Wright House, Wrong Peril
A Case Study in Hail Damage to a Frank Lloyd Wright Residence

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Abstract

There was no question that hail had damaged the copper roof of the only Dallas residential structure designed by the well-known architect, Frank Lloyd Wright. What began as a hail damage assessment on a historic house escalated to egregious claims that water intrusion and associated corrosion, wood rot and mold were the result of a single hail event that occurred in 2003.

The author presents a case study that outlines the facts of the case including basic hail damage theory, the claims by the property owner, and completes with impeaching testimony provided at deposition and trial. A key trial exhibit is presented that illustrates that the information and assessment provided by the expert witness author was instrumental in revealing that the majority of the claimed damage existed prior to the hail event and developed due to long-term water intrusion.

Introduction and History

Frank Lloyd Wright (FLW) designed a house in Big "D" for a wealthy oil man, John Gillin. It was one of the last homes constructed before his death in 1959. The residence was characteristic of Wright's Usonian designs, including a low-sloped (3:12) copper roof, no attic, no basement and a carport. It was geometrically based on hexagons and isosceles triangles (**Figure 1**). A structure of 11,000 square feet, it was developed by three wings that spun off a central hexagon, which formed the grand living area. The ventilator and spire above it were copied from his Arizona Biltmore hotel's ballroom.

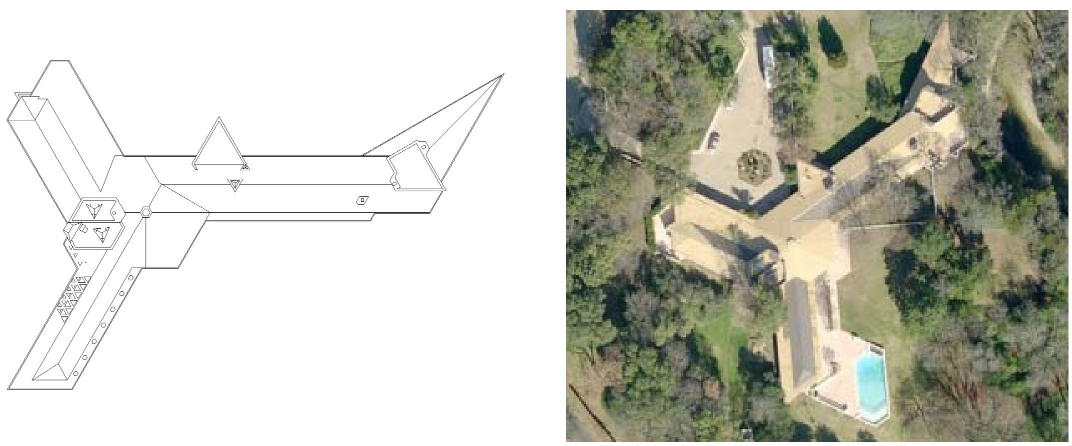

Figure 1. Aerial Views of Residence (Schematic and Actual)

Purpose

The purpose of the paper is to present basic hail damage theory and distinguish the types of damages that hail causes and does not cause. Illustrated through case study, methods are presented that establish the factual basis for an accurate opinion as to the cause and origin of the damage.

Scope

The scope of the analysis included a site visit, measurements and physical documentation of the distress to the roof and interior of the home, preparing opinions on the cause and extent of damage, meteorological research, discovery (deposition) analysis, and presenting those findings in a trial setting.

Hail Formation and Damaging Effects

The formation of hail generally occurs with thunderstorm activity. Cumulonimbus clouds form convective atmospheric systems that result in the production of hail. These may be generally called "thunderheads" or "anvil" clouds. The formation of hail generally requires a thunderhead of sufficient height and available moisture. Therefore, it is important that during an analysis of hail damage, the existence of a hailstorm is verified on the date of the alleged occurrence. Historical hailstorm activity can be freely obtained from the National Oceanic and Atmospheric Administration (NOAA).

Damage resulting from hailstones generally depends upon the mass and velocity of the stone and the amount of energy transferred to the receiving material. Damage caused by hail is typically identifiable by a concave indentation or burnish mark (scrape/abrasion) at the surface of the impacted material. It is commonly estimated that the size of the hailstone results in an impact crater diameter or strike indentation less than the original size of the hailstone. Generally, a hail impact mark (indentation) on metal surfaces (such as roof flashing) will measure approximately one-half (1/2) the diameter of the impacting hailstone (Noon, 1992). As the metal material thickness decreases, the indentation to hail diameter increases, including diameters *larger* than the original hailstone on soft metal surfaces such as flue-gas vents (Crenshaw and Koontz 2002).

Burnish marks, which are left behind due to hail abrading an oxidized surface, can range from one-half (1/2) to the full diameter of the hail. The diameter is approximated from the width of the mark and the length of the "skid" generally indicates direction of the hail. (Crenshaw and Koontz 2002).

All roofing materials have some resistance to hail damage, but as the size of hailstones increases, a threshold of impact energy is reached at which damage occurs. If large enough hail forms, it can damage a roof assembly sufficient enough that replacement is necessary.

Damage to roofing materials from hail is classified by three general categories:

> **Superficial damage** - which affects the appearance but does not materially interfere with the performance of the roof. This includes damage to appurtenance items such as metal roof vent covers, mechanical units, etc.
> **Latent damage** - which may affect the function of the roof materials at a later time.
> **Severe damage** - which leads to penetration of the roof system by the elements.

Examples of latent damage include moisture that has migrated between the roof covering and frozen in lower temperatures. Some indications of severe damage are cracks, punctures, tears, or openings in the surface or field areas of the roof system protecting the structure. Superficial damage may include items such as dents in the metal, asphaltic, or rubberized membranes. Hail damage to metal roofs can include bends/deformations to the standing seams, which can compromise the waterproofing capabilities of the roof. If the metal panels are structural panels, deformations on the ribs can affect the load-carrying capacity of the panels.

The vast majority of hailstorms contain hailstones that are relatively small (less than 1" diameter). These small hailstones can cause damage to crops and property, but not to all roof systems. Minor damage may be observed in glass, plastic, and thin gauge metal vent covers by any size hail; however, these materials are only appurtenances of the roof and may not be critical to the performance of the roof system. Refer to **Table 1** below for a general reference of hail sizes.

Table 1. Sizes of Hail (Storm Prediction Center 2009)

Reference Object	Measurement
Pea	0.25" (1/4")
Marble	0.50" (1/2")
Penny/Dime	0.75" (3/4")
Mothball/Nickel	0.88" (7/8")
Quarter	1.00"
Half dollar	1.25"
Ping Pong Ball	1.50"
Golf ball	1.75"
Hen Egg	2.00"
Tennis Ball	2.50"
Baseball	2.75"
Tea Cup	3.00"
Grapefruit	4.00"
Softball	4.50"+

Facts of the Case

The property owners purchased the residence in 1999 and were the third owners of the historical structure. Initially, the owners reported roof leaks at two of the bedrooms but indicated more serious water intrusion in August 2003. As reported by Marshall (Marshall 2004), a significant hail storm occurred in North Texas on April 5, 2003 and at the urging of a roofing contractor, a claim was made under their homeowner's insurance policy shortly after August.

A site visit and examination of the damage were performed by the author initially on April 30, 2004. Indentations consistent with hail impacts were evident throughout the roof (**Figure 2**). Weather research revealed that over 400 hailstorms had occurred in the vicinity of the structure since initial construction. The indentations represented superficial damage to the roof, but according to the adjuster triggered coverage for the copper panels. Therefore due to the obvious hail indents, the focus of the initial engineering investigation was on the cost of repair/restoration to the upper roof and not on the cause of loss. It was determined that roof could be "restored" for a cost slightly less than $2,000,000.

Restoration of the roof began in June 2004. However, as copper was removed and the associated underlayment, batten boards and concrete deck were uncovered, problems were revealed. This work essentially became inadvertent destructive testing and allowed viewing of the original construction. The original underlayment was severely deteriorated and the concrete deck was spalled and friable at the edges. Further, the owners had associated areas of plaster soffit removed only to find severe corrosion to the lathing, its supports, and structural steel framing (**Figure 3**). Expenses soared and soon the restoration scope of work became much more than a $2,000,000 project.

During the course of the restoration, structural repair documents were prepared for steel framing repair; but at some point, policy limits of $2,500,000 were reached and accordingly the insurance policy did not respond to corrosion and the other extensive water damage and mold that existed throughout the structure. The homeowners disagreed and later filed suit in 2008.

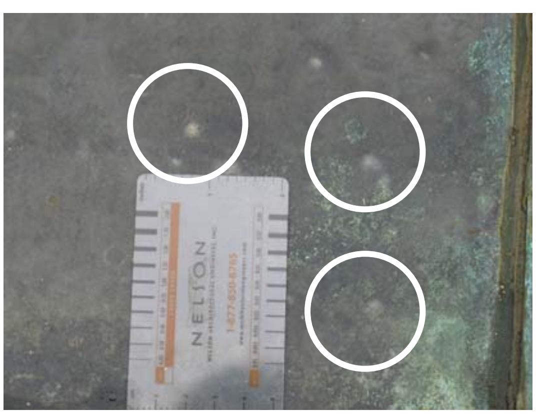

Figure 2. Hail Indentations to Copper Roof

Figure 3. Corrosion of Steel Framing (Claimed as Hail Damage)

Case Study

In addition to replacing the copper roof, claims alleged by the homeowners included repairs to HVAC, plumbing, steel framing, masonry, security system, security personnel, and architectural fees, to the tune of approximately $5,600,000. The homeowners were asserting the claim that all of the damages were the result of the hail storm of April 5, 2003. They further demanded $250,000/month in temporary lodging costs, owing to the fact that they would have to relocate during the extensive work.

As the claim escalated, the engineering investigation now turned its focus to cause and origin in order to define the limits of the scope of the original claim. Discovery ensued, and many relevant facts (which had been omitted by the homeowner) came to light.

The homeowner's expert and former FLW apprentice honed in on an "ice dam" theory, attributing all of the water intrusion due to ice damming at the eaves as a result of the hail storm (**Figure 4**). The only problem with that was the temperature, which according to NOAA (Weather 2003) ranged from approximately 50ºF to 80°F on April 5, 2003. Ice damming per the NRCA (NRCA 1996) typically only occurs for northern climates that experience average January temperatures of 30°F (Dallas' average temperature in January is approximately 43°F).

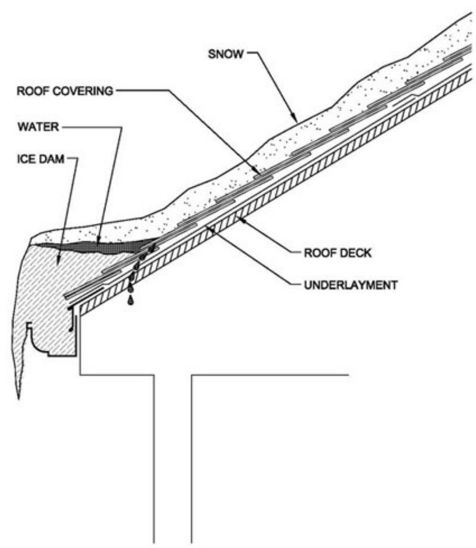

Figure 4. Ice Damming per NRCA (NRCA 1996)

The homeowners claimed at trial a total of roughly $6,500,000 of which $2,500,000 (policy limit) had already been paid. It was claimed that a rider of $2,500,000 was applicable and that because the insurance company breached its contract, it was entitled to the entirety less paid amount, or roughly $4,000,000.

The insurance company indicated that it had met its obligation and owed nothing more than the $2,500,000 limit and that the remaining damages were due to long-term water intrusion, which was the result of normal wear and tear, lack of maintenance and not hail related.

Initial deposition testimony (Depo. I) given by one of the homeowners indicated no reports had been prepared for the Gillin residence and in fact, that other than the two bedroom leaks, there were no roof leaks.

Depo. I

Q. Were you aware of any leaks or damage to the roof prior to April 5, 2003?
A. No.

Discovery led to an invoice from an architect whose files were subpoenaed. The architects file revealed the homeowner had hired both a restoration architect and an original FLW apprentice (now architect) *prior* to 2003 to assess the damage and advise on the restoration of the roof. These findings were withheld during the initial investigation and after the files were subpoenaed, led to another deposition (Depo. II). It also became clear that the property owner's roofing contractor had fled to Florida after the 2004 hurricanes, leaving the project unfinished, not to mention underfunded.

Depo. II

Q. Did you happen to disclose to the insurance company the restoration architect’s findings?
A. No.

Enter Exhibit A (Figure 5): Data collection from the April 2004 site visit was compared to data collected by the restoration architect who had prepared a report dated March 20, 2003. Interestingly, the grid lines as established by FLW in the original design had been used by the restoration architect to locate approximately 50 primary areas of water intrusion. Thus, the grid lines provided a very accurate way to pinpoint the location of the previously reported leaks. By comparison, the author plotted the 2004 documented areas of water intrusion (many located by the owner and claimed as a result of the hail storm) and superimposed them on an architectural plan creating Exhibit A. The hail-claimed areas of water intrusion were shown to have pre-existed. In fact, the restoration architect documented many more that pre-existed the hailstorm.

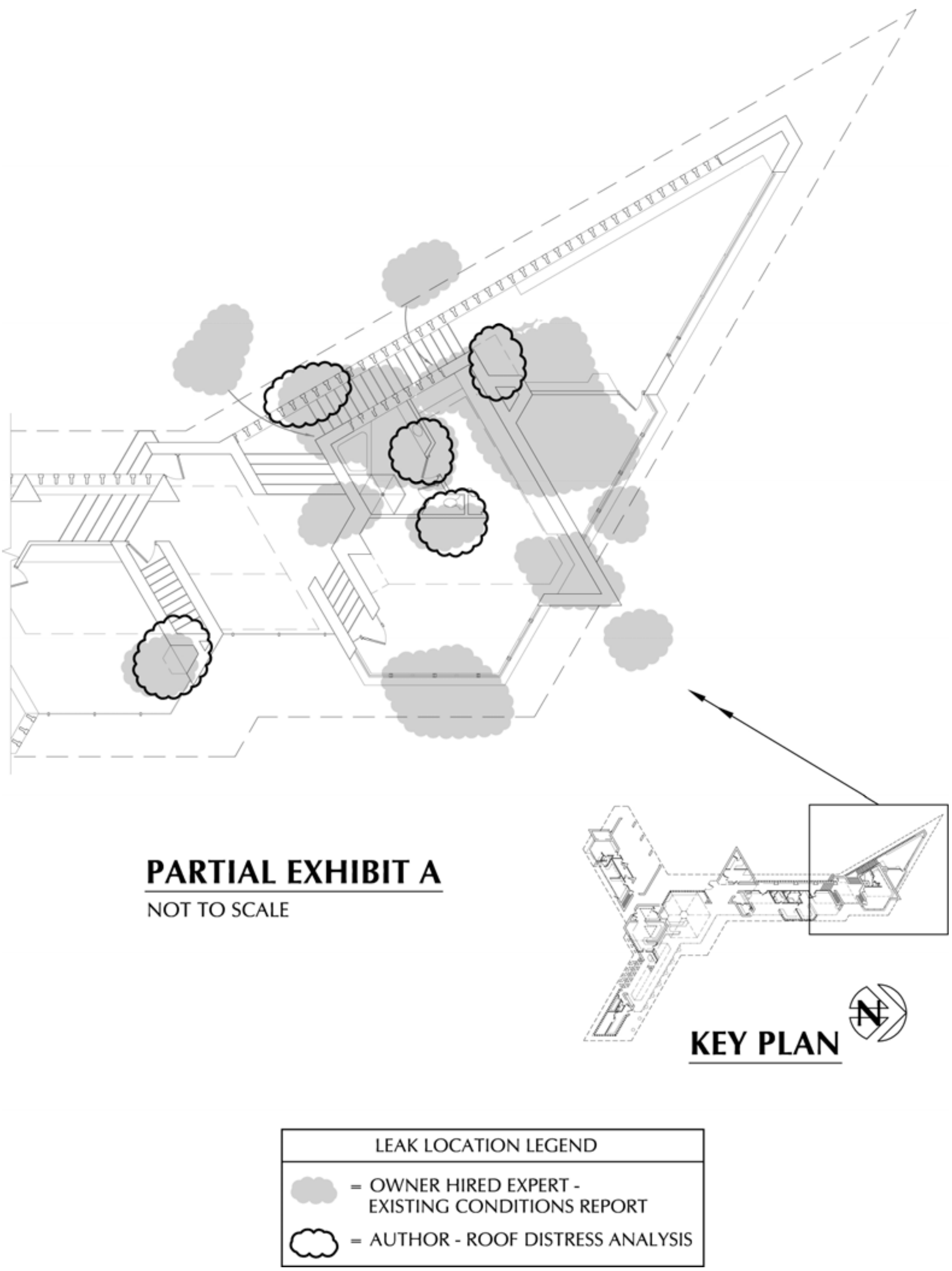

Figure 5. Partial Exhibit A,
Overlay of Author's Findings versus Restoration Architect's Pre-Storm Findings

The mechanism for water intrusion was clear from destructive testing. Staining and drainage patterns on the batten boards told the story of water intrusion at the seams through normal wear and tear. Unraveling of the solder joints over time and the associated lower slope of the batten and bent copper, led to repeated long-term water intrusion (**Figure 6 & 7**).

Due to the degree and extent of wood rot and steel framing corrosion, the author determined that water intrusion was a long-term condition not caused by hail and certainly not the result of the one recent hailstorm event alone. Further, hail impact was not evident at the seams and would not have occurred in a consistent manner as revealed by destructive testing.

As the low sloped roof changed close to a flat roof at the tapered batten, the drainage became poor. Water accumulated at these points and constantly "tested" the system. As time went on and the solder joints deteriorated from wear and tear (most likely thermal cycles), the joints eventually leaked and long term water intrusion damaged not only the roofing materials, concrete deck and steel framing, but the interior finishes of plaster and mahogany. Figures 6 & 7 clearly illustrate this mechanism by the staining patterns revealed.

Figure 6. Cause and Origin of Water Intrusion

Figure 7. Copper Seam and Water Staining on Cedar Battens

Conclusions

A case study is presented concurrently with methods used for evaluating hail damage. Hail dented the copper roof superficially and for aesthetic reasons (superficial damage), it required repair. It had not been established whether it was from the alleged event or multiple events to the roofing material (although history for the location indicated over 400 hail events since construction). It was demonstrated via physical evidence and key facts that hail in fact hadn't caused <u>all</u> the claimed areas that related to interior water damage, mold and corrosion of steel framing. The long-term effects of water intrusion via wear and tear on the low-slope copper roofing system was the cause of the corrosion, wood rot and the mold, not the hail.

Due to the case being tried in a federal court, the judge limited both sides' time and the trial lasted approximately one week. The jury returned a defense verdict (no liability for the defense, no damages awarded) in a matter of minutes.

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