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Moisture in the Roofs of Cold Storage Buildings

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ABSTRACT

The low-slope roofs of ten cold storage buildings in the Dallas area were examined visually and thermographically (Tobiasson and Korhonen 1985) from above and below. Two inch (51 mm) diameter cores were taken to verify infrared findings and to determine moisture contents for estimating wet thermal resistances (Tobiasson et al. 1991). Twelve inch (0.3 m) square specimens of many of the insulations were removed for laboratory studies of their thermal properties and structure. Insulations encountered included fibrous glass, fiberboard, perlite, woodfiber, expanded and extruded polystyrene, isocyanurate, and phenolic.

Six of the ten roofs had suffered problems and had new single-ply membranes. Of the six, all but one had insulation added above their old bituminous membranes.

Visually, all ten roofs appeared to be in good condition. However, areas of wet insulation were found in eight of them.

Some moisture was associated with infiltration of warm, moist outdoor air at roof-wall intersections without effective air seals. Figure 1 shows photographic and thermographic images taken within a freezer of a corner suffering such problems. Frost has formed there as warm moist outdoor air infiltrated into the freezer. The bright portion of the thermogram is the area warmed by infiltrating air. The adverse effects of air infiltration on the thermal performance of freezer roofs deserves further study.

Of all the insulations examined, permeable fibrous glass was the most susceptible to wetting by air infiltration. While fibrous glass insulation may be able to be dried out (by warming up the freezers), the rapidity at which cancers of wet insulation can grow in it make it somewhat ill-suited for use in freezers and coolers where vapor drive and air movement are both usually inward.

Some wetness was due to leaks caused by flaws in the roofing membranes and their flashings. Figure 2 shows photographic and thermographic images of a ballasted roof that contained wet phenolic insulation due to an inch (25 mm) long cut in the EPDM rubber roofing membrane there. The phenolic insulation had lost almost all of its insulating ability and thus the surface of the roof appeared colder (darker) in the thermogram than does the roof of the surrounding area where the phenolic insulation was dry and effective.

Nighttime on-the-roof infrared moisture surveys were more valuable than daytime indoor infrared surveys, but the indoor surveys and indoor visual inspections helped define the nature and extent of the moisture problems in these roofs.

Since the undersides of these roofs do not contain deliberate vapor retarders, it may be possible to recover some of the insulating ability lost to wetting of fibrous glass insulation by warming each freezer for a few days to allow the ice to melt and the meltwater to drain out of the roof at seams in the decks. However, the other insulations cannot be dried this way since they take much longer to dry. Thus, a cost-effective, easy, reliable way of drying most of the wet insulation in these roofs is not available.

Flaws in the new single-ply membranes caused wetting of new expanded polystyrene insulation placed between the old bituminous membrane and the new single-ply membrane. Unfortunately there is no way to dry such "trapped" insulation.

One roof with a steel deck contained several areas of wet phenolic insulation. Had that deck not been cold, the wet phenolic probably would have rusted it through. Being cold, the rate of rusting has been quite slow, but a safety hazard is developing there.

As long as a roof membrane and its flashings keep water and moist air away from the insulation in roofs of cold storage buildings, almost any insulation will stay dry and perform well. However, sustained one-way vapor drive, the sealing-in of moisture at the base of insulation in roofs of freezers by freezing, and the limited opportunities for drying wet insulation in such roofs, provide

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incentives to use insulation that is very resistant to wetting. Its very low rate of moisture gain by vapor diffusion and its resistance to wetting in the presence of freeze-thaw cycles (Tobiasson et al. 1997) makes extruded polystyrene insulation particularly appealing for use in the roofs of freezers and coolers.

The Cold Regions Research and Engineering Laboratory (CRREL) Special Report 98-13 "Moisture in the Roofs of Cold Storage Buildings" documents the details of this study. Copies are available from CRREL, 72 Lyme Road, Hanover, NH 03755-1290.

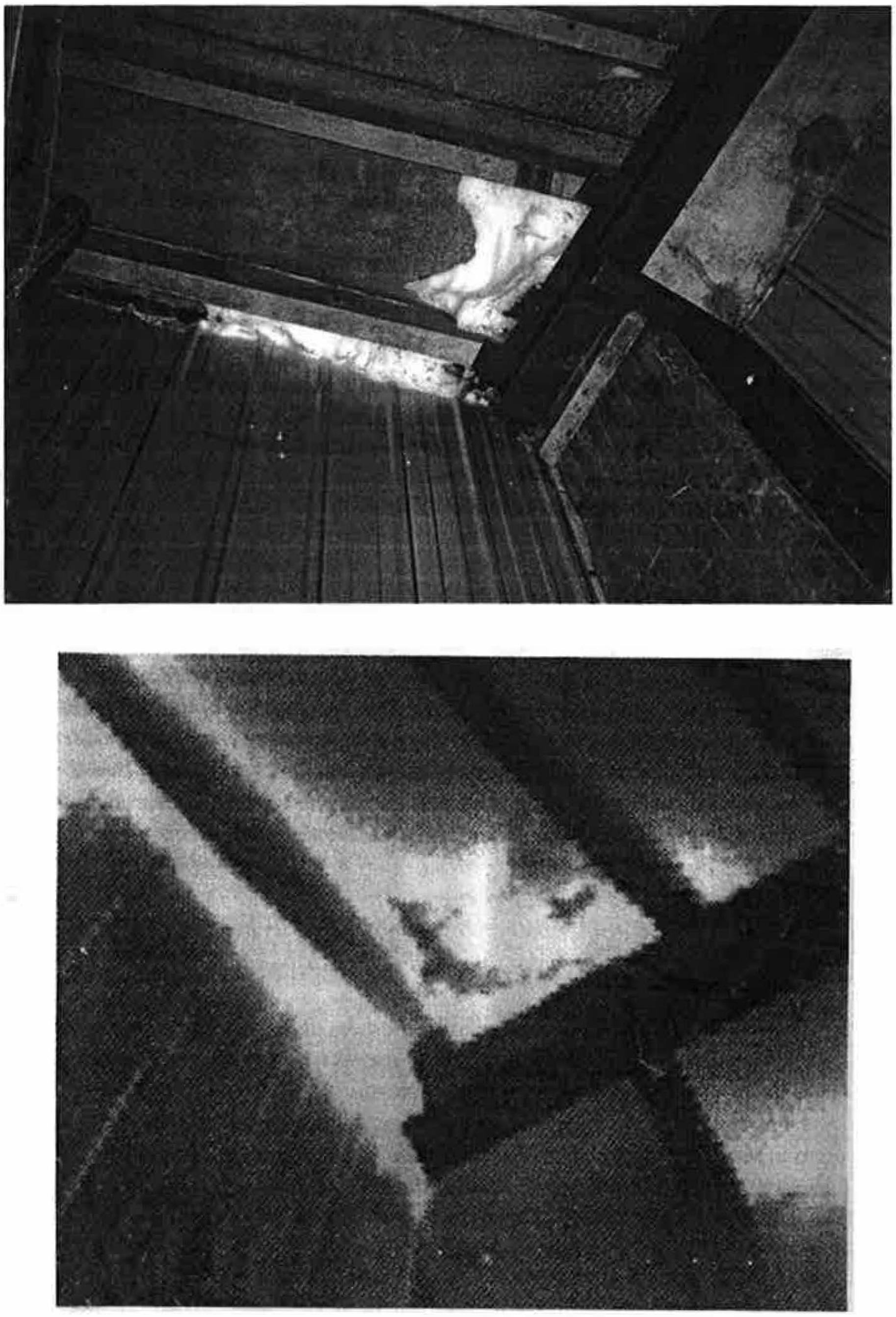
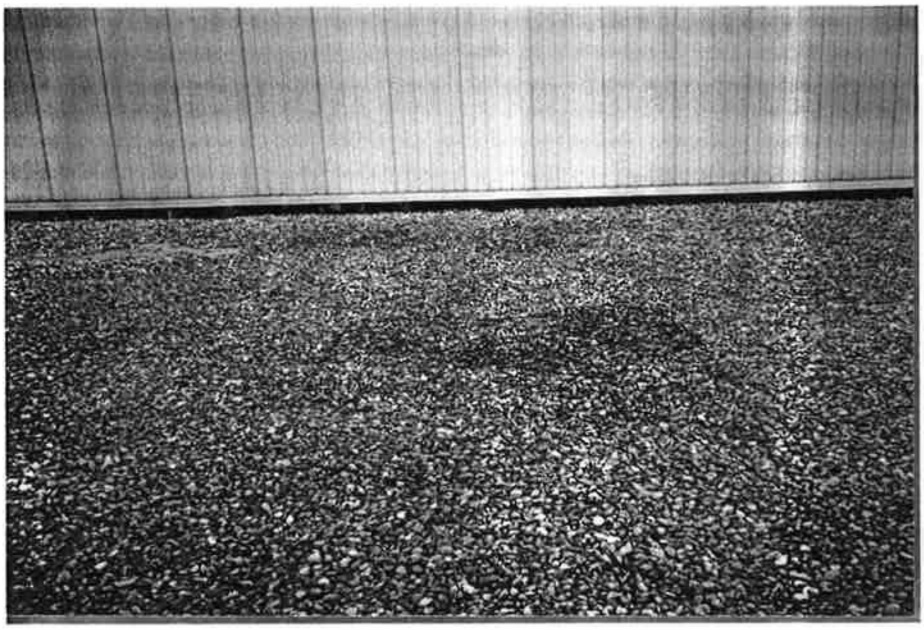


Figure 1 *Photograph and thermogram taken within a freezer looking up at its roof in a corner. Frost and ice are present there due to infiltration of warm, moist outdoor air where the two walls and roof join. Airtight seals are needed at such roof-wall intersections.*



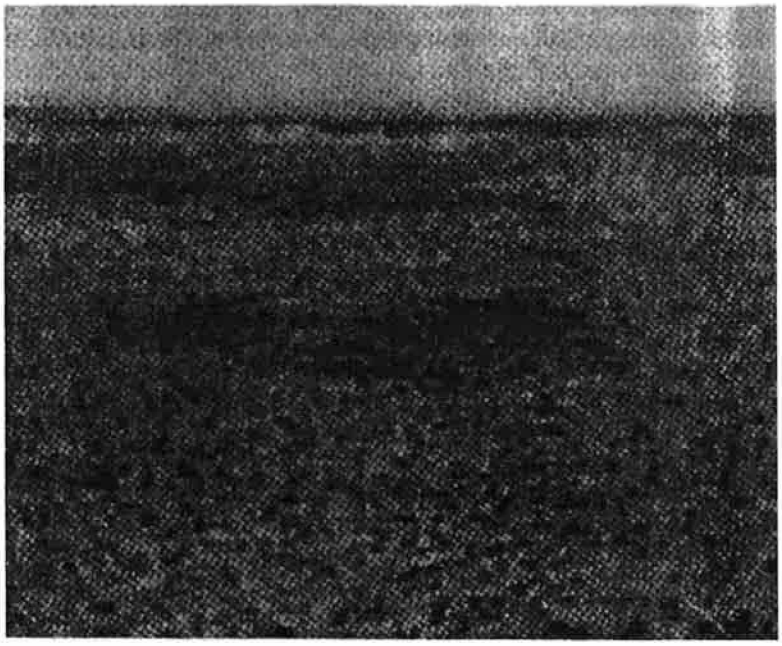


Figure 2 *Photograph and thermogram of a thermal anomaly on a freezer roof with a ballasted EPDM membrane. A small cut was present in the membrane here. A core sample taken in the middle of this anomaly found wet phenolic insulation.*

REFERENCES

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