Why GOOD Weather is BAD for Roofs!

Understanding the Effects of Solar Radiation on Roofs

By William A. Kirn, RRC

Consider the plight of the commercial building owner with multiple tenants under an aged and failing roof. On a rainy day, the owner waits in fear for the phone to ring from an irate tenant that "...the roof is leaking! Why wasn't it fixed after the last storm?" And "can I deduct the cost of computer repair and productivity down time from this month's rent?"

On a clear day the building owner can relax knowing at least this day the roof is OK. But is it really? When does the roof deteriorate the most, during inclement weather or clear weather? If one considers precipitation in the form of rain or snow and the resulting flow of water into a building as merely the effect of a roof that has lost its watertight integrity, then the rainy day merely is signalling that the roof leaks.

There's an irony here. Most roofing professionals consider the effects of sunlight, heat, and oxygen as the natural causes of the roof deterioration. Whether the roof is bituminous, thermoplastic or thermoset single ply, metal, tile, or sprayed-in-place polyurethane foam, the deterioration and degradation of the roof are accelerated more during fair than inclement weather. The single most destructive cause is from sunlight which bombards the roof surface with two distinct types of radiation.

The solar spectrum is actually a continuum of wavelengths, but two regions require specific comment. The first is the infrared region. This is the portion of the sunlight that provides heat. It can be seen as the red lights (as well as light that can't be seen with the eye) over the French fries at your local fast food restaurant. It's also the red heat lamp in some hotel bathrooms. We know that all chemical reactions and physical processes are accelerated by heat. Heat has a beneficial effect on the chemistry of baking (turning dough into cookies), but a deleterious effect on automobile engines and transmissions. This heat wears out components prematurely and is the reason why car engines are equipped with radiators and transmissions are equipped with transmission coolers. Similarly, heat has a deleterious effect on roofs. Consider a typical residential tract housing development where the houses were built at approximately the same time. Where two houses are facing the same exposure, the roof on the house with the lighter colored roof will outlast the roof on the house with the dark color.

What does this say about roof design and longevity? Simply put, it means that the roof should be surfaced with a light colored material designed to reflect the sun's infrared radiation. Cooler roofs last longer. Recent studies conducted by various national laboratories, NASA, and state and local municipalities have shown that reflective or "cooler" roofs actually reduce ozone and other atmospheric pollutants. This is because ozone formation is accelerated by heat, and atmospheric pollutants are the result of burning fossil fuel to generate electricity to operate air conditioners during hot weather. (An excellent article written by Dr. Hashem Akbari from Lawrence Berkeley Laboratory called "Cool Construction Materials Offer Energy Savings and Reduce Smog," published in *ASTM Standardization News,* November 1995, provides a comprehensive review of this topic.)

Moreover, these cool roofs also reduce the air conditioning loads on buildings and save electricity in the warm months. In fact, the Georgia Building Code has recently been amended to allow for substitution of "cool roofing materials" such as reflective roof membranes and coatings in place of insulation when designing a roof. The additional cost of using a reflective roof surface can be easily amortized or paid for with reduced electricity consumption during the air conditioning season. This is most effective in lower latitudes and warmer climates.

Let's look at the second source of deterioration coming from the sun. Sunlight contains shorter wavelength ultraviolet radiation which has been shown to be the cause of premature aging of our skin and the cause of skin cancers of various types. The UV radiation actually changes the skin cell structure and causes it to mutate and form tumors. On a roof, the process is a bit different. The UV radiation attacks the membrane and causes various chemical reactions to take place. These are observed by the roofing professional during a roof inspection as chalking, splitting, shrinkage, embrittlement, and other observations we characterize as "weathering."

Some roofing materials are more prone to UV attack than others. Asphalt and modified bitumens contain chemicals that can be destroyed by UV. This is observed as embrittlement, asphalt degradation, and cracking. Uncoated, sprayed-in-place polyurethane foam can deteriorate and erode as much as a half inch per year as a result of UV attack on the foam. Some single plies exhibit cracking and severe chalking as the base polymer in the membrane is actually broken into shorter chains by the UV portion of the sunlight. This phenomenon is known as "chain scission."

The obvious question is, "How can the roof be protected from the deleterious effects of the UV radiation?" Once again, the prudent selection of a blocking material on the surface of the waterproofing material can prevent UV attack. Such materials include gravel aggregate, granules, and UV blocking coatings. One word of caution here: Because a coating is opaque white, do not expect that it will block UV radiation. All non-asphaltic coatings use pigments (tiny rocks that feel like baking flour in their raw material form). These pigments are dispersed in a solvent or water. When the coating dries, the solvent evaporates, and the polymer (which may be acrylic, silicone, urethane, butyl, or other "binder") adheres the pigments to the substrate, in this case the roof membrane.

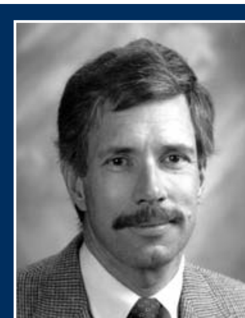
Most organic polymers (except aromatic urethanes) do not deteriorate under UV attack but are transparent to UV radiation. This allows the UV to move freely through the coating and attack the substrate, in this case the waterproofing material. The UV can easily be blocked by the incorporation of pigments. This is the same concept as using a sunscreen on your skin at the beach. However, not all pigments will reflect UV radiation, even though the coating appears opaque.

Typically, a well formulated roof coating may include some titanium dioxide and zinc oxide, two excellent UV blocking pigments. The coating may also contain some calcium carbonate that contributes to visible light opacity but not to UV blocking. An inferior coating will omit the UV blocking pigments such as titanium dioxide or zinc oxide. Unfortunately, there is no easy way to identify the presence or amount of UV blocking pigments from merely looking in the can. Coatings that meet ASTM specifications may or may not contain UV blocking pigments. Ask the coating manufacturer how much UV blocking pigments they incorporate into each gallon of roof coating.

The roof design professional is offered a continually increasing myriad of options from which to select when specifying a roof. Most will do a satisfactory job of maintaining watertight integrity when the roof is new. The fundamental difference lies in the selected roof material's ability to resist deterioration from sunlight—both infrared and ultraviolet—after years of exposure. Where the UV and IR resisting qualities of the roofing membrane are in doubt, the roof design professional can make the appropriate recommendation to include a coating or other surfacing that will reflect the sun's dangerous rays.

The next time a building owner or facility manager mentions to you as a roofing professional that "at least its not raining," you can reply, "Unfortunately, the roof is wearing out even faster today!" ■

About the Author



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