Technical Bulletin #109

REFLECTIVE INSULATION SYSTEMS IN FLOOR ASSEMBLIES

A Reflective Insulation System (RIS) is typically made up of one or more layers of reflective (low emittance) surfaces with air spaces between the layers. One very good construction application of a RIS is in a floor assembly installed to floor joist above a crawlspace or unheated basement.

Typical installations are one layer of reflective insulation installed to the bottom of the floor joist, one layer installed between floor joist, multiple layers installed in floor joist, single layer installs under radiant heat systems with or without the addition of mass insulation.

What makes an RIS installed in a floor assembly unique is that the floor is the only part of the thermal envelope that the heat flow is always in one direction. No matter the season it is always cooler in the crawlspace or unheated basement than in the living area above, therefore the direction of heat flow is always down.

Building Codes Requirements for Insulating Floor Joist

State, local and national building codes require varying amounts of thermal resistance needed in floor assemblies based on climate zones.

The following table is from the 2012 International Residential Code and depicts the minimum thermal resistance necessary to meet code requirements.

Table 1. Minimum Code Requirements for Floor Assemblies

Climate Zone	Floor R Value
1	13
2	13
3	19
4 except Marine	19
5 and Marine 4	30*
6	30*
7 & 8	38*

*Or insulation sufficient to fill the framing cavity R19 minimum

Expected range of R-values for Common Installation Assemblies

R-values have been calculated for below-floor assemblies that include enclosed reflective air space(s). Framing that is 24 in. on center with nominal 2 by 8 in., 2 by 10 in., or 2 by 12 in. floor joists are included in the range of R-values below.

The reflective insulation material used in the analysis was nominal 0.25 in. thick product with a material r-value of 1 $ft^2 \cdot h \cdot {}^oF/Btu$ and surface emittance of 0.04. The thermal boundary conditions used in the calculation were 40º F for the air below the floor and either 70º F or 140º F for the bottom surface of the subfloor. The 140º F corresponds to the presence of a radiant floor heating system. R-values for the enclosed reflective air spaces were calculated using the procedure discussed in ASTM STP 1116[1] using a two-dimensional correction proposed by Glicksman.[2] The air-film resistance for a low-emittance surface facing down was taken from the ASHRAE Handbook of Fundamentals.[3]

Assemblies Included in the Analysis

Assemblies are described in terms of the location of the reflective insulation below the floor. Table 2 contains a description of the assemblies for which the thermal resistance (R-value) between the subfloor and the air space below the floor are calculated. In each case, thermal resistance values are calculated for the three framing sizes listed above for both sets of boundary conditions.

Table 2. Assemblies with an Enclosed Reflective Air Space

Assembly	Description
1	Reflective insulation attached to the bottom of floor joists
2	Reflective Insulation attached between joists at mid-point
3	Reflective insulation at mid-point and attached to the bottom of the joists (two layer system)
4	Reflective insulation installed between joists at a specified distance below the floor. A. one inch below the floor B. two inches below the floor C. two inches below the floor with a second layer of reflective insulation attached to the bottom of the joists

Calculated R-values

Table 3 contains the calculated R-values for assemblies 1, 2, and 3. The table contains R-values for the region between the joists and floor to air (1D) and R-values with a two-dimension correction applied (2D). The results shown as 1D and 2D can be viewed as the R-value range to be anticipated in installations. All of the results are for heat flow down with R=4.55 ft²·h·ºF/Btu as the air-film resistance. The R-values in Tables 3 and 4 include air film resistance on the bottom exposed reflective surface.

Table 3. Calculated R-values for Assemblies 1, 2, and 3

Assembly	Temperatures (ºF)	Framing	R-value (1D)	R-value (2D)
1	70 - 40	2 by 8	16.1	11.7
		2 by 10	16.2	11.5
		2 by 12	16.2	11.4
1	140 – 40	2 by 8	13.5	10.2
		2 by 10	13.5	10.0
		2 by 12	13.4	9.8
2	70 - 40	2 by 8	14.8	12.0
		2 by 10	15.4	12.0
		2 by 12	15.8	11.9
2	140 – 40	2 by 8	12.9	10.6
		2 by 10	13.2	10.6
		2 by 12	13.4	10.4
3	70 - 40	2 by 8	27.9	21.5
		2 by 10	29.9	21.9
		2 by 12	31.2	21.9
3	140 – 40	2 by 8	23.8	18.6
		2 by 10	24.9	18.6
		2 by 12	25.6	18.4

Reflective Insulation used with Radiant Heat Floor Systems

Reflective insulation systems are uniquely suited for use under the hot water tubes or electric panels in radiant floor applications. The high reflective and low emissive surface(s) of the insulation reflect the radiant heat that is released from the heating elements back up towards the subfloor where it can conduct to the floor above. Many radiant floor systems recommend or require a reflective material be installed.

Reflective insulation systems can be installed just below the heating system with or without additional mass insulation. Or it can be installed to the bottom of the floor joist.

Table 4. Calculated R-values for Assembly 4

Assembly	Temperatures (ºF)	Framing	R-value (1D)	R-value (2D)
4A	140 – 40	all	9.4	9.0
4B	140 – 40	all	11.5	10.3
4C	140 – 40	2 by 8	22.9	17.9
		2 by 10	23.2	17.6
		2 by 12	23.2	17.3

Installation Guidelines

Inspect the floor assembly and make any needed repairs before installing insulation. Look for signs of mold, dry rot or excessive moisture.

Determine the spacing of the floor joist. Most will be 12 to 24 inches on center.

In a crawl space application determine if there are water pipes that will be below the insulation. In cold climates you may need to insulate them.

Start at the end of the house and face staple to the bottom of the floor joist. At the ends staple up to the sub floor or band board

Installing the reflective insulation to the bottom of the floor joist and taping the seams with foil tape will also create a vapor barrier to prevent ground water vapor from rotting the framing in areas of the country with high water tables.

References

[1] Desjarlais, A.O. and David W. Yarbrough, ASTM STP 1116 (1991) pp. 24-43.
[2] Leon R. Glicksman, Journal of Thermal Insulation 14 281-294 (1991).
[3] Chapter 26, 2009 ASHRAE Handbook of Fundamentals.

Reflective Insulation Manufacturers Association International (RIMA-I)
PO Box 4110
Olathe, KS 66063
Toll-Free: (800) 279-4123
Fax: (913) 839-8882
E-Mail: rima@rima.net
www.rimainternational.org

TB #109 11/11