Collateral Evidence of Hail

INTRODUCTION

When I first started inspecting properties for hail damage, I was taught to inspect the surroundings for collateral evidence of hail.

The initial task (or the scope of work) was to determine if some particular item was damaged by hail. In order to support the claim of damage to that item, it was helpful to look for evidence that hail struck the property beyond just looking at the item in question.

In other words, if asked to determine if a roof was damaged by hail, it is common practice to looks at anything on the property that might give an indication of the size of the hail or direction of the hail.

Unfortunately, there were no standards to compare observed damage on various items to known hail diameters.

This document helps relate what typical damage from various diameters of hail might look like if coming in contact with common items found at a typical residential property.

TABLE CONTENTS

1. DEFINITIONS

Kinetic Energy – the energy which a body possesses by virtue of being in motion.

Damage – the physical harm caused to something in such a way as to impair its value, usefulness, or normal function.

Mass / Matter – atoms and compounds. Anything that has mass takes up space (it has volume)

Velocity – speed of something in a given direction

Collateral – additional but subordinate; secondary

Evidence – the available body of facts or information indicating whether a belief or proposition is true or valid.

Collateral Evidence – additional facts

2. Hail Impact Energy

Hail damage can be defined as energy dissipation. Right before impact, the hailstone has a certain amount of Kinetic Energy based on its mass and velocity. Right after impact that energy has been immediately transformed into other forms of energy including fractures in the ice, heat in the ice, heat in the contact surface, distortions in the impacting surface, and elastic bounce in the opposite direction.

Simply put, small hail bounces leaving no observable change in the contact surface. Large hail causes change to the contacting surface. The larger the hailstone the greater the energy that needs to be dissipated and the greater amount of observable change to the impact surface. The observed changes after the storm has left is collateral evidence of hail.

3. Asphalt Shingles vs Hail

The ability of a roof surface to resist hail with no adverse effect has a lot to do with the condition of the roof. The condition of a roof has an ever decreasing resistance to hail with age. If someone sells a 50 year shingle that is stated to be "hail resistant" that means they will not be around when you need it replaced. A roof will simply transition from new to old. Newer roofs are better able to resist hail impact without physical change.

4. Hail Size

The size of hail is obviously important when evaluating what is damaged by hail. Not all hail is the same. Being hit in the leg numerous times by a small child with a plastic toy hammer is not comparable to being hit once by an adult with a real hammer. The same is true for hail. There is small "baby" hail and there is massively large hail.

Hail diameter is not the only factor to consider. Hail can be soft or hard. The important factor to know is impact energy. Hail impact energy increases dramatical as the size increases. The amount of energy transferred to the impacting surface has to do with where the energy is being dissipated. Does the hail bounce, smash, fracture, or imbed into the surface?

5. Steel Ball Impact Energy

It has generally been accepted that hail falls to the ground at a terminal velocity. Wind plays a role in increasing the resultant impact velocity at the point of contact. The terminal velocities of various hail stones are summarized in the table below.

Hailstone Fall to the Ground

Diameter inch	Terminal Velocity miles per hour
1/2	35
3/4	43
1	49
1 1/4	55
1 1/2	61
1 3/4	65
2	70
2 1/4	74

Without running through the math, each mass of particular hailstone when combined with the estimated terminal velocity can be represented as Kinetic Energy (Kinetic Energy = ½ mass x velocity^2)

Based on the conservation of energy, we know that energy is never really lost. Energy just converts to another form of energy. Therefore, the Kinetic Energy of a hailstone can be equated to a Potential Energy of a steel ball of equal size (Potential Energy = mass x gravity x height). Using these relationships hailstone impact energy can be equated to dropping a steel ball of equal size at certain heights.

Using these relationships Underwriting Laboratories UL has created four classes of Hail Resistance

Steel Ball Falling from a Certain Height

Diameter inch	Height Above Surface feet	
1/2	2	
3/4	7	
1	10	
1 1/4	12	UL 1
1 1/2	15	UL 2
1 3/4	17	UL 3
2	20	UL 4
2 1/4	22	

Looking at the table above, a 1-inch hailstone falling to the ground will have the same impact energy as a 1-inch steel ball dropped from a height of 10 feet.

6. UL 2218 Impact Rating

"The certifications for impact resistance are expressed as Class 1, 2, 3 or 4, which relate to a roof covering's ability to withstand impacts from 1 ¼, 1 ½, 1 ¾ and 2 inch diameter steel balls, respectively." The acceptance criteria used to establish roof-covering materials certifications is basically the lack of any visible changes when exposed to the respective impacts. For Class 4 impact resistance, 2-inch steel balls are dropped from 20-feet. This simulates the energy of hail of an equivalent 2-inch diameter ice ball falling to the ground and impacting the surface at the terminal speed of 70 mph. This is nearly unstoppable without damage to typical asphalt shingles.

A 2-inch hailstone that falls to the ground at a terminal velocity can cause extreme change to all sorts of items. It is about the force of an adult using a hammer to advance a nail. This can cause significant damage to people, plants, or almost any surface that is exposed to the hail.

7. Steel Balls vs Metal Box Vents

Steel balls were dropped on metal box vents to get a comparison of what an equivalent hailstone would cause. The following table is the summary of the test results:

Hail Size	Observation
½ inch	No denting observed. Hail ½ inch or smaller causes no observable change.
¾ inch	Small faint depressions are observed with very close inspection.
1 inch	Depressions are observed without significant difficulty.
1 ¼ inch	Deeper depressions in the flat surfaces are easily seen with little difficulty. The box starts to have deformations away from the impact location.

8. Steel Balls vs Plastic Box Vents

Steel balls were dropped on plastic box vents to get a comparison of what an equivalent hailstone would cause. The following table is the summary of the test results:

Hail Size	Observation
½ inch	No fractures. No evidence of any impact.
¾ inch	No fractures. No evidence of any impact.
1 inch	No Fractures. Some discoloration at point of impact.
1 ¼ inch	Onset of fractures. Some fractured. Some did not fracture. Some discoloration at point of impact.
1 ½ inch	Larger fractures occurring nearly every impact.
1 ¾ inch	Fractures at impact and fractures at locations away from the impact.

9. Steel Balls vs Aluminum Flue Caps

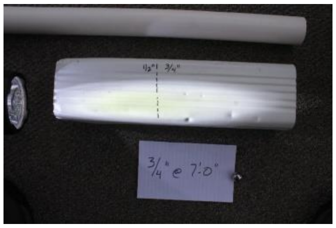
Steel balls were dropped on aluminum flue caps to get a comparison of what an equivalent hailstone would cause. The following table is the summary of the test results:

Hail Size	Observation
½ inch	Small faint shallow dents. Difficult to see without close inspection using the reflection of the sky or using chalk.
¾ inch	Small dents seen without much difficulty. Chalk not needed to see dents.
1 inch	Larger dents with diameters of 2-inches.
1 ¼ inch	Larger dents with diameters of 2-inches or larger.
1 ½ inch	Larger dents with distortions in the cap away from the impact.

10. Steel Balls vs Downspouts

Steel balls were dropped on downspout extensions to get a comparison of what an equivalent hailstone would cause. The following table is the summary of the test results:

Hail Size	Observation
½ inch	Small faint shallow dents. Difficult to see without close inspection using a flashlight or applying chalk.
¾ inch	Small dents, seen without much difficulty. Chalk and/or flashlights are needed for photograph.
1 inch	Dents are easily observed.
1 ¼ inch	Dents are easily seen without flashlights. The section starts to deform away from the point of impact.



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