

## 8. Frost Protected Shallow Foundations

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.

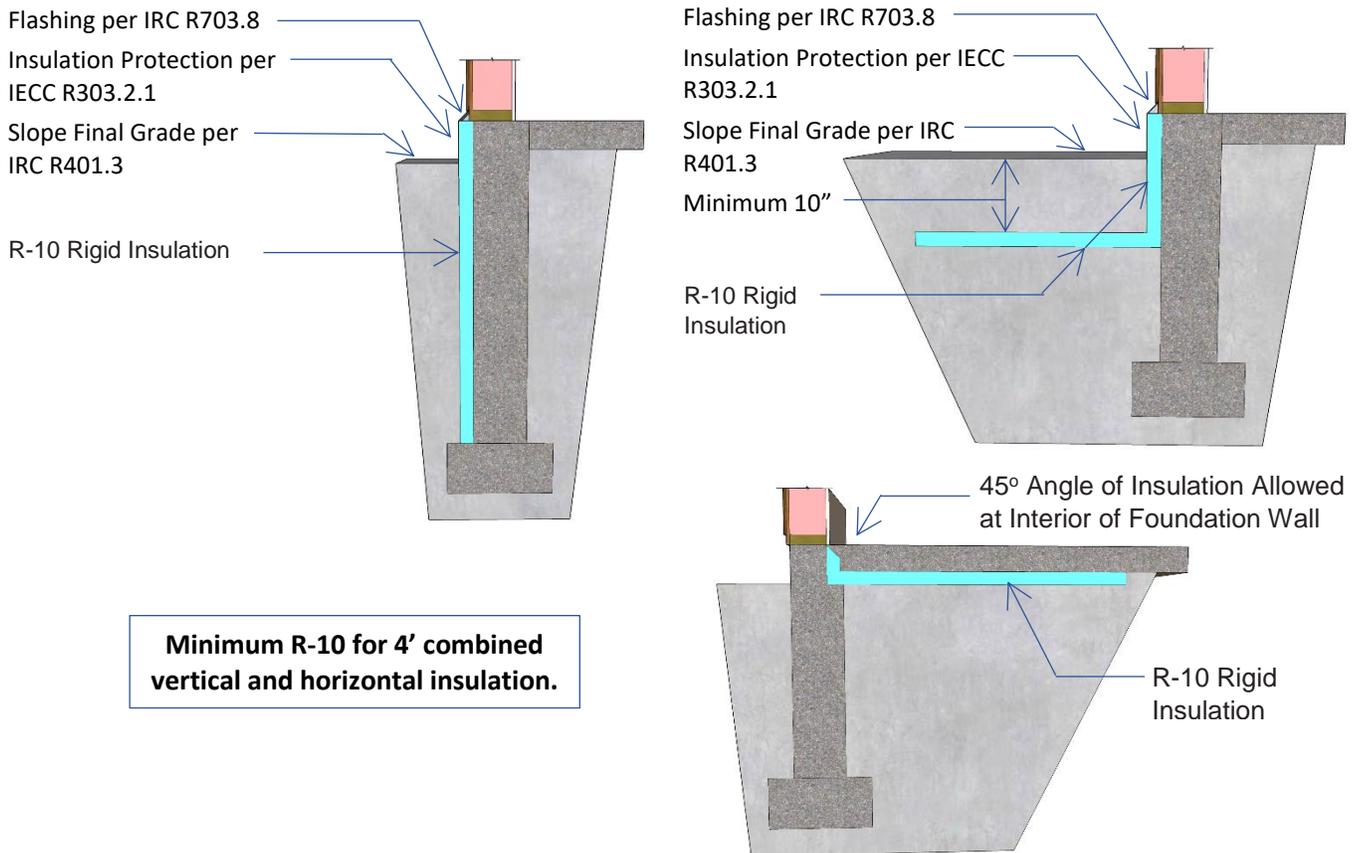


Figure 1. Conventional Slab-On-Grade Insulation Options



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.

**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 or 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. Figure 1 illustrates three conventional slab-on-grade approaches that comply with the code. R-15 insulation is required for heated slabs such as when hydronic radiative heat is embedded in the slab.

**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. There are seven Montana counties with an Air Freezing Index of 4,000 where the R-value requirements of IRC R402.2.9 become 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 1500 Air Freezing Index, is 14 inches. The minimum footing depth for all other counties is 16 inches. Figure 2 illustrates the key factors used in FPSF insulation placement and R-value requirements.

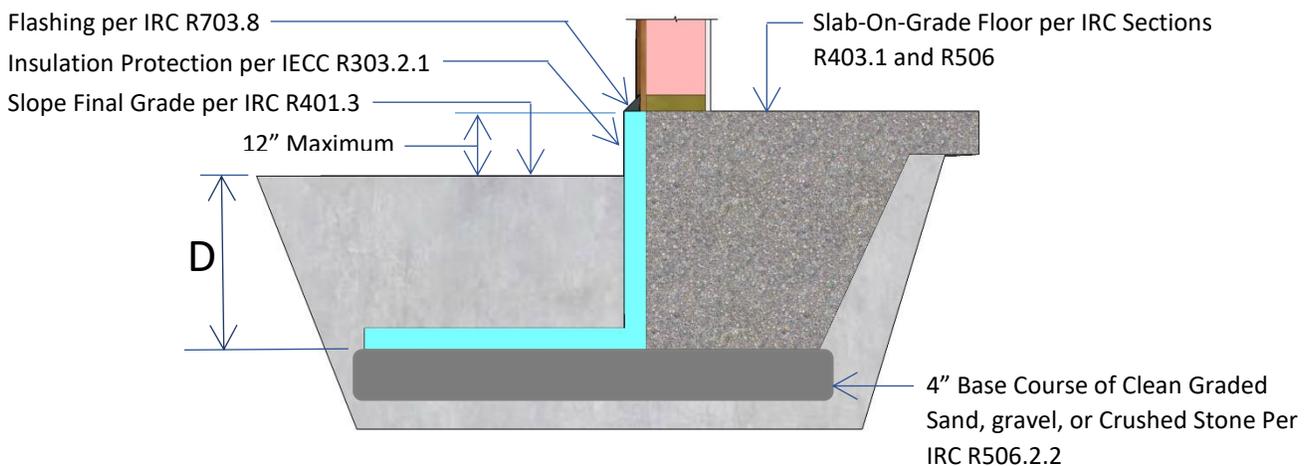


Figure 2. Insulation Placement in FPSF



**Air-Freezing Index.** 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. Figure 3 shows the Air Freezing Index for Montana counties.

Figure 3. 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		

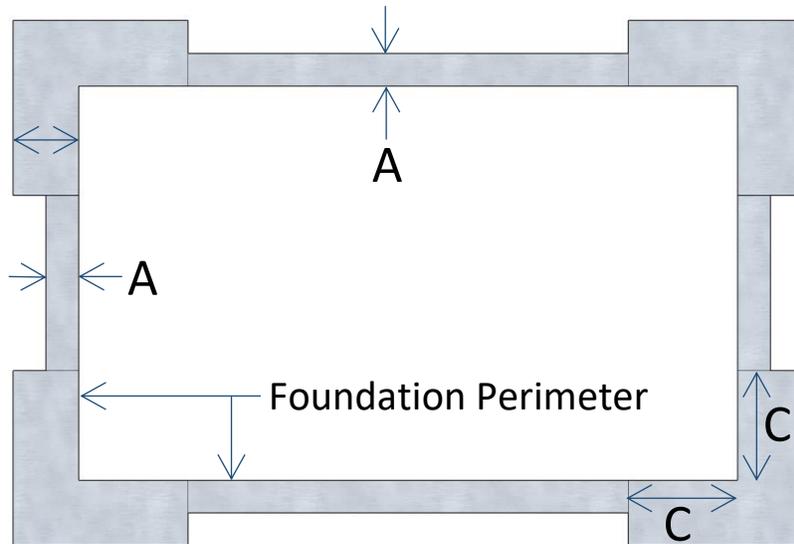
Figure 4 summarizes the FPSF requirements combining the provisions of the IRC and the IECC. For Montana counties with an Air Freezing Index of less than 4,000, the IECC establishes the insulation values required as well as the combined vertical and horizontal dimension of the insulation. For those seven counties with an Air Freezing Index of 4,000 the IRC establishes the minimum required vertical and horizontal insulation R-values and the horizontal insulation dimension. Refer to Figure 5. The IECC minimum 48 inches combined vertical and horizontal insulation dimension applies in all cases.



**Figure 4. 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.



**Figure 5. Horizontal Insulation Requirements Plan**  
Applicable only if County has an Air Freezing index of 4,000.

Note 1: Insulation materials used below grade must be labeled as complying with ASTM C 578.

Note 2: This article addresses a standalone structure. The IRC includes more details and specific requirements when a FPSF is adjacent to a heated structure and when a FPSF is adjacent to an unheated slab-on-grade structure. Refer to 2012 IRC Sections R403.3.1 and R403.3.2.



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Energy Code Reference Guide

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## Code References

**2012 IRC R403.3 Frost-Protected Shallow Foundation**

**2012 IRC R506 Concrete Floors (On Ground)**

**2012 IECC R402.2.9 Slab-On-Grade Floors**

## 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.