Roof insulation: Multiple layers is the best approach

by **Dave Flickinger, RRO**

Q: *What are the benefits of using two layers of insulation board in a low-slope membrane roof system?*

A: When designing energy-efficient roof systems that use rigid insulation board, NRCA recommends designers use two or more layers of roof insulation in their designs. It has long been recognized that installing two or more layers has many advantages compared with installing a single layer of insulation in terms of limiting heat transfer and maximizing a roof system's energy efficiency.

Some advantages of a multiple-layer approach are:

1. *Thermal loss is reduced.* Thermal loss commonly occurs through gaps at the boards' joints (see Figure 1). The paper "Thermal Evaluation of the Effects of Gaps Between Adjacent Roof Insulation Panels," which was published in *Proceedings: DOE* [Department of Energy]-*ORNL* [Oak Ridge National Laboratory] *Workshop on Mathematical Modeling of Roofs,* reveals reductions in overall thermal efficiency by as much as 10 percent for roof systems that use single layers of insulation. Installing a second insulation layer, offset from the layer below, greatly minimizes the heat loss or gain that occurs in a single-layer configuration.

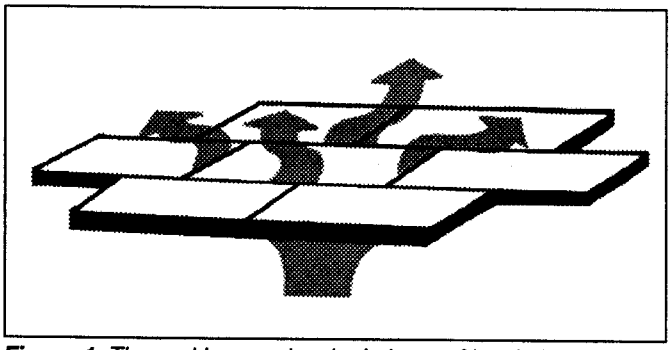

Figure 1: *Thermal loss and a single layer of insulation.*

2. *Roof membrane stress may be minimized.* Typically, there is increased stress on a fully adhered roof membrane at the insulation board joints. Movement of roof insulation and a structural deck can create stresses that are transferred through board joints, increasing the potential for membrane buckling, ridging and splitting. Two or more insulation layers (offset from adjacent layers) minimize localized isolation of, as well as assist in, absorbing these stresses.

3. *Thermal bridging is reduced.* Because metal is an excellent thermal conductor, metal fasteners provide a conduit (i.e., bridge) for thermal transfer and loss. The paper "A Heat Transfer Analysis of Metal Fasteners in Low-Slope Roofs," published in the American Society for Testing and Materials' Special Technical Publication 958, *Roofing Research and Standards Development,* reports losses of 3 percent to 8 percent in overall roof assembly thermal resistance (i.e., R-value) for metal fasteners and stress plates and losses of 1.7 percent to 4.5 percent for metal fasteners and plastic stress plates when fasteners penetrate an entire insulation assembly.

When mechanical fasteners are used, mechanical attachment of the base layer of insulation and adhesive attachment (e.g., bitumen) of consecutive layers significantly can reduce this thermal loss (see Figure 2). This configuration also minimizes potential membrane damage if problems with fastener back-out are experienced.

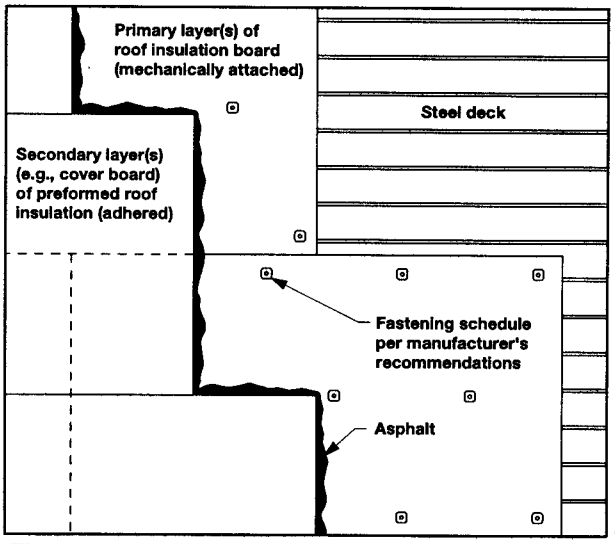

Figure 2: *A double layer of insulation.*

When a single-layer approach is used or mechanical fasteners penetrate an entire insulation assembly, roofing professionals are encouraged to consider and provide for the potential reduction in a roof system's overall thermal efficiency.

A few decades ago, roof systems commonly contained little or no insulation. In many cases, roof insulation did not enhance a building's energy efficiency significantly but provided a suitable substrate to which a roof membrane was applied. Now, roof systems using energy-efficient materials are commonplace, and the multilayer approach to insulating a roof system is one more way to minimize heat transfer and reduce heating and cooling costs. PR

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