Properties of rigid roof insulation

by **Mark S. Graham**

Rigid insulation is an integral component of many low-slope roof assemblies, and when properly manufactured, designed and installed, it serves several vital purposes. For example, rigid insulation reduces the energy required to heat and cool a building; can reduce the potential for condensation occurring on interior surfaces; provides a relatively smooth substrate to which other roofing materials can be applied; and can provide important fire-resistance characteristics.



Properties

The NRCA Roofing and Waterproofing Manual, Fourth Edition, identifies the following properties for ideal rigid roof insulation:

- Compatibility with bitumen and other adhesives. Ideal rigid insulation would withstand the effects of adhesives, solvents and hot bitumen at the application temperatures required for installation of a roof membrane.
- Impact resistance. Ideal rigid insulation would have strength, rigidity and a density high enough to resist impact damage.
- Fire resistance. Ideal rigid insulation would be noncombustible and comply with insurance underwriter and building code requirements.
- Moisture resistance. Ideal rigid insulation would resist the effects of moisture vapor and water without degrading.
- Thermal resistance. Ideal rigid insulation would have a low thermal conductivity (i.e., k-value) so that the highest possible thermal resistance (i.e., R-value) could be achieved in the thinnest piece of material.
- Stable thermal resistance value. Thermal resistance of ideal rigid insulation would remain constant and not drift with age (i.e., the insulation would not lose thermal resistance over time).
- Attachment capability. Ideal rigid insulation's surface would accommodate secure attachment.
- Dimensional stability. Ideal rigid insulation would remain dimensionally stable under varying temperature and moisture conditions.
- Component compatibility. Ideal rigid insulation material would be formulated to be compatible with other roof assembly components.

Unfortunately, no available product has all these properties. Roofing professionals must evaluate some insulation properties on a qualitative basis. For example, roof insulation products either can or cannot be attached with adhesives or by mechanical means. No quantitative evaluation method of this particular property exists.

However, for other properties, quantitative methods of assessment are available and provide bases for comparison.

ASTM standards

Evaluation of industry-accepted material standards for roof insulation products, such as those established by the American Society for Testing and Materials (ASTM), provides a means of quantitative comparison of properties of some rigid insulation types. These material standards generally establish minimum, but in some cases maximum (e.g., moisture absorption), properties for rigid insulation product types.

A list of rigid insulation products used in low-slope roof assemblies, their applicable ASTM material standard designations and side-by-side comparisons of some of their quantifiable physical properties are included in Figure 1.

When using the applicable ASTM material standards as the bases for comparing physical properties, it is important to note the test methods used to evaluate properties of different insulation products are not always similar. For example, water absorption of rigid insulation is tested by ASTM C 209, C 240, C 272 or C 2842, depending on the specific insulation material type. The test method that is considered most representative of a material typically is the one designated in a particular ASTM material standard.

Manufacturer standards

Evaluation of manufacturers' physical property data is another way to compare rigid roof insulation products and specific manufacturer's products within the same generic product category. In some instances, manufacturers make products that exceed the minimum requirements set forth in ASTM material standards.

Roofing professionals must evaluate some insulation properties on a qualitative basis.

Roofing professionals can review manufacturers' product literature and consult with manufacturers' representatives to determine physical property data for specific products. Also, NRCA's *Low-Slope Roofing Materials Guide* is a source for side-by-side comparisons of physical property data for manufacturers' products.

Closing comments

Because rigid insulation is an important part of many low-slope roof assemblies, a roofing professional should choose rigid insulation materials that have the best properties suited to a specific project and its conditions. PR

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ASTM material standards for rigid board insulation products

Insulation type	Water absorption (maximum)	Thermal resistance per 1-inch (25-mm) thickness (minimum)	Compressive strength (minimum)	Flexural strength (minimum)	Dimensional stability (maximum)
Cellular glass [ASTM C 552, Type IV]	0.5 percent volume [ASTM C 240]	2.9 F•h•ft² (0.41 km²/W) [ASTM C 117 or C 518]	65 psi* (448 kPa) [ASTM C 240 and C 165]	60 psi* (414 kPa) [ASTM C 240 and C 203]	Not reported
Glass fiber [ASTM C 612, Type I]	Not reported	3.8 F•h•ft² (0.26 km²/W) [ASTM C 117 or C 518]	25 psi* (1.2 kPa) [ASTM C 165]	Not reported	2 percent [ASTM C 356]
Perlite [ASTM C 728, Type I]	1.5 percent volume [ASTM C 209]	2.7 F•h•ft² (0.48 km²/W) [ASTM C 177 or C 518]	20 psi* (138 kPa) [ASTM C 165]	40 psi* (276 kPa) [ASTM C 203]	Not reported
Polyisocyanurate [ASTM C 1289, Type II]	1.5 percent volume [ASTM C 209]	5.6 F•h•ft² (0.97 km²/W) [ASTM C 117, C 236, C 518, C 976 or C 1114]	16 psi* (110 kPa) [ASTM D 1621]	40 psi* (275 kPa) [ASTM C 203]	4 percent [ASTM D 2126]
Expanded polystyrene [ASTM C 578, Type VIII]	3 percent volume [ASTM C 272]	3.8 F•h•ft² (0.26 km²/W) [ASTM C 177, C 518, C 236, C 976 or C 1114]	13 psi* (90 kPa) [ASTM C 165 or C 1621]	30 psi* (208 kPa) [ASTM C 203]	2 percent [ASTM D 2126]
Extruded polystyrene [ASTM C 578, Type VI]	0.3 percent volume [ASTM C 272]	5 F•h•ft² (0.2 km²/W) [ASTM C 177, C 518, C 236, C 976 or C 1114]	40 psi* (276 kPa) [ASTM C 165 or C 1621]	60 psi* (414 kPa) [ASTM C 203]	2 percent [ASTM D 2126]
Spray polyurethane foam [ASTM C 1029, Type III]	5 percent volume [ASTM D 2842]	6.2 F•h•ft² (1.1 km²/W) [ASTM C 177, C 236 or C 518]	40 psi* (276 kPa) [ASTM C 165 or D 1621]	Not reported	Not reported
Wood fiberboard [ASTM C 208, Type II, Grade I]	10 percent volume [ASTM C 209]	2.63 F•h•ft² (0.38 km²/W) [ASTM C 177, C 518, C 1045 or C 1114]	Not reported	Not reported	0.5 percent [ASTM D 1037]

*pounds per square inch

Note: Applicable ASTM material standards or test methods are designated in brackets.

Figure 1: *Common insulation types and their properties.*