COMMERCIAL BUILDING PRODUCTS

CBP

SERVING ARCHITECTS, CONTRACTORS, AND OWNERS IN COMMERCIAL CONSTRUCTION Jan/Feb 2014 Vol. 12 No. 1

DEPARTMENT ▶ *the green angle*

Stanley P. Graveline, Chemical Fabrics and Film Association

Cool Roofs Not Just For The Sun Belt

Put a cool roof on 80% of all U.S. commercial buildings and save $735 million annually.

When cool-roof materials enter a discussion, the tendency is to think of them as a class of products that fit best in sun-drenched, high-annual-temperature portions of the country. Research, however, tells us that the benefits can be realized in all climate zones.

Cool-roof materials, which have been in use since the 1960s in Europe and the 1970s in North America, reflect a significant portion of incident solar radiation back into the atmosphere (reflectance), and also quickly release to the atmosphere the fraction of energy that the roof absorbs (emittance). Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA, was one of the first to measure the cooling energy savings associated with cool roofs. LBNL's 2001 study of an Austin, TX, retail store found that switching a black-colored membrane to a white membrane reduced the facility's average summertime rooftop surface temperature from 168 F on the black to 126 F on the white. Peak-hour cooling-energy savings were at 14% and overall annual energy savings were $0.072/sq. ft. Adjusted for inflation in 2013, this would be the equivalent of $0.095/sq. ft.

LBNL also simulated the potential impact of substituting conventional dark-colored roofs with cool roofs in 236 cities. Using the U.S. Department of Energy's, Washington, DOE-2.1E energy model, they determined the differences in cooling and heating energy use between conventional dark roofs and aged cool roofs with an assumed average reflectivity of 0.55. Considerations were the types, ages, and construction density of the local building inventory, local energy sources, and other factors.

Not surprisingly, greatest net-energy savings were calculated for Sun Belt states such as Arizona, New Mexico, and Nevada. LBNL's modeling showed that, while there could be a heating energy penalty associated with the use of cool roofs in cold climates, its magnitude was quite small. In Minnesota, for example, they calculated it to be on average 0.137 therm/m^2/yr. for conditioned commercial buildings. Most importantly, excluding remote locations in Alaska, the summertime cooling energy savings more than offset any heating penalty, resulting in net annual energy savings.

Overall, LBNL estimates that the use of cool-roofing materials on 80% of U.S. commercial buildings would result in 10,400 GWh of cooling energy savings, and approximately $735 million in overall energy savings. This avoided production of the energy saved could reduce CO_2 emissions by 6.23 million tons annually.

Target Corp., Minneapolis, with approximately 1,900 facilities across the U.S., routinely tracks energy consumption and compares actual results with the projections generated by their own energy models. For more than two decades, Target has made using reflective thermoplastic vinyl roof membranes on their facilities an important component of their corporate energy-efficiency program. They have compared cool roofs with black roofs in cold climates and have not measured any difference in heating-energy consumption between the two.

Why should this be? Winter days are shorter than summer days, with more overcast skies. The sun is much lower to the horizon in the winter and generates much less heat. In northern states, winter solar irradiance is typically 20% to 35% of the summer-time irradiance for a given location. Therefore, a roof surface receives three to five times more sun in the summer than in the winter. Also, in many northern states, roofs will be covered by a highly reflective blanket of snow for extended periods of time, further reducing the impact of a darker-colored roof surface on heating energy.

In this vein, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN, estimated the energy equivalency of cool roofs versus non-cool roofs with additional insulation. They also calculated the additional amount of insulation needed to achieve energy-equal roofing systems for new construction and retrofit. They selected one city from each ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta) climate zone and assigned it a default R-value for new construction and retrofit cool roofs. Using the Simplified Transient Analysis of Roofs (STAR) model, they calculated cooling and heating energy costs. They then determined the additional insulation that would be required under a non-cool roof that had only 0.10 reflectivity to produce heating and cooling costs comparable to a roof having 0.65 reflectivity.

Additional insulation required to achieve energy equivalency with a cool roof ranged from R3 in Fairbanks, AK, to R17 in Miami, FL, with an average of R9 in new construction, R2 to R7, for the same cities respectively, and an average of R4 in retrofit.

Cool roofs provide energy savings benefits even if reflectivity levels fall well below the average of those achieved by the products available on the market. The Cool Roof Rating Council's, Oakland, CA, rated-product directory lists 448 low-slope roofing products defined as cool. The average initial reflectivity of this group of 448 products is 0.82, and the 3-yr. aged reflectivity of this same group is 0.69.

Industry sources estimate that approximately 5.5-billion sq. ft. of thermoplastic roofing membrane has been installed in ASHRAE climate zones 5 and higher in the past decade. More than 2 billion of that has been installed in zones 6 and 7 alone. In northern climates, where the net energy savings may be modest on a given building, peak energy demand reduction and mitigation of the urban heat-island effect are becoming increasingly important, and there is no sign of these trends reversing themselves in the foreseeable future. CBP

Stanley P. Graveline sits on the technical committee for the Vinyl Roofing Division of the Chemical Fabrics and Film Association, Cleveland.