Building Cancer: A Property Manager's Nightmare

W. Charles Perry, M.S., P.E.

Imagine discovering that you are suddenly responsible for replacing the entire roof structure on one of your buildings as well as temporarily relocating its tenants even though you followed customary maintenance procedures and even though you managed it for only one year. Recent research indicates that currently the roof structures on at least 1,000 low-rise mixed-occupancy commercial buildings nationwide are at-risk of extensive damage & possibly collapse unbeknownst to their property managers. The cancer-like decay & corrosion that is destroying these roofs is caused by the use of green or wet wood during construction, reliance on sealants instead of flashing & counter-flashing of roof seams & penetrations, the hidden spread of small water leaks along the joints between roof panels, inadequate ventilation below insulated roofs, and inadequate seasonal roof inspections. In terms of repair costs and lost rent, this represents a two-million dollar expense per building. In terms of potential injuries, the cost is incalculable. The story of one property manager's experience is an alarm for all.

The Mystery Unfolds

In the early morning hours on a clear summer day in 1994, a 8 foot long 2-by-6 wood joist fell through the suspended ceiling of a nondescript office building in Southern California. Fortunately, the building was not occupied at that early hour. The property manager immediately hired an contractor to determine the cause of the failure and to fix the damage. When the property manager's contractor looked through the suspended ceiling and removed the insulation on the underside of the roof, he discovered that the metal hangers that supported the entire roof were severely rusted, major beam supports were decayed, the roof nails were completely rusted, and that the entire roof was at risk of collapse. What was worse, an identical building next door under the property manager's care was in the same condition.

What caused this to happen? The mystery began with the location of the buildings. Southern California receives an average of 11 inches of rain per year; the average monthly high temperature is approximately 80º F; the average monthly low temperature is approximately 55º F; and the average relative humidity ranges from 40% to 90% daily. Second, the buildings appeared to be identical in construction form to roughly one-hundred-thousand buildings throughout the western & southwestern United States that had been built during the previous 30 years - tilt-up concrete walls, glulam wood main beams, pre-fabricated plywood roof panels, insulation on the underside of the roof, and a built-up-roof membrane. Third, the buildings were used for air-conditioned office space with no water, vapor, heat, or cold producing equipment; each had a ducted supply & return HVAC system; and each had a ventilated attic space. Fourth, the buildings were only 9 years old (they were completed & occupied in 1985). Fifth, the buildings had been inspected 4 years prior to the collapse by a reputable company when they were sold in 1990 - no leaks were noted and the roof-membranes was in good condition. Sixth, the property manager annually hired a roofing maintenance company to seal any leaks that appeared when it rained. And seventh, the same property manager had been with the buildings since they were first occupied. These are not the sort of circumstances that would cause a property manager to suspect that their buildings' roofs were going to collapse.

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Indoor Rain

After the roof failure was discovered, the tenant & property manager hired a roofing consultant, a structural engineer, a materials testing lab, a wood specialist, an HVAC engineer, a construction manager, and a contractor (the tenant held a triple-net lease and employed a property manager). The experts' collective opinion regarding the cause of the roof failure was that the insulation on the underside of the roof was trapping high-humidity air that flowed into the attic during the heat of the afternoon, the vapor in this air would condense on the metal hangers during the night, the hangers would rust, and the wood would decay. In other words, these experts felt that the insulation on the underside of the roof was producing rain in the insulated cavity beneath the roof deck. Collectively, they recommended that the ends of the insulation be cut to allow the roof to dry & prevent future condensation, that new metal roof-support hangers be installed, that plywood roof panels be replaced individually as determined by an engineer, and that a new built-up-roof membrane be applied. The tenant & property-manager followed the advice of their consultants and spent roughly $900,000 to repair roughly 70,000 square feet of roof on each building.

The Shooting Begins

One year later, the buildings' owner decided to sell the buildings. To the owner's surprise, the new joist hangers were corroding. The owner hired her own set of consultants who claimed to be aware of roughly 100 similar buildings with similar problems. While the owner's consultants reached similar conclusions to the tenant's consultants, they also felt that the entire problem would have been avoided if insulation had not been placed on the underside of the buildings' roofs. To remedy the problem, they recommended that the owner completely replace the recently-repaired roof structure of both buildings, insulate the new roofs with rigid insulation on top of the roof structures, install additional attic vents, and apply a new built-up-roof membrane on top of the rigid insulation. The estimate repair cost was $1,300,000 per building. The estimated cost of the repair including consultant fees and lost rent was roughly $2,000,000 per building.

To fund the repair, the owner initiated litigation against the developer / original owner, the architect, the tenant & property manager, the original general contractor, the tenant-improvement contractor, the built-up-roof membrane manufacturer, the built-up-roof membrane installer, and the roof-repair contractor. These parties then cross-complained against each other, the insulation subcontractor, the panelized roof subcontractor, the HVAC contractor, and the insulation manufacturer. Mysteriously, no claim was made by the owner against the company who inspected the buildings' roofs prior to their sale or against the realtor who sold the property.

The Casualties of War

The claim against the developer / original-owner was that they had sold a building without disclosing a known problem. The difficulty with recovering funds from the developer / original-owner was one of establishing notice – that the developer "either knew or should have known" of the problem. The condition of the roof structure was hidden by the roof membrane on the top of the roof, the insulation on the bottom of the roof, and the suspended ceiling between the occupied space and the attic. Metallurgical analysis of the rusted joist hangers indicated that the joist hangers had been rusting for between 1 and 10 years with the most likely age being 5 years – 1 year before the buildings were inspected by a reputable inspection company prior to the buildings' sale. The tenant / property-manager had not notified the owner of any problems with water intrusions into the building. The developer / original owner transferred the remaining 5 years of a 10 year warranty on the roof in exchange for a release from liability for any & all future roof damage due to water leakage. Furthermore, the developer / original-owner argued that he was not legally obligated to destructively test his building to look for a problem that theretofore had been discovered only in 100 buildings in the Los Angeles basin, that he was entitled to rely on the opinions of hired professionals regardless of the quality of their roof inspection, and that he was not obligated to provide notice to all prospective buyers of the appearance of seasonal leaks in 140,000 square feet of roof over a 5 year period.

The claims against the architect were that he had designed a building he knew would be used as an office yet insulated it as thought it would be used as a warehouse; that he had inadequately designed the ventilation of what would become an attic; and that he had not properly inspected construction of the building to confirm that it was built according to plans & specifications. There was merit to all of these arguments. First, the custom & practice in the industry was & is to place rigid insulation on the top of the roof structure of conditioned office buildings. Insulation on the underside is typically used for warehouses and other occupancies where the insulation is exposed to constant ventilation & observation. If insulation had not covered the underside of the roof, then any damage developing there would have been readily visible. The limitation to this argument is that rigid insulation is typically used on metal-deck & lightweight-concrete roofs; wood roof structures typically have insulation attached to their underside or above the ceiling. Second, the vents in the roof only operated when the exterior temperature exceeded 80º F, the vents were located on the downhill side of the roof, and one-half of one building's roof had no ventilation. The custom & practice in the industry was & is to provide complete & continuous ventilation – this is also a building code requirement. If ventilation had been adequate, then water from leaks or condensation would have dried and no damage would have developed Third, surface-mounted counterflashing had been used over the parapet flashing - instead of the as-designed reglet-mounted counterflashing - without the architect's approval; although this is a very standard detail, it requires annual maintenance to prevent water leakage at the interface between the parapet and roof. If the architect's original detail had been followed, then the parapet counterflashing could not have leaked into the roof structure. Fourth, green wood (i.e., wood that contains between 19% and 37% water) was used to

frame the roof panels, rain fell on the exposed roof plywood during construction, and this wet plywood & green wood was then encased between two impermeable membranes – the built-up roof on top and the insulation on the bottom – in violation of the architect's specification to use wood at 19% or less moisture content. Between 1 and 3 gallons of water were then available to cause corrosion & decay as the water vented from between these membranes over the first year of the buildings existence.

The claims against the tenant / property-manager were defective construction of tenant improvements, inadequate roof maintenance, failure to notify the owner of major leaks, failure to adequately investigate & repair roof leaks, and inadequate investigation & repair of the roof after the extensive damage to both buildings was found. While there was merit to the first four claims, the last claim was troublesome. When these buildings were originally constructed they were empty shells with no heating, plumbing, electricity, or interior construction of any kind. The tenant-improvement contractor then installed roughly 40 skylights and 40 mechanical & electrical penetration by simply cutting holes through the existing roof & membrane, installing the equipment, and placing tar around the penetrations; no curbs were built, no cant strips were installed, and no flashing or counterflashing was installed; and equipment sleepers were simply placed on top of the roof membrane. Consequently, the roof leaked every year. Leakage was so severe that water would pond on top of the aluminized layer of the insulation, tear the insulation from the roof, and splash onto the ceiling below. Even though leaks were located and patched when they were found, the sealant behind the surface-mounted parapet counter flashing was not maintained. Consequently, water leaked into the roof structure around the entire parapet for the last 1 to 4 years of its life. When the tenant repaired the damaged roofs for the first time, the roofs were not allowed to dry before new joist hangers, nails, built-up-roof membrane, & insulation were installed. Even though the tenant cut the ends of the existing insulation as recommended by the American Institute for Timber Construction (AITC) & the Reflective Insulation Manufacturers Association (REMA) in order to allow the roof structure to dry, the existing moisture allowed the new joist hangers to corrode until the wood dried. Furthermore, decayed main support beams were not repaired or replaced. And the plywood roof panels that were reused were of questionable structural integrity because of iron-rot around their nails and delamination of the plywood edges in the vicinity of the nails. However, the owner had a representative from her legal counsel's firm plus a structural engineer on site on a daily to weekly basis to inspect and approve the repair work done by the tenant. Furthermore, the tenant had a contractual right to perform the repairs in an expeditious manner in order to minimize its business interruption expenses. Finally, the buildings' owner had no right to betterment of her property regardless of whether her experts liked insulation on the underside of the roof or thought it contributed to the damage in some manner.

The claims against the built-up-roof membrane manufacturer & installer were based on the 10 year guarantee against defects in material & workmanship in the built-up roof membrane. As part of the guarantee approval process, the manufacturer inspected the roof after it was originally built, inspected the roof after the tenant

improvements were installed, and had the damage done by the tenant improvement contractor "repaired" by the original built-up membrane installer. When a claim was made against this guarantee, the manufacturer declined to cover it because the damage was from leakage through flashing & counterflashing and such leakage was explicitly excluded by the guarantee. The built-up roof membrane installer counter-claimed that the repairs that it did to the damage from the tenant-improvement contractor were within the custom & practice in the industry and not a violation of the building code; if the tenant / property manager / owner wanted curbs, pipe-jacks, cant-strips, flashing, & counterflashing, then the tenant / property manager / owner could have paid for them. Furthermore, if the tenant / property manager did not want leaks, then the tenant / property manager should have properly maintained the sealant around the various penetrations through the roof membrane. The trickier claim for the built-up-roof membrane installer to refute was the use of surface-mounted counterflashing that violated the architects plans & specifications. Although using surface-mounted was & is the custom & practice in the industry and was & is not a violation of the building code, if it had not been used, then water could not have leaked beneath the flashing in into the roof structure. The best defense the installer could muster was to lay the blame at the feet of the tenant / property manager; if the sealant between the parapet and the surface-mounted counterflashing had been maintained, then leaks would not have developed.

The Non-Smoking Gun

The claims against the other litigants either can be deduced from the preceding narrative or were based on the legal theory of non-delegable duties (i.e., bosses are responsible for the mistakes of their subordinates) - except for one. The most hotly contested claims of the lawsuit were against the insulation manufacturer. As mentioned before, consultants for the buildings' owner as well as the tenant / property-manager were of the opinion that the roof failure was caused by insulation on the underside of the roof trapping high-humidity air that flowed into the attic during the heat of the afternoon which subsequently would condense on the metal hangers during the night; the hangers would rust; and the wood would decay. The basis for this theory was that when the roof was inspected after the joist first fell, the roof structure was completely saturated and water was trapped in the insulation. During the heat of the day this water would vaporize and condense on anything cold that it touched. Furthermore, condensation in panelized roof systems was a well known phenomenon in cold climates. And finally, the building code did not allow insulation on the underside of roofs without ventilation between the insulation and the roof deck in residential construction. The trouble with this theory was that this phenomenon was never observed during the two year period these buildings were monitored. Data were collected by full-time sensors connected to computers & plotters for two week periods in spring, summer, winter, & autumn during hot, cold, rainy, & dry weather. Indoor rain never happened. A computer simulation was performed using the most extreme climatic condition on record during the life of the building. The computer simulation predicted that indoor rain never had and never would happen. Other

buildings with "the same" problem were investigated and were found either to have extensive roof leaks or to have been constructed during the rain and the trapped moisture was working its way out of the structure. And thousands of similar buildings existed in the same geographic region that did not have the same problem.

Consultants for the buildings' owner as well as the tenant / property manager also opined that the insulation manufacturer should have warned the tenant / property manager and owner of the potential danger of installing the insulation on roof framing that might get wet. There were three problem with this theory. First, the installation instructions for the insulation clearly stated "Do not install on wet wood." Second, the risks associated with the use of insulation on the underside of roofs is well understood & documented in the technical literature, and engineers & architects presumably are sufficiently trained to determine when & where the use of such insulation is appropriate. Third, the California State Building Code allowed – and still allows – this form on construction.

Finally, consultants for the buildings' owner opined that the insulation was defective because once water entered the roof structure, the presence of insulation on the underside of the roof would cause the roof to dry more slowly and consequently cause any damage that developed to be greater than it would have been otherwise. With a panelized roof, the only way to avoid the risks associated with insulation on the underside of the roof is to use rigid insulation on the top of the roof. The cost differential between below-roof insulation & above-roof insulation is roughly $40,000 per roof for the average panelized roof. Based on the incident insulation manufacturer's sales records, its customers would have spent an additional $750,000,000 to potentially reduce the scope of damage in the two incident buildings. The question of whether the insulation was defective was phrased in the question, "Should this manufacturer's customers have been required to spend $750,000,000 to potentially save one customer some fraction of $4,000,000?" The answer to this question was a resounding no.

The Smoke Clears

The preponderance of evidence in this litigation indicated that the subject buildings were damaged primarily by water that entered through improperly designed, installed, & maintained flashing / counterflashing on the roof and secondarily by rain-water & wood-moisture that was trapped in the roof structure during original construction. While condensation can & does occur in some buildings such a factories with open hot-water equipment in cold climates, it was not a factor in these buildings. The uniformity of the damage was attributed to the ability of water from a point leak to spread across the entire roof by traveling through the joints between the roof panels; water leaking through the surface-mounted parapet counterflashing during a 1 inch rain storm was sufficient to expose every hanger in the building to moisture. The severity of the damage was attributed to an almost total absence of ventilation in the buildings' attics; once these hangers were wet, they would stay wet for days to weeks (portions of the roof that were exposed to ventilation were undamaged). And the failure to discover the damage was attributed

to roof inspectors who never once looked at the underside of the roof – they only looked at the top of the roof membrane.

The questionable performance of the first repair was attributed to not adequately drying the roof structure before placing new nails & hangers in contact with wet wood, not adequately ventilating the attic space, reusing damaged roof panels, and not repairing damaged main support beams.

Dodging Bullets

The first step in dodging this bullet is to make certain that your are carefully reviewed by legal counsel to provide you with the maximum protection. You also want to be a named additional insured on your client's property insurance policy.

The second step in dodging this bullet is to spot the cancer (i.e., water leaks, decay, & corrosion) early. Inspect roofs annually by removing the insulation from a statistically representative sample of the roof panels and look for the presence of decay or rust. Meticulously maintain their roofs by annually inspecting for fish-mouths, blisters, cracks, delaminations, dried sealant, et cetera then repairing all damage and sealing all flashing & counterflashing – starting with their first year of use. Inspect for continuous adequate ventilation in all attics and dead-air spaces; if it is missing, then have it installed. Annually test roofs for leakage with the building under a negative pressure. And annually have your HVAC systems inspected & tested for proper operation.

The third step in dodging this bullet is to carry professional liability insurance. Property insurance typically excludes damage due to decay & corrosion, damage that is not caused by a sudden event, damage caused by defective construction, and consequential damage from defective construction. A property insurance carrier might provide a defense for you under a reservation of rights, or it might decline coverage entirely under a declaratory relief motion. When the shooting starts, you will want to be represented by counsel and advised by experts – not caught in the cross-fire between a building owner and a property insurance carrier.

Parting Shots

In the western & southwestern United States, roughly one-hundred-thousand buildings exist with insulation of all forms on the underside of panelized wood roofs. They are office buildings, warehouses, factories, assembly plants, retail stores, and wholesale outlets. Nationwide, the total is not known. Roughly 1 percent of these buildings are estimated to have moisture entrapped (from wet wood, leaks, & poor ventilation) throughout their roof structures between the roof membranes and the insulation. This entrapped moisture places these buildings at risk of

developing wood decay & metal corrosion throughout their roof structures. Undiscovered & unchecked, this cancer-like decay & corrosion can destroy a roof structure and cause it to collapse. Current roof inspection & maintenance practices typically will not find this corrosion, decay, or source of water. Until now, identifying buildings with these problems has been done by waiting for a failure to occur. Now, property managers can take a pro-active role in preventing, finding, & stopping them. The millions of dollars they save might be their own.