METAL ROOFING & INTERIOR CONDITIONS

BY E. FRANK KELM, RRC

As metal roofing becomes more commonplace, it is being called upon to protect different interior environments. These environments include offices, classrooms, and manufacturing facilities, to name a few. As expected, the requirements of each environment can vary greatly.

One component that should be addressed very early in the planning stage is the interior relative humidly (RH) of the occupied space. Higher interior humidity may require the use of different materials or construction techniques. Geographic location can also be a factor. Designs that work well in southern climates may not give the desired performance when constructed in northern climates.

It may be difficult to locate a specific manufacturer's recommendations for design based upon interior conditions. However, one manufacturer's design manual contains suggested guidelines for various interior humidity levels. Page 70-01.7 of the *Butler Roof Systems Design/Specifiers Manual* offers the following:

> "The standard application of the MR-24 roof system using faced blanket insulation meets most building end use requirements where the interior relative humidity (RH) is 30% or less. Building interiors requiring 30% to 50% RH require blanket insulation with a quality foil facing for specific vapor control, special attention to insulation application at joints and roof-to-wall transitions, and provisions for adequate air movement. Building interiors with RH requirements of 50% or greater require a mechanical engineer's approval of the insulation system planned in conjunction with adequate vapor control and air movement."

So here we have one manufacturer's basic guidelines to follow for three distinct humidity ranges. These ranges are:

- Less than or equal to 30%
- 30% to 50%
- Greater than 50%.

Note these recommendations do not include a corresponding interior temperature. A volume of air at 70% RH behaves very differently at 0˚F, 70˚F, and 100˚F. If the RH of the same volume of air is constant, the vapor pressure will increase as the temperature increases. This raises another important point: interior tempera-

Photo 1: Moisture seeping through corrosion in roof panel.

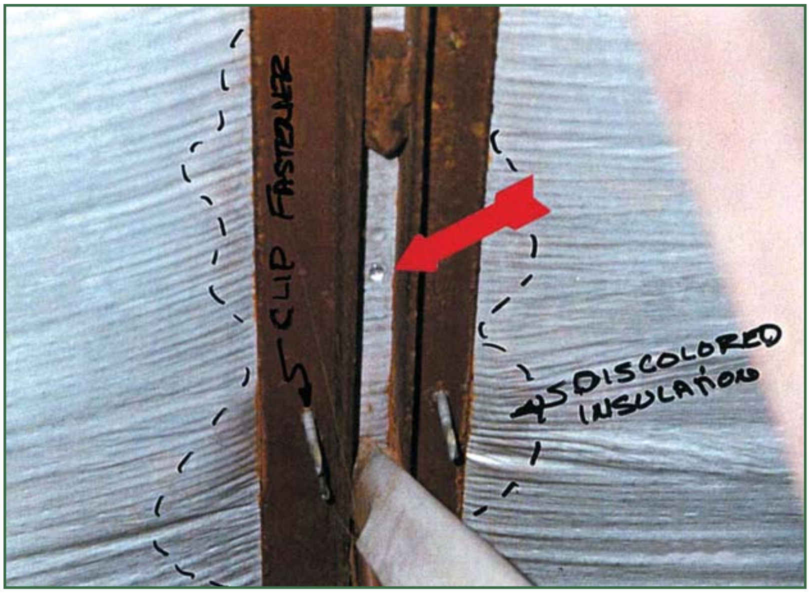
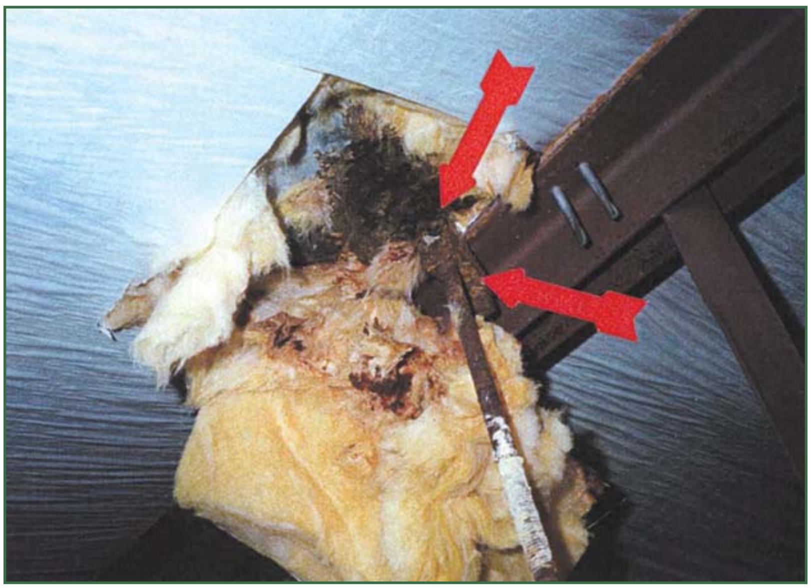


Photo 2: Condensation forming on insulation facer.



Above: Photo 3: Deterioration of beam clamp and underside of roof panel.

ture is also a major consideration of moisture control. If there is a higher than normal interior temperature (>75˚F), it may be prudent to consult with a mechanical engineer regardless of the anticipated relative humidity. For this article, we'll assume that the manufacturer has set these ranges based upon an interior temperature of 70˚F.

So the next question is, what relative humidity can we expect to encounter? To paraphrase, ASHRAE Standard 55 suggests that the comfort range for relative humidity is between 40% and 60%. These values are clearly above the 30% maximum previously stated for "standard applications" and extend into the >50% range at which a mechanical engineer should be consulted. Therefore, it seems prudent that within "normal" office environments (40% to 60% RH and 65˚F to 75˚F), one should always consult with the manufacturer, and possibly with a mechanical engineer, when designing a metal roofing system. Topics of discussion should include insulation, vapor retarder, detailing, and ventilation requirements.

How important is it to follow these recommendations? Each situation must be considered upon its own merits, but two examples are offered. The first involves a project located in Iowa with a standing seam roof installed with standard insulation, vapor retarder, and detailing (no special provisions for high humidity). The roofing system was seven years old and suffering from corrosion of the metal roof panels.

One could actually walk across the roof and see water seep out of the roofing system. Corrosion had penetrated the panel, and moisture was released by the saturated insulation when it was compressed by foot traffic *(see Photo 1)*.

Inside, virtually all of the roof insulation blankets were discolored and sagging. In several instances, condensation could be viewed on the surface of the vapor retarder *(Photo 2)*.

It was also interesting to view the damage that had occurred at a beam clamp. The clamp had been used to support a sprinkler line and was installed on the top chord of a truss. The head of the clamp had penetrated the vapor retarder and was in contact with the underside of the metal roof panel *(Photo 3)*. The clamp, threaded rod, and deck panel were all badly corroded at this point.

This roofing system had clearly suffered significant damage. Our investigation revealed high

Photo 4: Buckets suspended from roof framing.

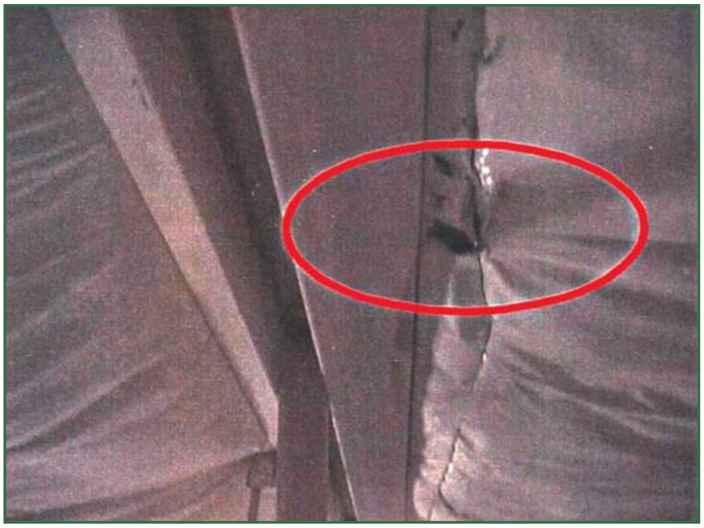


Photo 5: Insulation sidelap is "open" and not centered over framing member.

interior temperatures and humidity. Conditions recorded in the damaged area ranged from 36% to 68% RH and temperatures from 67˚F to 81˚F. The worst case recorded was an interior temperature of 75˚F, RH of 62%, with a resulting dew point of 61˚F.

In keeping with the previously listed recommendations, the manufacturer and a mechanical engineer should have been consulted during the design process. A few extra dollars spent up front could have saved the owner the frustration and expense of a costly and premature repair.

The second example involves a manufacturing facility, also located in Iowa. The parent company had several operating plants located in the South, all based upon a standardized, pre-engineered metal building design. When the Iowa plant was completed and placed into operation, nuisance leaks were reported throughout the plant, primarily during periods of cold weather.

When we viewed the interior of the building, we found that a large portion of the insulation blanket was wet, sagging from position, and dripping water where it had been punctured. As the blanket insulation became wet and sagged, the owner periodically punctured the "low point" of the blanket to allow water to escape in an effort to prevent the blanket from becoming dislodged and falling.

As we walked through the plant, we noted that buckets had been suspended from the roof trusses. These had been placed in strategic locations to prevent water from dripping onto sensitive equipment *(Photo 4)*.

The sidelaps of the blanket insulation were found to have gaps and were not taped or sealed together *(Photo 5)*. We also found that the blanket insulation had not been sealed around projections *(Photo 6)*.

When the client was asked about the building's interior conditions, he stated that the ideal operating conditions for the plant were 70˚F and 42% RH. On-site measurements revealed that the interior temperature ranged from 70˚F to 80˚F, and the RH varied from 40% to 50%. These ranges were within the client's acceptable operating limits.

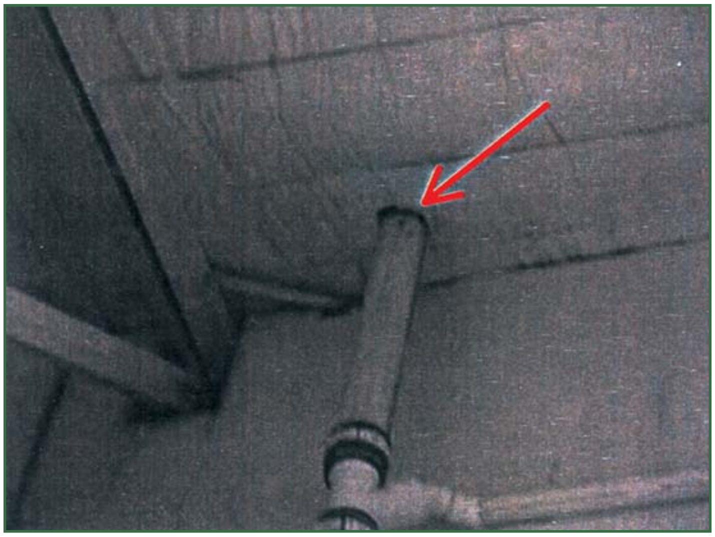


Photo 6: Insulation facer is not sealed around projection through roof.

The client was dismayed when its previously successful design (which worked fine in the South), failed to perform in a more northern climate. This example points out another variable to be considered – geographic location.

The National Roofing Contractors Association (NRCA) recommends "that dew point related problems be considered in the design of the roofing when the outside mean January temperature is below 40˚F, and/or the expected interior relative humidity is 45 percent or greater."

Had the designers heeded (or been aware of) the guidelines listed above, they may have been able to prevent this unpleasant surprise. As a result, the owner was faced with an expensive repair that could have been avoided. As is often the case, the cost to make repairs after the fact is much greater than if these enhancements were incorporated into the original construction.

In summary, we should all be aware that the interior temperature, relative humidity requirements, and the project's geographic location can have a dramatic effect on the proper design of a roof. ■

About the Author

Frank Kelm is a project manager for the Howard R. Green Company, located in Cedar Rapids, Iowa, and works primarily with building exteriors. He has more than thirty years' experience in the roofing industry, and is a Registered Roof Consultant (RRC) with the Roof Consultants Institute.

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