

**All that is gold does not glitter, not all that is strong does not wither, deep roots are not reached by frost.**

—J.R.R. Tolkien

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## Frost Protected Shallow Foundations

### Background

A frost protected shallow foundation (FPSF) is a practical alternative to a deeper, more-costly foundation in cold regions with seasonal ground freezing and the potential for frost heave. FPSF results in a shallower frost penetration depth around the building due to soil that has been warmed by both building and geothermal heat. The insulation around the foundation perimeter conserves and redirects heat loss through the slab toward the soil below the foundation. Geothermal heat from the underlying ground also helps to warm the soil and raise the frost depth around the building.

Frost protected shallow foundations are most suitable for slab-on-grade homes on sites with moderate to low sloping grades. Slab-on-grade FPSFs can be installed with one placement of concrete, eliminating multiple inspections and speeding construction time. The method may also be used effectively with walkout basements by insulating the foundation on the downhill side of the house. Frost protected shallow foundations are also useful for remodeling projects because their installation minimizes site disturbance. The International Residential Code (IRC) allows construction of a FPSF in heated buildings. Before looking at the FPSF provisions in the IRC, let's review the IECC requirements for a conventional slab-on-grade.



Above: Horizontal perimeter insulation partially installed and covered with earth.

At Left: Thickened slab edge with rebar prepared for concrete pour.

## Conventional Slab-On-Grade Construction

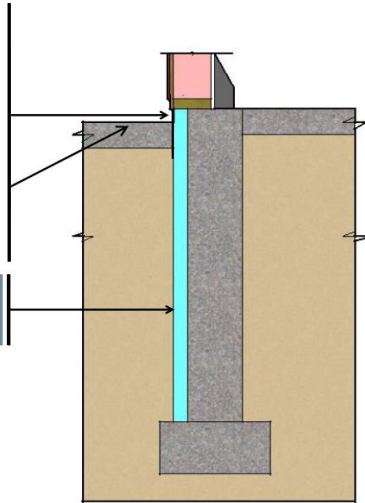
The 2012 IECC Section R402.2.9 and Table R402.1.1 establish insulation values required for conventional slab-on-grade construction with the foundation wall extending below the frost line. The required R-10 insulation must extend down from the top of the slab on the inside or outside of the foundation wall. The insulation below grade must extend four feet vertically or horizontally or a combination of both, either under the slab or outward from the building. Insulation extending away from the building must be protected by pavement for a minimum of ten inches of soil. The top edge of the insulation installed between the exterior wall and the edge of the interior slab may be cut at a 45° angle away from the exterior wall. R-15 insulation is required for heated slabs such as when hydronic heat is embedded in the slab.

Insulation Protection (IECC R303.2.1) Must Extend a Minimum of 6" Below Grade

Preservative-Treated or naturally durable wood required if less than 2" from concrete surfaces (IRC R317.1(5))

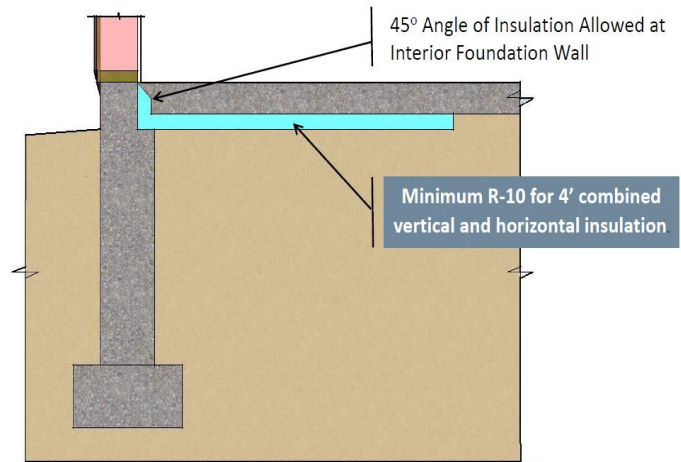
Impervious Surfaces Slope Minimum 2% Away from Building

Minimum R-10 for 4' combined vertical and horizontal insulation



**Conventional Foundation Exterior Insulation at Slab-On-Grade and Concrete Porch**

In conventional slab-on-grade construction the footings must extend below frost line as specified by the IRC or the local code jurisdiction.



**Conventional Foundation Interior Insulation at Concrete Slab-On-Grade**

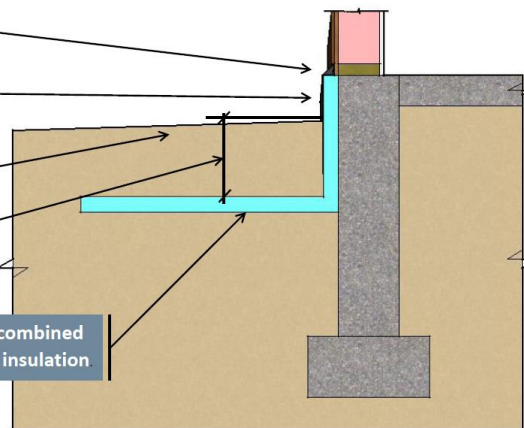
Flashing (IRC R703.4)

Insulation Protection (IECC R303.2.1)

Slope of Final Grade 6" in 10' (IRC R401.3)

Minimum 10"

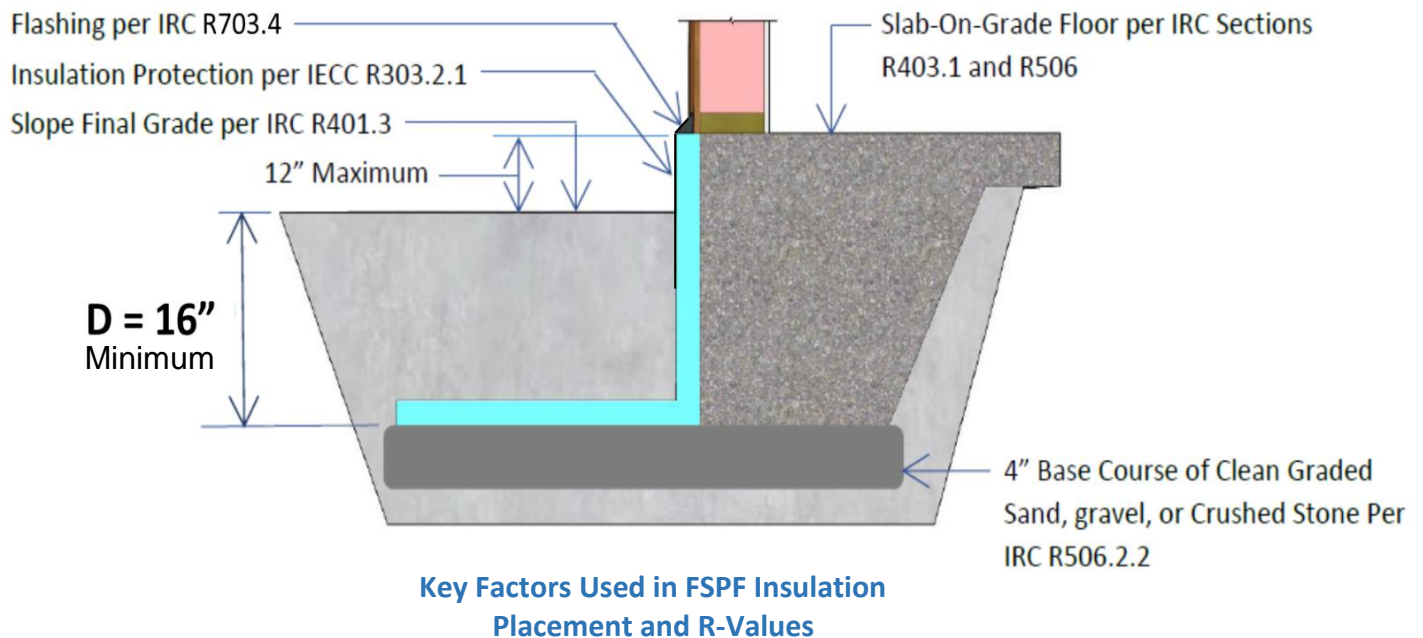
Minimum R-10 for 4' combined vertical and horizontal insulation



**Conventional Foundation Exterior Horizontal Insulation at Concrete Slab-On-Grade**

## Frost Protected Shallow Foundations

The FPSF is a special case that is addressed in Section R402.2.9 of the IRC. A FPSF is only allowed in buildings with a monthly mean temperature maintained at a minimum of 64°F. This heated building requirement makes common sense as this foundation strategy is dependent on heat generated by the building warming the ground below the footing. Section R402.2.9 specifies the vertical R-Value, minimum depth of the insulation, and horizontal R-values at the corners and at the non-corner walls. The IRC states that R-values greater than those specified by R402.2.9 may be required to meet energy conservation standards. R-10, as required by the IECC, becomes the minimum R-value allowed for most counties in Montana if the slab is not used for radiant heat. There are seven Montana counties with an Air Freezing Index of 4,000, where the R-value requirements of IRC R402.2.9 becomes applicable. Refer to the table provided later in this article for the Air Freezing Index of Montana counties. The minimum footing depth for Mineral County, with its 1,500 Air Freezing Index, is 14 inches. The minimum footing depth for all other counties is 16 inches. The figure below illustrates the key factors used in FPSF insulation placement and R-value requirements.



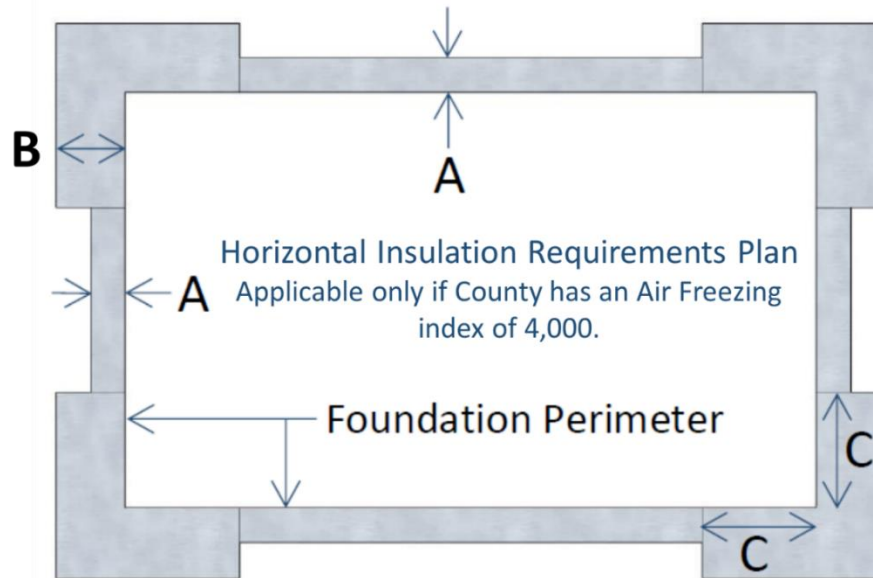
A frost protected shallow foundation is only allowed in buildings with a monthly mean temperature maintained at a minimum of 64°F.

**Air-Freezing Index (AFI).** The Air Freezing Index is the cumulative degree days below 32°F. It is used as a measure of the combined magnitude and duration of air temperature below freezing computed over an estimated 11-year period. The table on the following page shows the Air Freezing Index for Montana counties.

Montana Air Freezing Index by County (°F-days)					
1500 or less	2000	2500	3000	3500	4000
Mineral	Broadwater	Big Horn	Carter	Beaverhead	Daniels
	Golden Valley	Carbon	Cascade	Blaine	Hill
	Granite	Jefferson	Deer Lodge	Chouteau	Phillips
	Lake	Judith Basin	Falcon	Custer	Richland
	Lincoln	Lewis and Clark	Fergus	Dawson	Roosevelt
	Missoula	Meagher	Flathead	Garfield	Sheridan
	Ravalli	Musselshell	Gallanting	Liberty	Valley
	Sanders	Powder River	Glacier	McCone	
	Sweet Grass	Powell	Madison	Prairie	
		Silver Bow	Park	Toole	
		Stillwater	Petroleum	Wibaux	
		Westland	Pondera		
			Rosebud		
			Teton		
			Treasure		
			Yellowstone		

The table below and figure on the following page summarizes the FPSF requirements by combining the provisions of the IRC and the IECC. For Montana counties with an AFI of less than 4,000, the IECC establishes the insulation values required as well as the combined vertical and horizontal dimension of the insulation. For those seven counties with an AFI of 4,000, the IRC establishes the minimum required vertical and horizontal insulation R-values and the horizontal insulation dimension. The IECC minimum 48 inches combined vertical and horizontal insulation dimension applies to all counties.

Minimum Footing Depth and Insulation Requirements for FPSF in Heated Buildings							
Air Freezing Index (°F-days)	Minimum Footing Depth D (Inches)	Vertical Insulation R-Value	Horizontal Insulation R-Value		Combined Vertical & Horizontal Insulation Dimension (Inches)		
≤ 4,000	16	10	10		48		
			Horiz. Insulation R-Value		Horizontal Insulation Dimensions (Inches)*		
			Along Walls	At Corners	A	B	C
4000	16	10.1	10.5	13.1	24	36	60
* - The combined vertical and horizontal insulation dimension must be at least 48 inches.							



### Foundations Adjoining a FPSF (IRC R403.3.1)

The IRC includes more details and specific requirements when an FPSF is adjacent to a heated structure and when a FPSF is adjacent to an unheated (maintained at less than 64°F) slab-on-ground structure. Refer to 2012 IRC Sections R403.3.1.1 and R403.3.1.2.

**Attachment to Unheated Slab-On-Ground Structure.** FPSF vertical wall insulation must extend between the FPSF and the adjoining slab foundation. Required FPSF horizontal insulation must be continuous under the adjoining slab foundation and through any adjoining foundation walls. When this occurs, the insulation must be either adequately load bearing or the foundation wall design must eliminate bearing on the insulation.

**Attachment to Heated Structures.** FPSF vertical and horizontal insulation is not required between FPSF and the adjoining slab foundation. Where the FPSF abuts a heated structure, the FPSF vertical and horizontal insulation must extend along the adjoining foundation at least 24 inches if the AFI is greater than or equal to 3,500, at least 12 inches if AFI is less than 3,500 and greater than or equal to 2,500, not required if AFI less than 2,500.

### Resources

2012 International Residential Code, Copyright 2011 by the International Energy Codes Council, Inc., Falls Church, Virginia.

2012 International Energy Conservation Code, Copyright August 2011 by the International Energy Codes Council, Inc., Falls Church, Virginia.

2012 IECC Code and Commentary, Copyright August 2012 by the International Energy Codes Council, Inc., Falls Church, Virginia.