the top of the basement floor, to the finished grade, whichever is higher.

### Masonry Walls

- Masonry walls must have not less than 3/8" Portland cement parging applied to the exterior of the wall.
- The parging must be dampproofed according with one of the following:
  1. bituminous coating
  2. 3 pounds per square yard of acrylic modified cement
  3. 1/8" coat of surface-bonding cement complying with ASTM C887
  4. Any material permitted for waterproofing in Sec. R406.2
  5. Other approved methods and materials
- Concrete walls must be damp proofed by applying any one of the listed dampproofing materials or any one of the waterproofing materials listed in Section R406.2 to the exterior of the wall.

## WATERPROOFING - CONCRETE & MASONRY FOUNDATION

*(Based on IRC R406.2)*

- 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 must be waterproofed from the top of the footing or 6" below the top of the basement floor, to the finished grade, whichever is higher.
- Walls must be waterproofed according to one of the following ways:
  1. Two-ply hot-mopped felts
  2. Fifty-five pound roll roofing
  3. Six mil polyvinyl chloride
  4. Six mil polyethylene
  5. Forty-mil polymer-modified asphalt
  6. Sixty-mil flexible polymer cement
  7. 1/8" cement-based, fiber-reinforced, waterproof coating
  8. Sixty-mil solvent-free liquid-applied synthetic rubber
- All joints in membrane waterproofing must be lapped and sealed with an adhesive compatible with the membrane.

## DAMP-PROOFING - PRECAST CONCRETE FOUNDATION SYSTEM

*(Based on IRC R406.4)*

Unless required to be waterproofed, precast concrete foundation walls enclosing habitable or usable spaces located below grade must be dampproofed according to Section R406.1.

## DAMP-PROOFING - WOOD FOUNDATION

*(Based on IRC R406.3)*

Wood foundation enclosing habitable or usable spaces located below grade must be dampproofed according to the following:

### Panel Joint Sealed

- Plywood panel joints in the foundation walls must be sealed full length with a caulking compound capable of producing a moistureproof seal under the temperature and moisture content at which it will be applied and used.

### Below-Grade Moisture Barrier

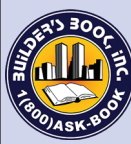
- A 6-mil thick polyethylene film must be applied over the below grade portion of exterior foundation walls prior to backfilling.
- Joints in the polyethylene film must be lapped 6" and sealed with adhesive.
- Top edge of polyethylene film must be bonded to sheathing to form a seal.
- Film areas at grade level must 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" below grade.
- The joint between the strip and the wall must be caulked full length prior to fastening the strip to the wall.
- Where approved, other coverings appropriate to the architectural treatment must be permitted to be used.
- The polyethylene film must extend down to the bottom of the wood footing plate but must not overlap or extend into the gravel or crushed stone footing.

### Porous Fill

- The space between the excavation and the foundation wall must be backfilled with the same material used for footings, up to a height of 1 ft. above the footing for well-drained sites, or one half the total backfill height for poorly drained sites.
- The porous fill must be covered with strips of 30 lbs. asphalt paper of 6-mil polyethylene to permit water seepage while avoiding infiltration of fine soils.

### Backfill

- The remainder of the excavated area must be backfilled with the same type of soil that was removed during the excavation.



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