SEI/ASCE 32-01

ASCE STANDARD

American Society of Civil Engineers

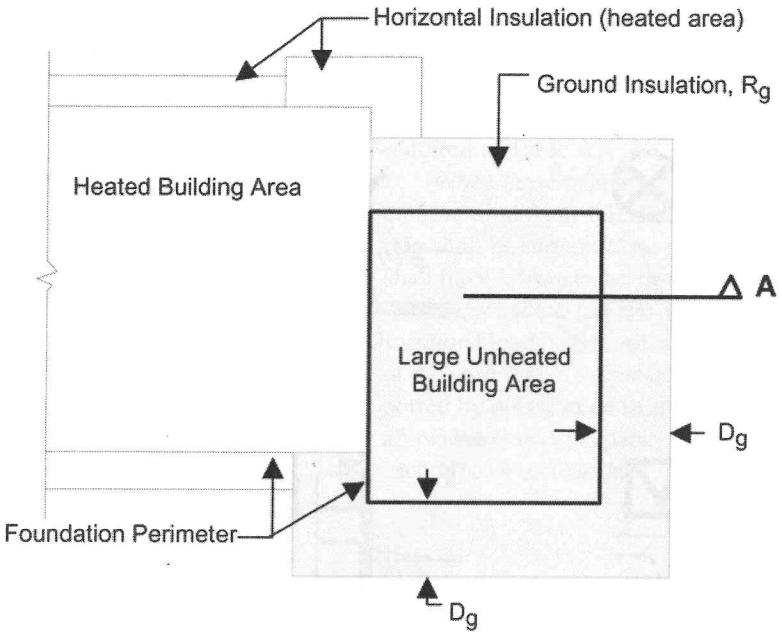
Design and Construction of Frost-Protected Shallow Foundations

ASCE

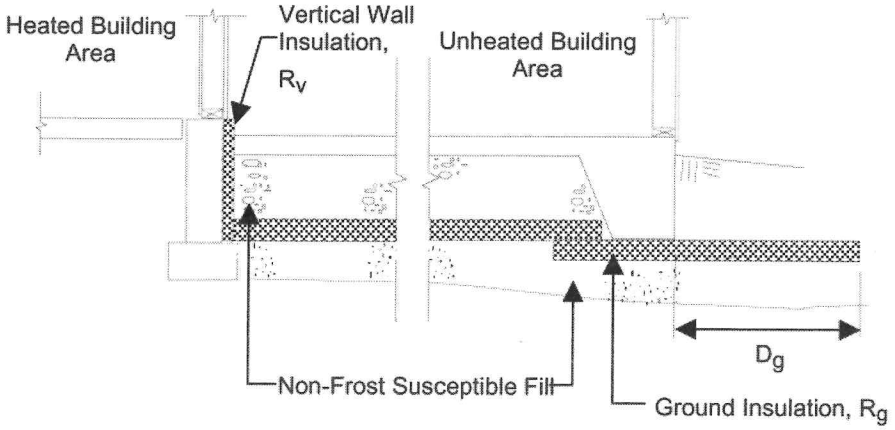
SEI Structural Engineering Institute

National Association of Home Builders of the United States

NAHB RESEARCH CENTER SM



Insulation Plan



Cross-Section A

FIGURE 10. Insulation Detail for a Large Unheated Area

A.3 CLIMATE DATA

TABLE A3. Estimates of the Mean Annual Temperature (MAT) and the Design Air-Freezing Index (F_{100}) at Select Locations

Location	Mean Annual Temperature[1] (°F)	Design AFI Estimates[2] 100-Year Mean Return Period, F_{100} (°F-days)
Alaska, Anchorage (Elmendorf AFB)	35.0	3,430
Colorado, Denver	50.3	710
Connecticut, Hartford	49.7	940
Idaho, Idaho Falls	43.8	2,350
Illinois, Chicago	50.6	1,430
Indiana, South Bend	49.4	1,380
Iowa, Fort Dodge	47.4	2,130
Kansas, Topeka	54.1	1,000
Kentucky, Lexington	54.9	720
Maine, Portland	45.0	1,410
Michigan, Lansing	47.2	1,530
Minnesota, Duluth	38.2	3,130
Missouri, Jefferson City	55.1	900
Montana, Lewistown	41.9	2,470
Nebraska, North Platte	48.1	1,690
Nevada, Elko	46.2	1,530
New Hampshire, Concord	45.3	1,600
New York, Syracuse	47.7	1,210
North Dakota, Bismarck	41.3	3,360
Ohio, Mansfield	48.2	1,370
Oregon, Baker	45.6	1,450
Pennsylvania, State College	49.3	1,170
South Dakota, Redfield	43.9	3,010
Utah, Ogden	50.8	1,080
Vermont, Burlington	44.1	2,050
Virginia, Big Meadows	47.2	1,150
Washington, Spokane	47.2	1,230
West Virginia, Elkins	49.4	1,050
Wisconsin, Wausau	42.4	2,490
Wyoming, Sheridan	44.6	2,280

[1] Climatography of the United States No. 81, Supplement No. 3, "Maps of Annual 1961–1990 Normal Temperature, Precipitation, and Degree Days" U.S. Dept of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center, Asheville NC.
[2] Steurer, Peter M. Methods Used to Create an Estimate of the 100-year Return Period of the Air-Freezing Index. U.S. Dept of Commerce, National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center, Asheville NC (1989).

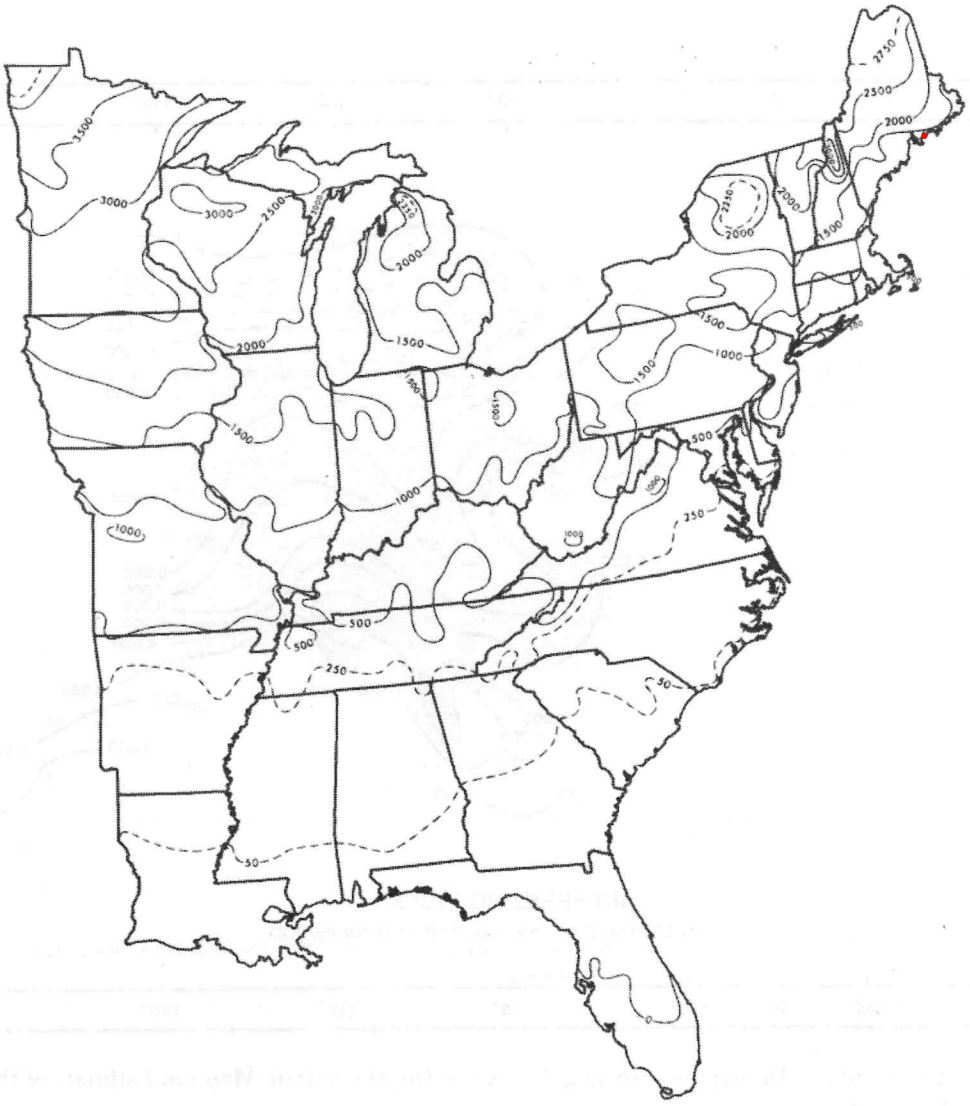


FIGURE A1, Continued. United States Design Air-Freezing Index (°F-Days) Contour Map (an Estimate of the 100-Year Mean Return Period), F_{100}

FIGURE A2, Continued. Mean Annual Temperature (°F) Contour Map For The United States.

TABLE A7. Minimum Thermal Resistance of Wing Insulation, R_{hc}, for Use at Corners with 16-inch (0.4-m) Footing Depth

		R-values for Various Wing Widths at Corners, D_{hc} (inches)					
F_{100} (°F-days)	L_c (in)	16	24	30	36	42	48
2,250 or fewer	0	0.0					
2,625	40	6.5	4.9	4.0			
3,000	40	9.6	8.6	8.0	7.4		
3,375	60		11.1	10.5	9.8	9.1	
3,750	60		13.1	12.5	12.0	11.2	10.8
4,125	60			14.5	13.7	13.0	12.5
4,500	80				15.9	15.1	14.8

Interpolation shall be permitted.

TABLE A8. Minimum Thermal Resistance (R-Value) of Ground Insulation, R_g, and Horizontal Extension, D_g, for Unheated Buildings

		Mean Annual Temperature (°F):				
F_{100} (°F-days)	D_g (inches)	≤32	36	38	40	≥41
750 or fewer	30	5.7	5.7	5.7	5.7	5.7
1,500	49	13.1	9.7	8.5	8.0	6.8
2,250	63	19.4	15.9	13.6	11.4	10.2
3,000	79	25.0	21.0	18.2	15.3	14.2
3,750	91	31.2	26.1	22.7	—	—
4,500	108	37.5	31.8	—	—	—

Interpolation shall be permitted.

6.8/2.6 = 2.6 inches min.
6.8/2.8 = 2.4 inches min.
6.8/4.0 = 1.7 inches min.

Effective R/inch (see next page)

APPENDIX A

A. DESIGN DATA

A.1 PURPOSE

This Appendix provides mandatory design data supporting frost-protected shallow foundation (FPSF) design in accordance with this Standard.

A.2 MATERIAL PROPERTIES

A.2.1 Soil Properties

The soil shall be considered to be frost-susceptible unless otherwise classified as non–frost-susceptible in accordance with Section 4.2 of the Standard.

A.2.2 Insulation Materials

The insulation products used to meet the requirements of this Standard shall be expanded polystyrene or extruded polystyrene manufactured in compliance with ASTM C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation. The effective resistivity, r_{eff}, (R per inch) in Table A1 shall be used to determine insulation thicknesses required for below-ground application. Insulation materials shall be permitted to be placed in multiple layers to meet required insulation thickness, provided the thickness of any individual layer is not less than the minimum thickness required in Table A1.

When these insulation materials are subject to compression from soil and building loads, the insulation shall be supported on suitable bearing material and shall have adequate compressive strength and long-term deformation (creep) characteristics to resist the sustained loads (live and dead) during the expected life of the structure. Compressive (bearing) loads supported by polystyrene insulation shall not exceed the allowable bearing capacities given in Table A1 for each type of insulation.

TABLE A1. Design Values for FPSF Insulation Materials

Insulation Type per ASTM C578	Minimum Insulation Density per ASTM C578 (pcf)	Effective Resistivity, r_{eff}[1] (R per Inch)		Nominal Resistivity per ASTM C578 (R per inch)	Allowable Bearing Capacity[2] (psf)	Minimum Insulation Thickness (inches)	
		Vertical	Horizontal			Vertical	Horizontal
			Expanded Polystyrene				
Type II	1.35	3.2	2.6	4.0	N/A	2	3
Type IX	1.8	3.4	2.8	4.2	1,200	1.5	2
			Extruded Polystyrene				
Type X	1.35	4.5	4.0	5.0	N/A	1.5	2
Type IV	1.6	4.5	4.0	5.0	1,200	1	1.5
Type VI	1.8	4.5	4.0	5.0	1,920	1	1
Type VII	2.2	4.5	4.0	5.0	2,880	1	1
Type V	3.0	4.5	4.0	5.0	4,800	1	1

[1] Effective resistivity is based on tests from laboratory and field studies of insulation products under long-term exposure to moist, below-ground conditions. 'Vertical' effective resistivity shall be used for insulation placed vertically on exterior foundation walls. 'Horizontal' effective resistivity shall be used for insulation placed horizontally, below ground.

[2] Allowable bearing capacity is based on ASTM C578 compressive strength at 10% deformation divided by a safety factor of 3.0 for conditions without cyclic loading (i.e., highway vehicle loading).

'N/A' prohibits use where structural foundation loads are supported (i.e., insulation below footings).