Guidelines to Assess Hail Damage to Shingle Roofs

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ABSTRACT

The severity of hail damage to residential and commercial roofs depends on several parameters including the age and type of roofing material, the roofing assembly, hail size, and roof slope, among others.

Asphalt shingled roofs comprise a large percentage of insurance claims submitted for roof-related hail damage. For asphalt shingled roofs, hail damage typically consists of radial/circular areas of granule loss, which constitute latent damage and may affect the future performance and lifespan of the shingles. The severity and extent of hail damage to asphalt shingled roofs is not as visually apparent as compared with some other common high-slope roofing materials, such as metal panels, wood shakes, and clay/concrete tiles. Assessing the extent of hail damage to shingled roofs and developing a scope of repairs can be difficult. Furthermore, guidelines for such assessment are not well established.

Based on the authors' experience, we propose guidelines and procedures to assess the extent of hail damage to asphalt shingled roofs from which a scope of repairs can be developed. A cost analysis for the consideration of repair versus replacement is also presented.

WEATHER RESEARCH AND DETERMINATION OF HAIL SIZE

During an investigation of hail damage to roofing materials, it is important to determine the approximate size of the impacting hail. Hail size will vary not only between different storm events, but also within a particular storm event. Because of the exponential increase in kinetic energy with the increase in hail size (due to increased mass and increased velocity), the size of the largest hailstones from the storm event are of primary interest (Noon 2001).

Weather research can be conducted using information freely available from the National Oceanic and Atmospheric Administration (NOAA) or by obtaining a more detailed site specific meteorological report by private companies. Because hail size can vary between locations during a hail event, the distance between the site and the location of reported hail should be considered.

Even if an investigator has reported weather information, the conditions at the site are typically the best indicator of hail size and severity. Indentations in metal surfaces and burnish markings on metal or other smooth surfaces can provide valuable information regarding hail size and even the directionality of falling hail during a storm event.

Burnish marks occur where impact from hailstones removes the surfacing of an exposed material, such as dirt, fungal discoloration on wood surfaces, or slight oxidation on metal surfaces. This burnishing changes the appearance of the surface, leaving distinct markings which can be useful in determining the approximate size and distribution of hailstones. Burnish marks on vertical surfaces and the splash patterns of burnish marks on horizontal surfaces can also aid in determination of the directionality of hail impacts.

Considering typical light gauge metal surfaces (such as 24 or 26 gauge metal panels or parapet wall cap flashing), an indentation from hail impact will usually measure approximately half the diameter of the impacting hailstone (Koontz and Crenshaw 2002). Indentations in softer metal surfaces, such as aluminum coil fins at roof top HVAC units and soft metal covering for pipe insulation, can also give an indication of hail size (Noon 2001). While it is important to evaluate the shingle roofing for evidence of impact damage, the information gained from the weather data and the conditions at other building materials can assist in the overall evaluation of hail occurrence.

HAIL DAMAGE TO SHINGLE ROOFING

When evaluating shingles for hail damage, two types of damage are considered: latent damage and severe damage. Latent damage may affect the function of the roof materials at a later time. Latent damage to shingles exists when the hailstone impact removes the protective mineral surface granules and exposes the asphaltic matrix to ultraviolet light. This can accelerate the deterioration of a shingle. Severe damage exists when a shingle is punctured/fractured or torn by a hailstone impact.

Shingles overlaying a previous shingle roof are more susceptible to impact damage from hail than if the same shingles had been installed directly over a roof deck. Underlying shingles are much more forgiving (or less resistant) than wood decking, which allows impacting hailstones to better penetrate a roof system comprised of two or more layers of shingles. Additionally, inadequate ventilation and/or material deficiencies can cause shingles to curl at the edges. These curled edges are unsupported and typically brittle, and are therefore susceptible to impact damage from hail. Furthermore, as shingles age, they can become more brittle as the asphalt hardens within, decreasing their hail impact resistance.

ASSESSMENT OF HAIL DAMAGE TO SHINGLES

When assessing hail damage to shingle roofs, the roof should be walked thoroughly and a roof plan should be drawn. In addition to evaluating roof shingles for hail damage, roof appurtenances (i.e., vents, any rooftop units/equipment, etc.) should be evaluated. **Figure 1** below shows typical indents due to hail on a roof vent cover. Additionally, the exterior of the structure, including auxiliary structures (i.e., carports), should also be visually evaluated for signs of hail distress. Observed hail distress at both the roof and exterior of the structure should be properly documented.

Roof Plan. Prior to evaluating both the roof and exterior for hail distress, a roof plan should be drawn. For larger and more complex structures an aerial image, such as those freely available through Google Earth or Bing Maps, can aid in the development of the roof plan. At the site, dimensions can be measured and recorded on the aerial image and the various features (i.e., roof pitch, roof edge, valleys, hips, ridges, vents, etc.) can be outlined. For smaller and simpler structures, a scaled roof sketch can be prepared on-site. With a roof plan, the roof size can be computed, field notes can be recorded, and observed distress can be accurately located.

General On-Site Observations. In addition to evaluating the roof, the exterior of the structure should also be evaluated for hail distress. This includes evaluating the exterior finishes of the structure, window assemblies, door assemblies, and auxiliary structures. Any evidence of hail distress, such as burnish marks or indentations in metal materials, should be documented. Additionally, exposed condenser coil fins at air conditioning units are susceptible to impact damage and should be evaluated. **Figures 2** shows typical hail indents in condenser coil fins.

Figure 1. Hail indents on a roof vent cover.

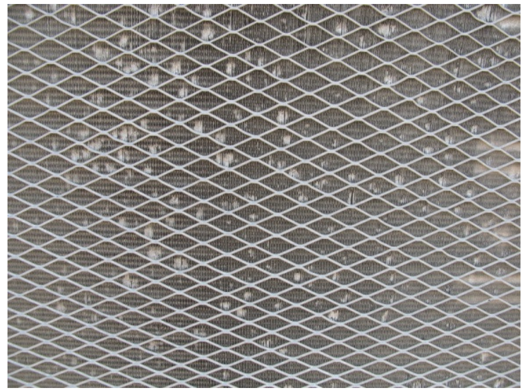

Figure 2. Hail indents in condenser coil fins.

When evaluating the roof shingles for hail damage, all accessible roof areas should be evaluated. At the accessible roof areas, impact damage to the shingles should be documented. Care should be taken to ensure that the impact damage is consistent with hail. Granule loss on roof coverings can occur from hail impacts; however, granule loss in and of itself does not prove hail damage. Granule loss can also be the result of material and/or installation defects, natural weathering, foot traffic from maintenance, and miscellaneous impact abuse. In the authors' experience, circular areas of granule loss are generally consistent with hail impact damage. For older hail damage, the circular impact marks are typically more clearly defined. Over time, the underlying asphalt at the area of impact shrinks/contracts due to ultraviolet exposure, which creates a distinct circular mark, such as that shown below in **Figure 3**. For newer (or more recent) hail damage, the area of impact will appear bruised similar to that shown below in **Figure 4**.

Figure 3. Hail impact mark on a roof shingle.

Figure 4. Hail impact mark on a roof shingle.

When documenting hail distress at both the exterior and roof of a structure, the evaluator should pay close attention to the directionality of the hail distress. At the exterior, the evaluator should determine which side(s) exhibits the greatest frequency of hail distress. Similarly, at the roof, the evaluator should determine which roof slope direction has been impacted most by hail. Evaluating impact marks within a sample area (as discussed in further detail in the following paragraph) will assist in determining the frequency of impact distress at the roof. In addition to documenting the directionality of hail distress, the size of the hail impact mark should also be documented. This includes measuring the diameters of burnish marks, indentations in metal surfaces, and/or impact marks on the shingles. The directionality of the hail distress and the impact size can be correlated with the researched weather data.

Sample Areas. In order to obtain a representative sampling of hail distress at the roof, sample areas are used. For typical residential roofs, one sample area per roof slope direction will suffice. For larger residential structures or multi-family dwellings, such as apartment buildings, it may be beneficial to evaluate more than one sample area per roof slope direction for each building. Typical sample areas should measure approximately 10' by 10'. However, based on the roof size and/or for safety purposes, the evaluator may have to limit the size of the sample areas to 10' by 5' or even 5' by 5'. For statistical purposes, it may be preferable that the sample areas include only full shingles. Since each course of shingles are offset from the adjacent courses, this will require the sample areas to be irregularly shaped.

Each sample area should be carefully evaluated, and within each sample area, impact marks consistent with hail distress should be documented.

Analysis. When analyzing the sample areas, it is the authors' recommendation that a table/spreadsheet be created. The table should include (at a minimum) the roof slope cardinal direction where the sample areas were taken, the number of impact marks consistent with hail distress within the sample areas, and the percentage of damaged shingles within the sample areas (for both architectural and 3-tab shingles). For 3-tab shingles, the percentage of damaged shingles should be calculated based on full shingles (as opposed to the number of tabs), because proper replacement of a damaged tab requires replacement of the full shingle. When calculating the percentage of damaged shingles within the sample areas, the evaluator may assume that not more than one impact affected a shingle (conservative assumption for high density storms where more than one hail impact may affect a given shingle). Recommendations for repair versus replacement of the shingles will be based on the percentage of damaged shingles within the sample areas.

COST ANALYSIS

The purpose of the cost analysis in this paper is to determine an estimated percentage threshold of hail damage which will generally signify that roof replacement should be considered as more economically feasible than individual shingle repair. Labor and material costs may vary significantly by geographic area, time of year, contractor experience and availability, and other factors. Exact pricing may be unknown at the time of the roofing evaluation. However, based on sampled costs and standard industry repair methods, it is the authors' opinion that it is generally possible to formulate a repair/replace decision within a reasonable certainty based on the percentage of hail-damaged shingles observed.

Repair Method. Replacement of hail-damaged shingles should be done according to industry standard repair methods. The repair method for replacement of individual shingles outlined in CertainTeed's "Shingle Applicators' Manual" was used for the purposes of this paper. Most major roofing manufacturers publish similar methods for individual shingle replacement. The general process to replace individual damaged shingles includes unsealing the adhesive strip on the damaged shingle and the shingle(s) on the first and second course immediately above the damaged shingle. The nails in the damaged shingle and in the shingle(s) on the course immediately above that also penetrate the damaged shingle are removed. After installation, the replacement shingle and all loosened tabs are hand-sealed with an acceptable asphalt adhesive (CertainTeed Corporation 2011). Depending on its location on the roof, this process requires manipulation of two to four other shingles in addition to the damaged shingle.

Figure 5 below represents a typical 10' by 10' sample area and illustrates this repair process. The darker shaded shingle denotes a hail damaged shingle requiring replacement. The lighter shaded shingles denote shingles requiring manipulation to replace the hail damaged shingle.

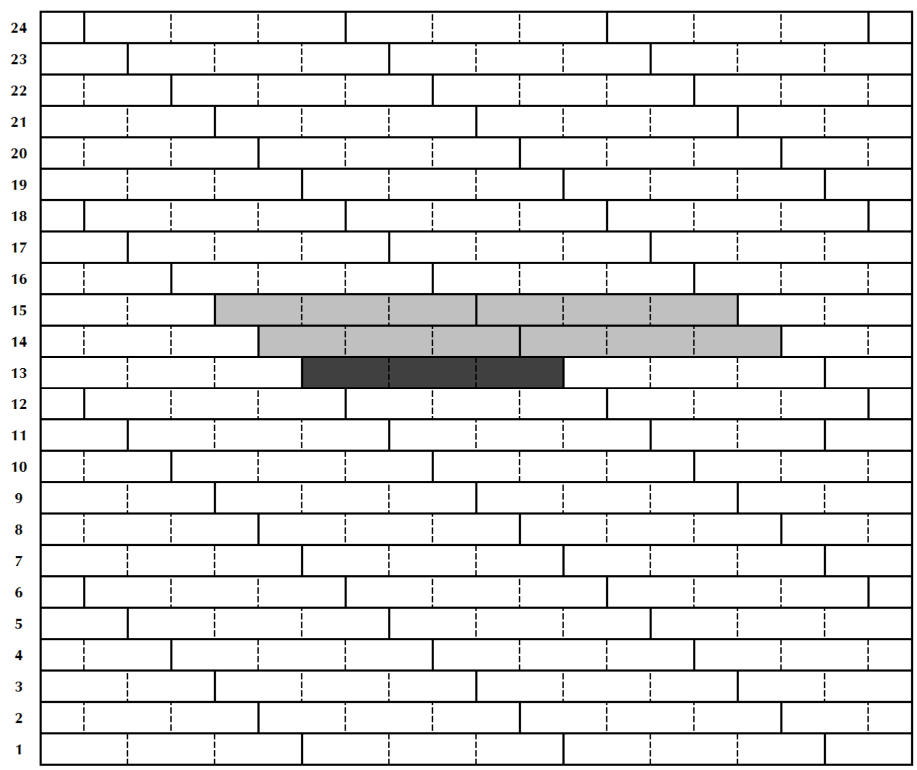

Figure 5. 10' by 10' sample area.

In **Figure 6** below, the eight hail-damaged shingles represent approximately 10% of the total number of shingles within the sample area, yet the total number of shingles which must be manipulated (including the hail damaged shingles) is 31, or approximately 39% of the total number of shingles in the sample area.

Depending on the location and density of damaged shingles relative to one another, some overlapping of the repair process generally occurs. The replacement of adjacent, undamaged shingles which overlap the repair process is frequently more cost effective as the savings on labor more than accounts for the limited additional material cost. As illustrated in **Figure 6**, since the damaged shingle on course 15 overlaps the repair process for the damaged shingle on course 13, there is little incentive to attempt to salvage the undamaged shingle in between the two as replacement is more efficient. Similar overlapping occurs between course 21 and course 23, which would most likely lead to the roofer replacing the adjacent undamaged course 22 shingles.

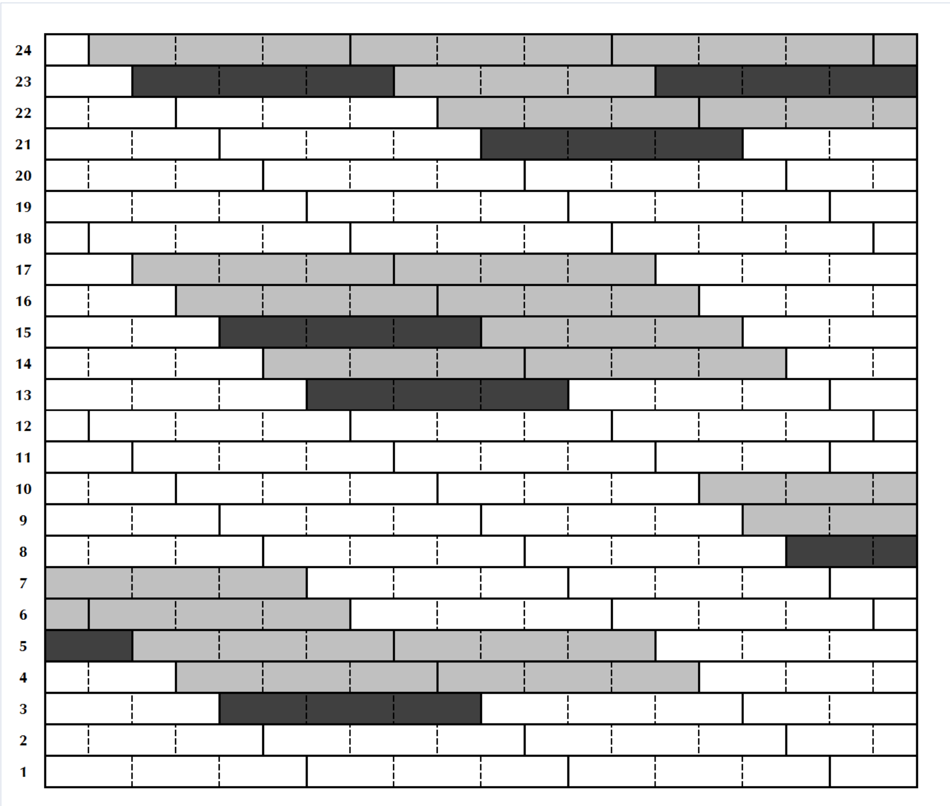

Figure 6. 10' by 10' sample area.

PRICING RESEARCH

Cost data was assembled using Xactimate® estimating software (version 27.3) and XactAnalysis® Industry Trend Reports by Xactware Solutions, Inc. (Xactware) with published national, state, and local pricing for roofing labor, materials, and equipment as of April 2012. Xactimate® is one of the most commonly used property claims estimating software suites and pricing data service in the property insurance and restoration industry.

Model Roof Baseline. For estimating purposes, a model roof baseline for replacement was selected using the XactAnalysis® *Roof 25 yr Shingle - Labor & Materials* industry trend report. This model roof baseline is based on a 46.33 SQ (4,633 square feet) typical residential 25-year 3-tab shingle roof replacement, including appurtenances such as drip edge, valley metal, ridge, and flashing. (Xactware Solutions, Inc. 2012).

Based on published pricing data, the national average cost for total replacement of the model roof baseline was $13,600 with a cost ratio of approximately 60% labor and 40% materials ($8,193 in labor and $5,407 in materials). By comparison, the national average cost for individual shingle replacement was estimated to be $13.72 per shingle with a cost ratio of approximately 89% labor and 11% materials ($12.19 in labor and $1.53 in materials).

ESTIMATION METHODOLOGY

Estimating parameters and assumptions used for the purposes of estimating the costs to repair individual shingles versus costs to replace the model roof baseline are as follows:

General Conditions. Site conditions affecting the repair were assumed to be minimal, that is, the roof was assumed to be of standard slope (4/12), one story, and accessible with no unusual site conditions which would significantly alter a contractor's proposed costs.

Shingle Exposure. The number of shingles within 1 square (100 square feet) of roofing was assumed to be 80.

Repair Process. For the purposes of this paper, the authors' assumed that, on average, three shingles require manipulation. Repairs to ridge shingles were calculated based on the lineal footage of ridge per square in the model roof baseline.

Shingle Breakage. Replacement of individual shingles may cause damage to adjacent, undamaged shingles during the course of repair dependent upon factors such as the age and condition of the existing shingles, weather conditions during the repairs, and training and experience of the roofer. For the purposes of this paper, the authors' assumed a breakage factor of 10%.

Other Factors. This paper does not consider replacement of shingles for color-matching or other aesthetic purposes. Replacement shingles are assumed to be commercially available at market prices. The remaining service life of the undamaged shingles was also not included in the calculations.

Other Costs: Sales tax has not been added to the estimated costs in this paper. Other expenses such as permits or fees have also been excluded.

REPAIR/REPLACE ANALYSIS

Based on the industry standard repair methods, pricing research, other parameters, and assumptions previously detailed, **Table 1** below lists the estimated costs to individually repair shingles by assessed percentage of hail damage compared to the total replacement costs for the model roof baseline. Unit costs are based on the previously discussed national averages of labor and materials.

Table 1. Per Shingle Repairs v. Total Roof Replacement

Percent of Hail-Damage	Total Number of Shingles Replaced (Hail + Breakage)	Total Number of Shingles Replaced or Manipulated	Number of Shingles Replaced or Manipulated (as % of the Total Roof Shingles)	Estimated Cost for Shingle Repairs	Estimated Cost for Shingle Repairs (as % of Total Roof Replacement Cost)
1%	46	151	4.3%	$657.20	4.8%
2%	91	301	8.6%	$1,308.91	9.6%
3%	137	452	12.9%	$1,960.62	14.4%
4%	182	602	17.2%	$2,612.33	19.2%
5%	228	753	21.5%	$3,269.53	24.0%
6%	273	903	25.9%	$3,921.24	28.8%
7%	319	1054	30.2%	$4,572.95	33.6%
8%	363	1200	34.3%	$5,206.82	38.3%
9%	408	1350	38.7%	$5,858.53	43.1%
10%	454	1501	43.0%	$6,515.73	47.9%
11%	499	1651	47.3%	$7,167.44	52.7%
12%	545	1802	51.6%	$7,819.15	57.5%
13%	590	1952	55.9%	$8,470.86	62.3%
14%	636	2103	60.2%	$9,128.06	67.1%
15%	681	2253	64.5%	$9,779.77	71.9%
16%	727	2404	68.8%	$10,431.48	76.7%
17%	772	2554	73.1%	$11,083.19	81.5%
18%	818	2705	77.4%	$11,734.90	86.3%
19%	863	2855	81.7%	$12,392.10	91.1%
20%	909	3006	86.0%	$13,043.81	95.9%
21%	954	3156	90.4%	$13,695.52	100.7%

REPAIR/ REPLACE DETERMINATION

The percentage threshold of hail damage for repair/replace determination is based on multiple factors, such as reasonable economic feasibility. For example, at 21% hail damage in **Table 1** above, the cost for individual shingle repair is approximately equal to the replacement cost for the entire roof, drip edge, valley metal, ridge, and flashing. Recommending individual shingle repair to this extent is obviously not reasonable or practical.

Below 10% hail damage, complete replacement solely because of hail damage is generally not required as individual shingle repairs are economically practical. Unusual factors or general conditions unrelated to the hail damage may apply that would make individual shingle repairs impractical in rare cases.

At 10% hail damage, the number of shingles requiring replacement/manipulation exceeds 40% of the total roof shingles. At 12% hail damage, greater than 50% of the total roof shingles require replacement/manipulation. In the authors' opinion, complete replacement should be considered within this range as substantial efforts in terms of shingle manipulation and cost are required. Individual shingle repairs may preferable in certain cases, and complete roof replacement preferable in others.

Above 12% hail damage, complete replacement solely because of hail damage is generally always required as individual shingle repairs are not economically practical. Unusual factors or general conditions unrelated to the hail damage may apply that would make individual shingle repairs practical in rare cases.

It is the authors' recommendation that the final determination of individual shingle repair versus roof replacement due to hail impact damage take into consideration additional factors such as the age and general condition of the shingles, number of affected slopes, and the willingness of roofing contractors to accept a repair project without exposure to disproportionate risk based on the extent of repairs.

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