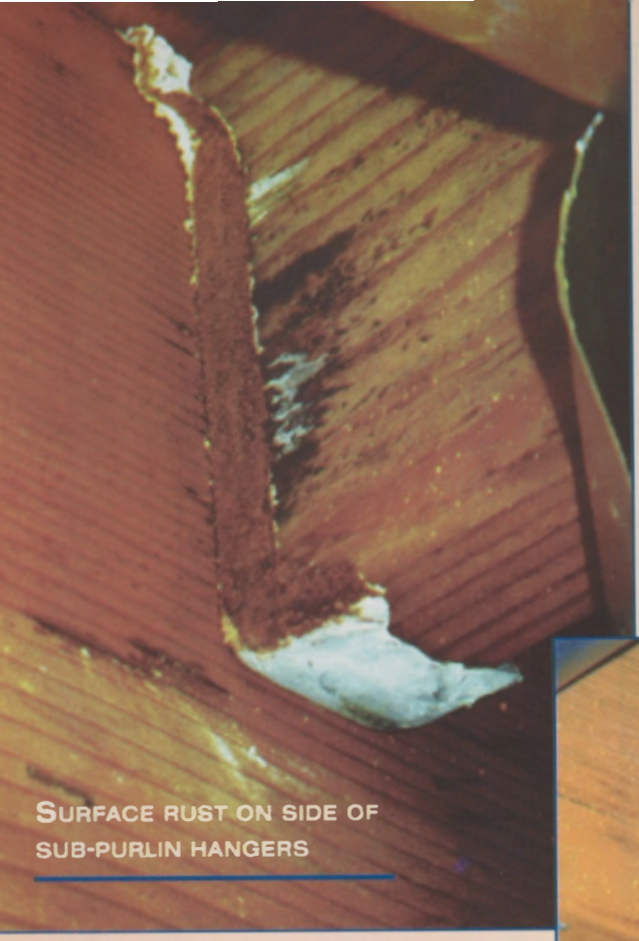
CORROSION OF METAL COMPONENTS in Wood Construction—

By Steven A. Mandzik, RRC, CDT



Surface rust on side of sub-purlin hangers

Clean sub-purlin hanger with white powder beginning to form

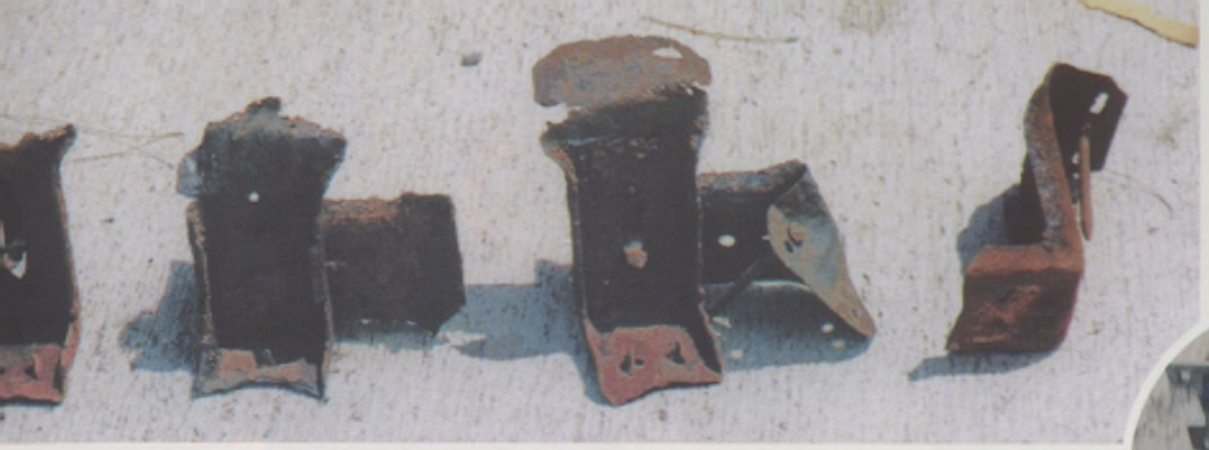
White powder covering entire sub-purlin hanger

Surface rust on side of sub-purlin hangers.

Ceiling foil has been widely used in California commercial buildings. All owners, managers, roofers, maintenance persons, and consultants should be aware of problems resulting from its use. It is a paper product faced on both sides with foil and stapled under each sub purlin, creating a 2'x8'x3-1/2" cavity between the plywood decking and the foil. Reasons for its use vary from being a radiant barrier (reflecting heat away from the building) to being used for light reflectivity (reflecting light into the building) so that the building has a much brighter appearance when showing it to prospective buyers. Ceiling foil should not be confused with batt insulation, also faced on one or both sides with foil.

Over the past several years, there has been an increasing occurrence relating to the rusting of sub purlin hanger supports within the ceilings of buildings, in part caused by the use of this foil. It is a problem that is likely occurring in numerous buildings, yet goes undetected until re-roofing or roof repairs begin.

This rusting has occurred in Southern California commercial buildings consisting of plywood decking with wood sub-purlin, purlin, and Glulam



TYPICAL RUSTING OF SUB-PURLIN HANGERS

NEW (FACE-NAILED) SUB-PURLIN HANGER

supports joined with metal hangers. The plywood decking and the structural wood were not a fire-resistant/pressure-treated type. The existing roof systems have been a base sheet (mechanically-fastened), one ply of felt, and a mineral surfaced cap sheet installed in hot asphalt with no roof insulation used.

It first came to our attention in 1993 during a re-roofing operation when the old roof was being removed. During the tear-off process, several 2"x4"x8' sub-purlins fell, only to be supported by the acoustical ceiling below. No new roofing had yet been installed, and no plywood decking had been removed to cause the problem. Upon inspection of the plywood deck, we found that the plywood decking nail heads were completely rusted off and their shanks greatly reduced in diameter. The plywood decking was then removed for a close inspection under the deck. We found that the top lip of the sub-purlins hangers—the portion that rests on top of the purlins—was completely missing. The remaining sides and bottoms of the hangers were in an advanced state of rusting. This rusting occurred in numerous areas throughout the entire plywood decking area in varying degrees of rust. The re-roofing work was immediately stopped, and a structural engineer was employed to review the situation.

Due to the severe rusting, it was determined that the sub-purlin hangers no longer had the ability to carry a vertical load. The structural engineer provided recommendations and drawings requiring 2"x4" wood ledgers to be nailed underneath all sub-purlins. As the building was almost entirely warehouse space, the work was performed from within the building by a general contractor and averaged $0.72 per square foot above the cost of the roof. Typically, plywood decking replacement has averaged 1% during re-roofing; however, due to the structural inspections conducted from on top of the roof, approximately 15% of the plywood decking was removed and replaced. Major portions of the decking were renailed where nails were no longer present. This additional work was performed by the roofing contractor and added another $0.12 per square foot to the contract.

Since 1993, we have experienced three more sub-purlin hanger failures, all beginning with a re-roof operation and ending with similar structural remodeling as described above. The latest project (1995) had all acoustical ceilings and required 100% of the plywood decking to be removed from on top of the roof as none of the work could be done from within the building. Under each sub purlin, 2"x4" wood ledgers were installed while standing on the decking supports and adjacent plywood panels. The structural repair costs were $2.68 per square foot above the re-roof cost.

In each of the four cases noted above, we spent considerable time researching the cause of the rusting. We found tenants in each building were not conducting any high-level humidity operations. In terms of age, three of the buildings were 16 years old, while the fourth was 11 years old at the time of discovery. The 11-year-old building demonstrated the worst case of rusting. The interior humidity was recorded in this last building at floor level in two different areas and measured 28% and 44% while the exterior humidity was 44%. Although the floor level humidity did not appear extreme, there must have been a considerable amount of humidity trapped above the ceiling foil to cause the severe rusting. During the normal cycles of daily weather changes from hot to cold, the dew point was achieved in the roof cavities, and this humidity condensed on the surfaces of the metal hangers. Since there were no gaps left at the edges of the stapled foil, no venting of moisture vapor was possible.

Over the past two years, I have inspected 24 buildings on behalf of one owner who has taken a proactive approach to assessing roof conditions as they relate to the use of ceiling foil. To date we have not found the severe, flaking rust conditions on the sub-purlin hangers as experienced elsewhere. However, we have found surface rusting of the hangers in almost every building, as well as the presence of a white powder covering the sides and bottoms of the hangers. Direct evidence of moisture was found on top of the ceiling foil in at least one building.

Although severe rusting was not found, the owner has been advised that it is possible these buildings may experience sub-purlin hanger failure unless some action is taken.

The use of ceiling foil has had an effect on a portion of the 25 million square feet I help to manage. There has been a great amount of inconvenience and danger associated with the situation. Tenants have narrowly avoided being hit with falling sub-purlins. In one case, a tenant evacuated the building for fear of accidents. Roofers have almost fallen through the poorly-supported decking while making repairs or during the re-roofing process. Because of potential problems associated with its use, building costs are bound to rise with the increased chance of accidents. All buildings with this type of construction should be inspected for possible rusted hanger problems.

TYPICAL CEILING FOIL PAPER STAPLED BENEATH SUB-PURLINS

It has been a very complicated procedure to inspect this condition and just as difficult to find conclusive recommendations from professionals. The ceiling foil may only be a radiant barrier and completely removing it is probably the first step in reducing or preventing the condensation. However, city building departments, fire marshals, and architects are unwilling to comment on, or put in writing, the use of the foil and if it can be taken down.

RUSTED HEAD AND SHANK OF PLYWOOD DECKING NAIL.

Energy Efficiency Standards published by the California Energy Commission containing the California Code of Regulations Title 24 indicate "aluminum foil" as a type of insulation in the form of "reflective foil." The regulation further states that "Repairs shall not increase the pre-existing energy consumption of the repaired component, system, or equipment." Consequently, tearing it down or even changing its design (cutting holes or slits in it for ventilation) appears to violate the energy regulations. I have found publications indicating that the use of ceiling foil as a radiant barrier has its advantages in reflecting heat away from the building. However, I have not found any information on the disadvantages of its use. It appears to have created a problem that could amount to very expensive structural repair costs for building owners in California, if not other states. The reluctance of licensed or registered building professionals, designers or builders—people who have recommended its use in the past—to recommend tearing it down may be based on current energy regulations and fear of retribution from building officials.

CONDENSATION STAINING ON PAPER CEILING FOIL DIRECTLY BENEATH SUB-PURLIN HANGER

Unfortunately, it is a problem that is not going away. Considering the possible loss of life, the expense of possible structural remodeling, and the future use of ceiling foil, further research is needed. Any input from those who may have insight into this matter is appreciated.

About the Author

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Steve Mandzik *has 26 years in the construction industry as a roofing contractor, roof consultant, and, in the last six years, as the in-house roof consultant for Property Consulting Services, a division of Insignia Commercial Group Inc., responsible for managing more than 25 million square feet of roofing. He is a Registered Roof Consultant with RCI and a Certified Document Technologist with CSI.*

Fastener Quality Act – Again Delayed

The Fastener Quality Act (FQA), passed by Congress in 1990, was postponed for the second time in the fall of 1998. The act, which would have required fastener manufacturers to certify their manufacturing processes and to have them tested at laboratories certified by the federal government, was stalled due to doubts about perceived problems.

The National Institute of Standards & Technology (NIST), charged to develop standards on fasteners, expressed doubts about the need for such. Fastener manufacturers and exporters have lobbied to delay the FQA due to burdensome requirements, noting no fatality can be directly attributed to fastener failure. At the same time, critics of the industry claim only luck has prevented disaster to date following a flood of cheap and poorly labeled fasteners into the U.S. since the late 1980s.

Builders should be cautious in their purchasing practices, other industry leaders suggest.