

RE-COVERS: REROOFING BY SUPERIMPOSING NEW ROOF SYSTEMS OVER EXISTING—A DISSENTING OPINION

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The purpose of this paper is to introduce a summary of the author's experience investigating and studying roof system failures. A disproportionate number of the failures, especially in the past five to 10 years, occurred in reroofing projects that employed re-covering vs. tear-off and replacement. The author's broad examination of this phenomenon disclosed a series of conditions and factors that are detrimental to good roofing practice. A review of the findings leads to the position that the practice of re-covering existing roofs is harmful to most participants in the reroofing process—namely the owners, the roofing contractors, and the design professionals, and the author strongly discourages it.

KEYWORDS

Cellular foam, dead load, fatigue cracking, "ghost leaks," latex, live load, overlay, pH level, phenol, "picture framing," re-cover, relative humidity, superimpose.

INTRODUCTION

At the present time, there is insufficient independent research on the subject of re-covering to base a position purely on research and material facts. Much of the author's work in this area is derived from anecdotal evidence, in-house research, roof failure investigations, extensive experience in evaluating roofs, and the application of general technical principles of roofing knowledge. The author has performed failure investigations and condition surveys for major industrial companies and municipalities nationwide for more than 20 years, covering in excess of 1 million m² (10,800,000 ft²) of roofing.

Common and collective experience in the roofing industry in the United States is characterized by various inputs from the material producers, users, and general interest groups. This patchwork of productive innovation, occasionally colored by opportunism, both increased the sophistication of the industry and also delivered a series of costly failures. What it also produced is a set of axioms and practices in the form of recommendations, warnings, and guidelines. Although this process generally advanced the roofing industry, the lapses have been damaging. For example, delays in warning the consumer about the real value of warranties; endorsement (i.e., marketing by manufacturers and use by specifiers) of insufficiently tested and developed insulation materials; lack of assessment of the new polymeric membrane systems; or promulgation of a recent trend—drying out roofs, are just a few examples of the industry failures.

Perhaps one of the most damaging of these lapses in steering the industry to success is the approval by manufacturers and specifiers of the practice of installing new roof systems over existing, ostensibly failed, roofs. This concept violates virtually all established principles of roofing practices, applicable technical principles, and experience.

By some accounts, a wide-spread use of overlays in commercial roofing dates back to the early 1970s. The economic pressures and perception that overlays are an opportunity to increase thermal performance of commercial roofs without any significant drawbacks appeared viable. At its present level, with significant regional variances, this practice is applied in almost 40 percent of reroofing applications in the United States, and approximately 10 percent in Canada, as indicated to the author through interviews with U.S. and Canadian contractors. The occurrence of overlays predating this time was relegated to residential roofing and two- and three-ply built-up roofing membranes applied to smooth-surface roofs. The rationale for choosing this practice as a viable method of reroofing spanned across a wide range of technical and marketing practices. Built-up roofing manufacturers found themselves in intense competition with single-ply manufacturers. The market was driven by warranties, first-cost savings, and increased energy efficiencies of the roof assemblies. Many of the new energy-efficient insulations could not be used with conventional built-up systems, thus the conventional membrane manufacturers had to include the existing roofs in the entire assembly. Conversely, single-ply manufacturers needed to penetrate the marketplace, and so in conjunction with marketing warranties, they strongly supported the concept of overlays as a cost-saving method of reroofing.

Overlays also appear to be a viable system to many roofing contractors who, not surprisingly, found removal of the old roofs, particularly with cold tar membranes, noisy, dirty, dusty, unpleasant, and potentially unhealthy. Removing the existing aggregate and re-covering after performing minor repairs of the old membrane seemed to be much more acceptable. A series of other arguments, such as keeping the facility protected during reroofing, adding slope to the new roofs, and encapsulation of asbestos roofing membranes, seemed like technically plausible and economically viable alternatives.¹ Growth of the moisture detection industry, supported by reputable research, furthered the cause of overlays. The lack of objection or sound direction from the industry facilitated the use of overlays in almost all roof system types, climates, and building configurations. Today, the overlay market commands a staggering \$5 billion per year.^{2,3}

The range of re-cover applications includes mechanically fastened built-up roof systems, sprayed-in-place polyurethane foam systems, scrim-reinforced coatings applied over insulation panels adhered to the existing roof surfaces with adhesives, and single-ply roofs installed over various existing roof types. This also includes, of course, the old practice of installing shingles over existing roofs on residential dwellings. Metal roofs, applied over structural spans and various structural deck assemblies, are constructed over the existing facilities, leaving old roof systems in place. Some of the more extreme practices include applying metal shingles over aged organic or glass shingle roofs. In commercial roofing, these practices include reusing ostensibly salvageable insulation from the original roofs in single-ply overlays and even stripping off built-up roof membranes and applying new roof overlays to existing, now damaged, insulation.

In various investigations, the author has found instances as extreme as facilities of some of the best-managed Fortune 500 companies having roof areas where 13 overlays were applied to the original roof. Finding two or three roofs, all of them prematurely failed, often with the service life being reduced for each successive overlay, has been a common occurrence (even though codes do not permit this) on commercial facilities spanning across the United States. In one recent major study, the majority of the overlaid roofs failed in less than 15 years, many failing after eight to 12 years, while most of the original roofs lasted in excess of 20 years.

PROBLEMATIC ASPECTS OF OVERLAYING ROOFS

Overlaying existing roofs typically increases the original design loads, often doubling them.⁴ Although it is always recommended that the aggregate of an existing built-up roof is to be removed and the surface cleaned, removal crews are typically high-production teams with insufficient attention to detail. In some instances, the adhesion of the gravel or slag of built-up roofs makes it virtually impossible to remove sufficient quantities of the old ballast. It also significantly increases originally anticipated live loads. Differential accumulation of water, snow, and ice expose the facility to load irregularities, which can put lighter structures at risk of deck collapse or lead to ice damage to overlay membranes.⁵ The differential accumulations of live loads frequently occur in low-slope roofs where the original drainage patterns were nominal. The overlay does not have the opportunity to provide the original slope to a sufficient extent, because the failing original roofs do not provide the smooth and consistent contour of the structural deck. Additionally, the practice of overlaying roofs often produces irregularities in the surface contour of the new roof because of blisters, folds in the membrane, or moisture-induced deformations of the insulation boards (Photos 1, 2, 3, 4, 5 and 6). Frequently, parallel wrinkling and buckling will occur when certain sections of the existing deck do not provide sufficient support for the mechanical fastening patterns of the overlay. These drainage impediments may also expose the roof membrane to differential aging caused by increased ponding and ice accumulation.

The perception that overlays allow the opportunity to introduce positive drainage by the use of sloped insulations is often compromised by the configuration of roof areas, location of roof drains, flashing heights of rooftop units in the field of roofing, and insufficient heights of parapet walls. In



Photo 1.



Photo 2.



Photo 3.

some instances, it was observed that where the sloped insulation could be applied under an overlay membrane, even in nominal rates of slope, the thickness of insulation in the perimeter walls, and the thickness of the original membrane, required the use of fasteners in excess of 200 mm (8 inches). Installation of screws of such length can be highly problem-

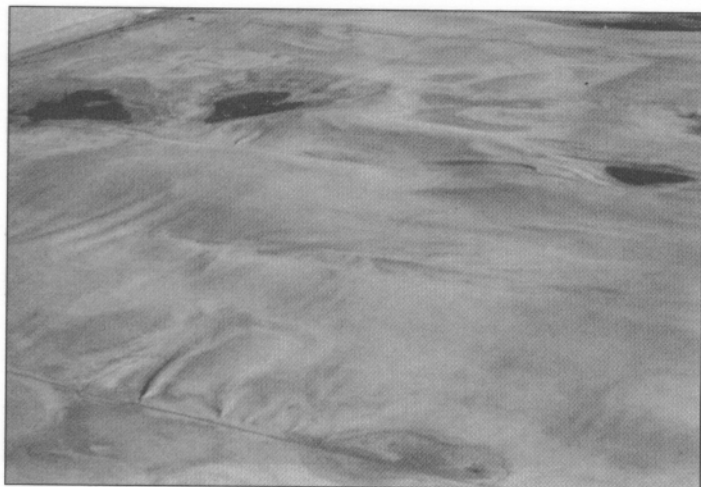


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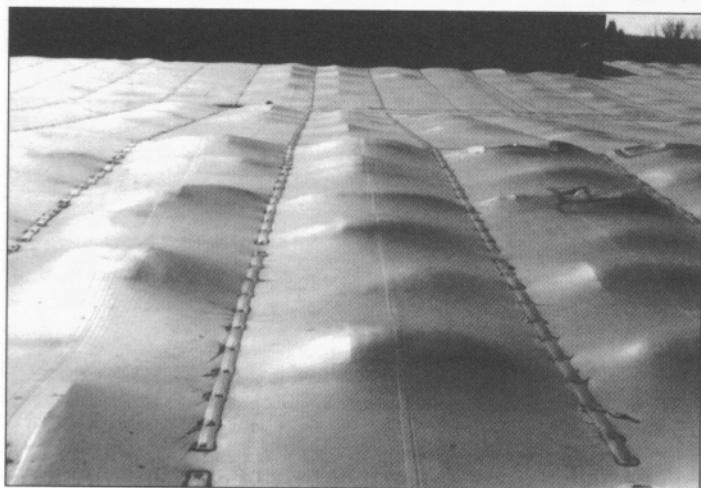


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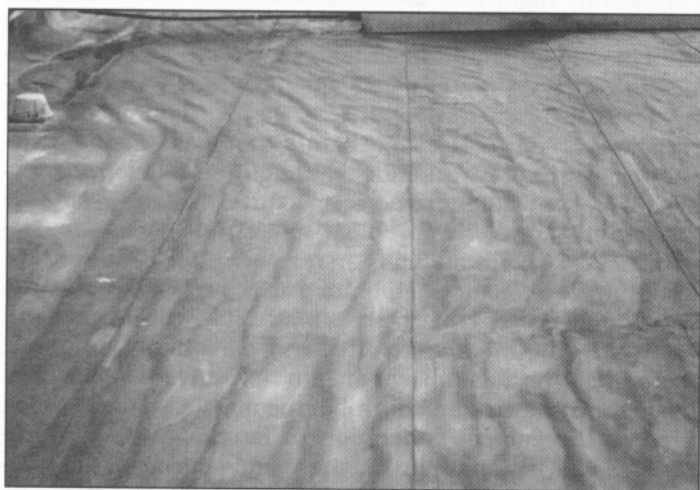


Photo 6.

atic because of the instability of the angle of attack between the screw and the deck and may compromise the attachment of the overlay systems at the roof perimeters.

Premature aging of the overlay membranes has been noted to various degrees across the climatic regions in the United States. Tensioned flashings and deformations of vents and pipes in the field of roofing (especially perimeters and

corners) are common for overlays less than 10 years old. In older installations, where the overlays were not mechanically fastened, these conditions were typical. More intense heat exposures, with less of an opportunity for the heat to dissipate through the entire roof system composite, have been affecting built-up roof overlays and the overlays using APP-modified roof membranes (Photo 7). Climate zones with the most frequent thermal change adversely affect engineered polymers and produce differential and accelerated weathering of these membranes (Photo 8). (Note: A number of major roof system manufacturers do not offer their standard long-term warranties for overlays that are comparable or sometimes identical to the original roof system.)

The industry acknowledges that a disproportionate number of problems occur in wall and penetration flashings. Overlays sacrifice the most important element of flashing performance, which is flashing height. This situation constitutes an increased difficulty for the installation of the new flashings in most instances and presents almost technically impossible solutions in some. Reusing existing, properly installed counterflashings often poses an unrealistic technical challenge, as do some deficient conditions in the flashing construction of the original roof. This leads to improvisations that have a low probability of success (Photos 9, 10, and 11). Requirements to raise perimeter edges and install multiple edge fascias result in peculiar architectural definition of the building contour (Photo 12). In further aggravating the flashing situation when using overlays, it should be remembered that, almost as a rule, an exorbitant number of nonfunctioning moisture-relief vents are added. These installations have no discernible function, and they greatly increase the potential for leaks in the field of roofing.⁶

Serviceability, repair, and meaningful maintenance of overlays is basically ineffective. Leaks under overlays occur in locations where the old leaks existed or where termination provisions, such as flashings or expansion joints, were removed to facilitate the installation of the overlay. Finding and eliminating leaks in roofs where overlays were installed is typically an extremely frustrating experience for both the owner and the roofing contractor. It frequently becomes a situation where the owner seeks remedies available under the law or under contract provisions, damaging the relationship with his roofing contractor.

Moisture in an old roof membrane, surfacing, and insulation is, however, by far the most insidious and risk-loaded fac-

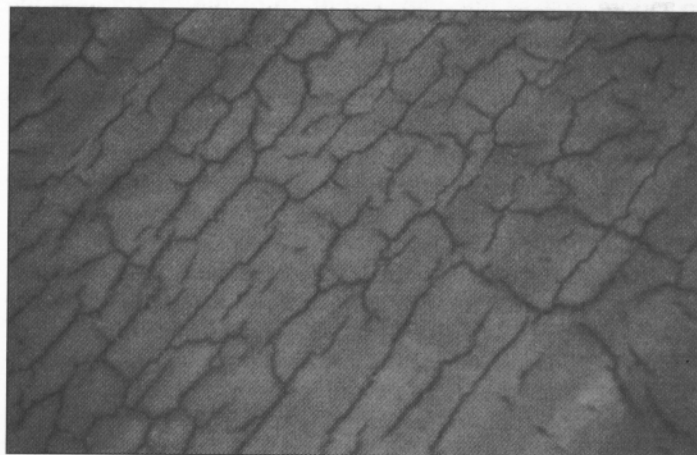


Photo 7.



Photo 8.



Photo 10.

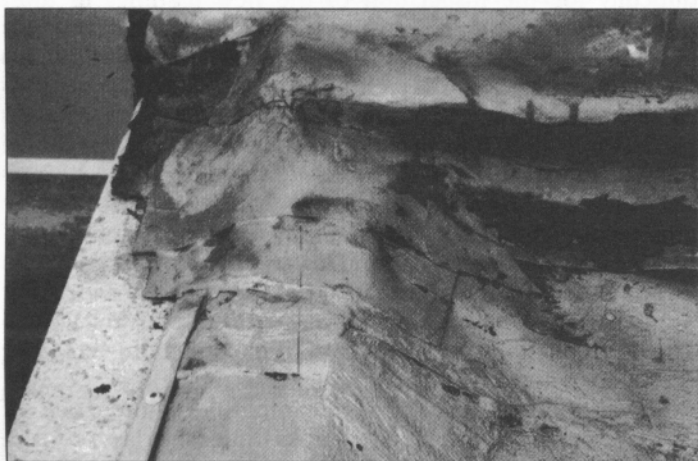


Photo 9.



Photo 11.

tor in installing overlays.

The effect of moisture is most harmless in the practice of installing metal roof structures over existing roofs. Hopefully, the residual moisture can be controlled by various appropriate attic designs and by maintaining an acceptable level of relative humidity in the space between the old and the new roof.⁷ The economics of this practice, however, are a puzzle. Metal roofing trade journals are replete with references to these kinds of projects where the costs of these "20-year" overlays are approaching \$15.00/0.1 m² (square foot).⁸

The most damaging effect of moisture, which is invariably present in overlay composites and which activates various damaging conditions by simple and recognized mechanics of condensation and evaporation, can be seen in relation to dimensional stability of insulation, fastener corrosion, metal deck corrosion, or deck dry rot.

Most insulations are either destabilized by moisture or they are chemically activated. Moisture infusion across the cell walls of cellular foams (Photo 13) causes deformation of the boards and, regardless of the level of mechanical attachment, renders the insulation layer in overlays unsuitable as a substrate (Photos 14, 15, 16 and 17). Vertical deformations of insulation boards render the overlay roof completely unserviceable. The more commonly encountered horizontal deformation (picture framing) exposes the overlay membrane to a grid of incremental cyclical fatigue, eventually fatigue-cracking the overlay membrane (Photo 18).

The failure rate of overlays where the insulation was attached to the original membrane surface by mopping was consistently high, and the assumption that mechanical fastening would solve this problem was wrong. Corrosion of insulation and membrane fasteners was almost a rule in temperate zones, especially over slag- and gravel-surfaced built-up roofs. The reason for this is simple. This method of installing overlays places mechanical fasteners into a chemically aggressive environment. Although fluorochlorocarbon (FCC-) coated fasteners perform better than untreated or galvanized screws, the problem just varies in degree. The presence of chemical activators of corrosion in the insulation, membrane, and membrane surfacing is almost universal. Phenol-based resins, latex binders in the insulations, binders in the membrane felts, and particularly the acidic membrane surfaces present an almost insurmountable challenge for the corrosion control of the metal fasteners,⁹ which predate the current generation of fasteners with multiple coatings. Corrosion of the fastener plates and shanks in overlays is a common occurrence (Photos 19, 20, and 21). The author's laboratory studies, during the late 1980s, indicated that pH readings (of insulations diluted in distilled water) approaching 3.5 were not uncommon in a variety of the existing roof types. Particularly aggressive is the chemistry of slag-surfaced built-up roofs, where the ponding areas on deteriorated slag-surfaced built-up roofs approach a pH of 3. The constant presence of moisture, however minimal (which only increases the pH), between the original roof and the overlay

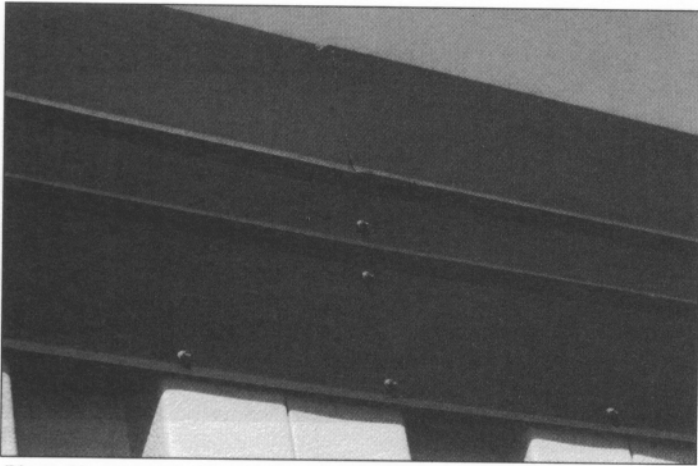


Photo 12.

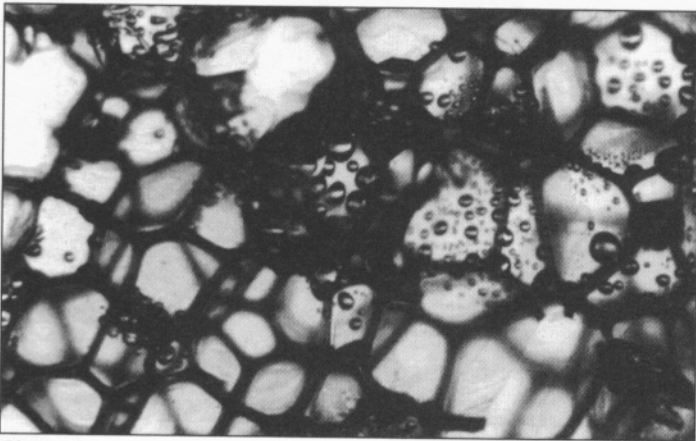


Photo 13.

creates an extremely chemically aggressive medium. Fungus and mold growth on the underside of insulation panels of the overlays in the presence of slag is common (Photo 22). (The fact that the surfaces of slag-surfaced roofs are acidic is confirmed by occasional biogrowth in absence of extensive ponding; plants prefer acidic environments [Photo 23]).

Chronic ghost leaks common with overlays when the top membrane allows moisture intrusion tend to accelerate the deterioration of the metal decks by allowing the intruding water to become hydrogen-rich¹⁰ as it migrates across the surface of the original roof membrane to the old leak locations. This frequently occurs in corners and along the perimeter walls, where the anchoring of mechanical fasteners is critical and where it becomes most likely to be compromised by corrosion-weakened decks with reduced fastener-holding capacity (Photos 24 and 25).

CONCLUSION

Considering that the use of overlays increased almost 100 percent between 1983 and 1988,¹¹ that by 1992 it exceeded reroofing with tear-off in all roof system categories except for built-up roofs,¹² and that reroofing without tear-off reached more than 40 percent for all roofing work in the commercial market (more than 70 percent of the total roofing market in 1996),¹² overlays represent an enormous expenditure in the total U.S. roofing market. This expenditure is directed through a plethora of risks to almost all participants.

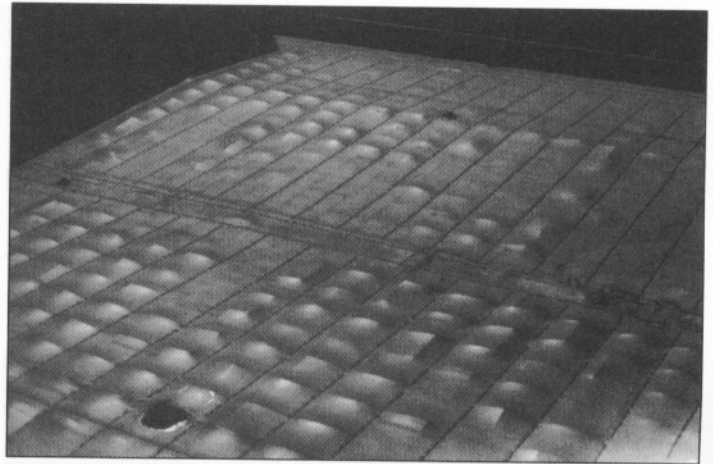


Photo 14.



Photo 15.

In addition to reducing the service life of roofs in the United States through the use of single-ply systems and through over-insulating roofs, the industry is supporting this trend of service life reduction by acquiescing to the use of overlays.

This process is, to a large extent, a lose-lose situation for all of the participants, except, perhaps, for the roofing materials manufacturers who legitimize it by cloaking it with a veneer of assurance by providing basically useless warranties. There are no benefits for the other parties. The owner thinks he's actually getting a new roof. The roofing contractor is cut out of the opportunity to do things right and to earn money on honest labor involved in the removal of the failed roof. The design professional is sailing in uncharted waters and experimenting with his client's money.

It must be mentioned that there have been many rational attempts to improve and refine the use of overlays and that there are many valuable guideline documents,^{13, 14, 15} but in the final analysis, the recommendations and guidelines are, in sum total, so restrictive and complex that the whole process of evaluating the opportunity for installing overlays negates any realistic potential for a successful project.

The flawed attempts at legitimizing this practice^{2, 16} only add to the illusion that there is a good fundamental reason for pursuing the practice of overlaying roofs. It is as if the industry gave birth to a really preposterous idea, and now we're supposed to keep it on a life-support system no matter what. Acquiescing and supporting the practice of overlaying

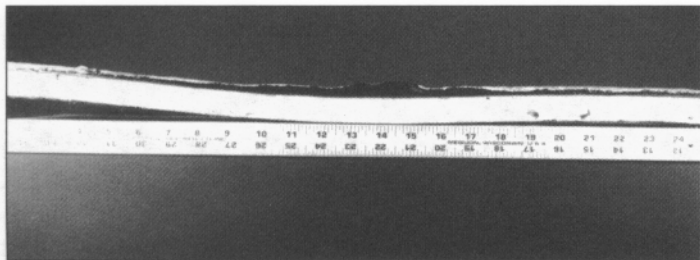


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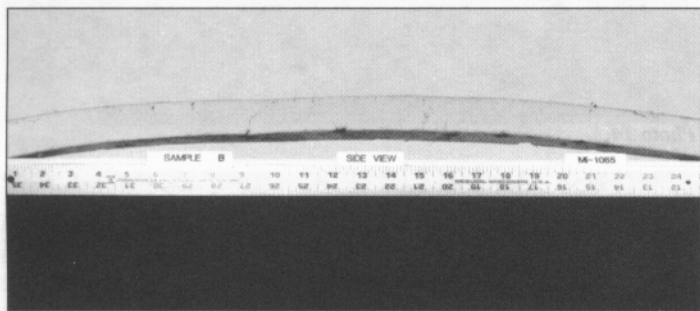


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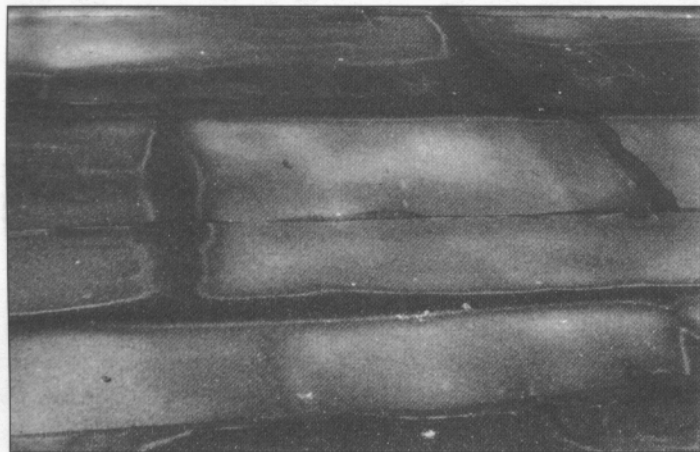


Photo 18.

existing roofs will only damage the reputation of the roofing industry and its leaders.

RECOMMENDATION

It is the author's opinion that the industry would greatly benefit from support for extending studies, such as Project Pinpoint, specifically focused on potential or existing problems and studies that would meaningfully quantify the wealth of experience in the industry, rather than exotic engineering assessments of narrow issues. In the meantime, the author strongly recommends that the practice of superimposing new roofs over existing roofs be discouraged.

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Photo 19.

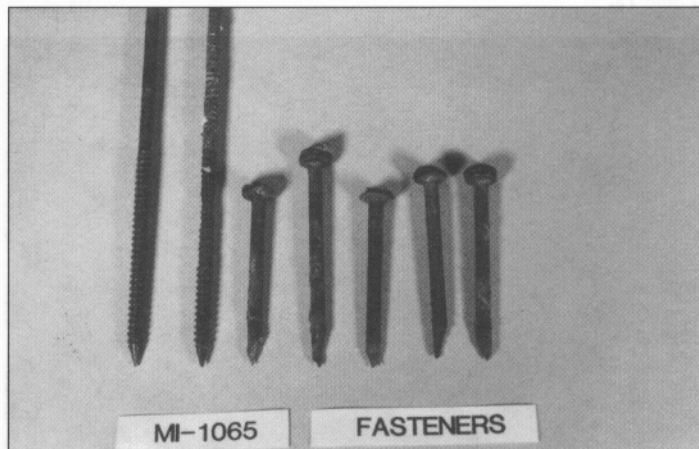


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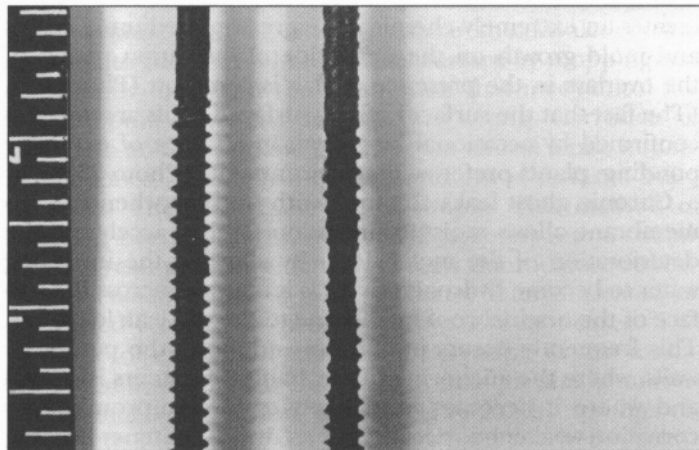


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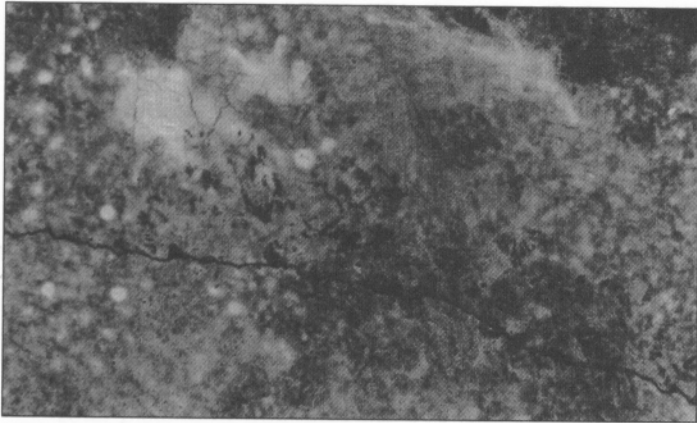


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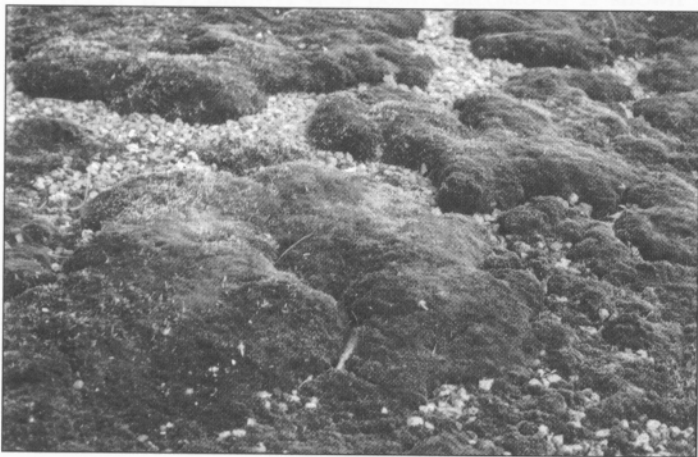


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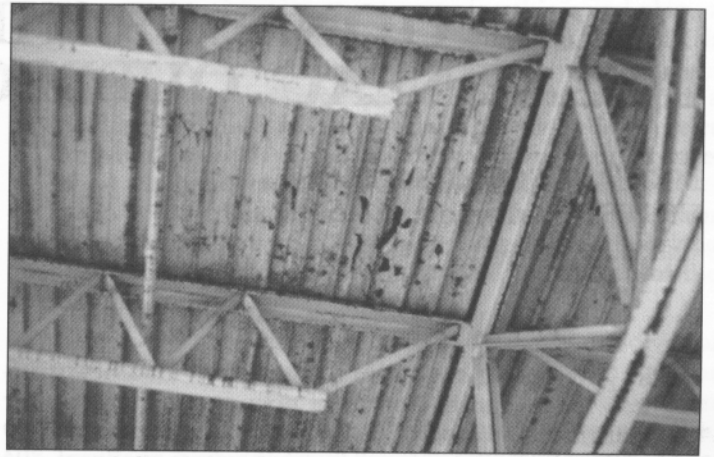


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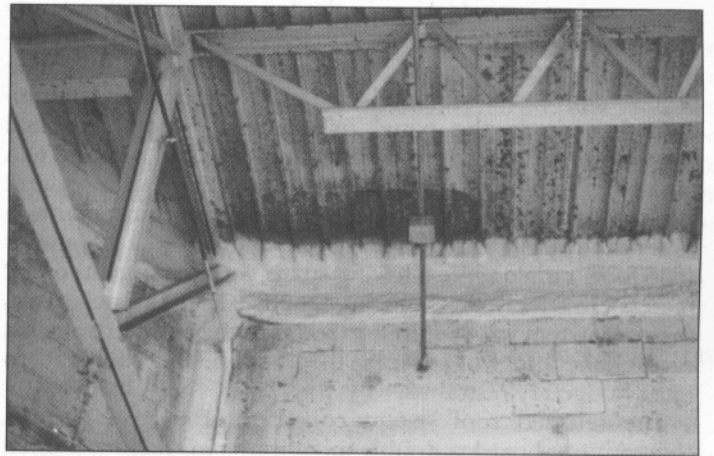


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