Pure-vinyl vapor retarders were used almost exclusively earlier, but vinyl usage is declining. Despite its low cost, vinyl has very high permeance, low puncture resistance, and a tendency to yellow and crack with age (Fig. 8.2). Any of the new materials can do the job much better. If the price is the only criterion, nonmetallized polypropylene/scrim/kraft facing, often marketed as a replacement for vinyl, is among the cheapest white reinforced facings available. However, its high perm rating (0.09 or so) is 4.5 times larger than that of the metallized version, which is still moderately priced.

Using a high-quality vapor retarder improves the quality of building construction and facilitates any future change of occupancy. It is not uncommon to see a "dry" building later change its use to the one that produces a lot of moisture—while the same mediocre vapor retarder stays in place. This virtually ensures serious condensation problems later, as explained in the section that follows. It is worth noting that the difference between the cheapest and the most expensive product available could be as little as two-tenths of 1 percent of the total building cost.[10]

8.5 HOW TO MAXIMIZE THERMAL PERFORMANCE

8.5.1 Avoiding Condensation

Condensation and rusting problems in metal building systems are quite common. Says William A. Lotz, a noted consultant on building moisture and insulation: "In my experience, 'conventional' metal building insulation and facers do not protect the metal building from condensation and rust for very long when there is humidity inside a building located in a cold climate."[11] Yet even the best insulation and vapor retarder facing can be severely compromised if installed incorrectly. Specifying a vapor retarder with low permeability is only the beginning. As Ref. 12 and others point out, moisture diffusion through vapor retarders is a slow process which rarely causes actual problems. A much

FIGURE 8.2 Cracked and torn vinyl vapor retarder.

more practical danger is leakage of moisture-laden air into the insulated space caused by poorly sealed seams of vapor retarder and by unprotected penetrations. Unless all the facing joints and penetrations are properly sealed, moisture will seep into the insulation and eventually condense on the underside of metal surfaces, saturating the insulation and ruining its thermal performance.

The acceptable sealing materials include sealants and adhesive tapes formulated for use with specific vapor retarders. Ordinary duct tape is not suitable for long-term vapor sealing.[13]

Interestingly, the type of building insulation does not significantly affect the amount of air infiltration, according to several studies. The degree of experience and diligence of individual workers in sealing the seams and penetrations probably has a larger impact on the amount of air leakage than does the type of insulation used.

Some of the latest insulation facing products offer adhesive or release-paper seams which could provide a better seal than the traditional fold-and-staple method as shown in Fig. 8.3. Thus a mediocre vapor retarder with good seams may perform better than a top-of-the-line product with leaky edges. We should note that mislocated staples significantly reduce the effectiveness of vapor retarders. According to Lotz,[13] a single errant staple can increase the perm rate of a foil-kraft laminate from 0.02 to 0.34!

Permeability of interior vapor retarders is usually larger than that of metal roofing and siding. When humidity inside the building is high, moisture will eventually seep through the vapor retarder and condense on the metal. (For this reason, items like insulation retainers should be made of nonferrous materials or have a plastic coating to prevent rust stains.) At this stage, ventilation of insulated space between the metal and the vapor retarder becomes the only solution that can prevent moisture accumulation and hidden corrosion. Therefore, providing the cold side of the assembly—the exterior in this case—with some mechanism for moisture release, such as soffit and ridge vents (Fig. 8.4), is beneficial. Unfortunately, the ventilated metal-building roof assembly is still a rare one.

Ventilation does not guarantee absence of condensation and the resulting damage to finishes, only a reduction in its severity. In cases where indoor humidity is expected to be extremely high, especially in cold climates, it may be wise to use a nonmetal roof system better able to dissipate moisture. In the words of Tobiasson and Buska:[14] "As an example, a vinyl vapor retarder/fibrous glass batt insulation/standing seam metal roofing system, ventilated or not, is probably not appropriate for a building housing an indoor pool in Minnesota."

Moreover, ventilation is sometimes a double-edged sword, inviting moisture into the roof during summer months. (Remember that to keep a house basement dry it is best *not* to ventilate it in the summer and to use a dehumidifier. Regrettably, dehumidification of an insulated roof cavity does not yet seem practical.)

The whole issue of specifying vapor retarders in warm climates is a complicated one. According to O'Brien and Condren,[15] most traditional analysis methods may not give proper answers when used in southern climates, but the authors provide some guidelines.

A special problem occurs with composite metal panels that are factory sealed for the stated purpose of preventing water intrusion. Alas, no seal is ever perfect. It is much easier for the moisture to get inside this vapor trap than to evaporate, as the owners of many permanently clouded insulated-glass doors and windows can testify. The trouble is, while the glass does not corrode and the seal failure is clearly visible in a window, it is exactly the opposite for metal panels. The difficult task of simultaneously providing ventilation openings in the panel and preventing rain intrusion should go beyond simply making weep holes to drain the condensate.

Some practical tips on avoiding condensation in metal buildings are given in the "MBMA Condensation Fact Sheet."[16]

8.5.2 Minimizing Heat Loss through Fiberglass Insulation

A well-known phenomenon of thermal bridging occurs when a piece of highly conductive material such as metal connects exterior and interior spaces, "short circuiting" the insulation. In cool weather it leads to cold spots, energy losses, and condensation problems. A great example of thermal bridging occurs when metal roofing or siding is fastened through fiberglass insulation into secondary framing.