



## HAIL DAMAGE ON COATED SHEET STEEL ROOFING

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### HAIL DAMAGE

Each year, hail causes about 1.6 billion dollars worth of damage to residential roofs in the United States <sup>1</sup>. Hailstorms are most concentrated in the southern and central plains states but have been observed almost everywhere that thunderstorms take place. Hailstorms can potentially cause damage to any exposed objects, especially when hailstone diameters exceed one inch. The level of hail damage depends on the size, density, falling velocity and distribution of the hailstones, as well as the climate and the building structure. Roofs are very susceptible to damage. Hailstones can cause more damage to low slope roofs than to high slope roofs, because the most damage occurs at a 90-degree angle impact. Therefore, a steep slope (6:12 and greater) will improve the impact resistance of a roof <sup>1</sup>. In general, hailstone damage can be categorized into two types: aesthetic damage and functional damage. Aesthetic damage is simply damage that has an adverse effect on appearance, but does not affect the performance of the roof. Functional damage results in diminished water-shedding ability and a reduction in the expected service life of the roof.

### IMPACT RESISTANCE OF ROOFING MATERIAL

The most effective way to reduce hail damage is to use impact resistant materials for roofing applications. Underwriters Laboratory has developed a test, UL 2218, to evaluate the impact resistance of roofing material. This test evaluates materials by dropping a steel ball onto the roofing panel twice at the same location. The material must show no evidence of fracture, cracking, splitting or any other failure, which would result in an opening of the roofing material. The sizes of the steel balls are from 1.25 inches to 2.00 inches. Four impact levels are defined in Table I. Class 4 is the most impact resistant. Class 1 is the least impact resistant. The Institute for Business & Home Safety (IBHS) has recommended UL2218 Class 3 or 4 products in hail-prone regions <sup>2</sup>.

**Table I. UL 2218 Class Rating Description <sup>3</sup>**

Rating	Diameter of Steel Ball (in)	Drop Distance (ft)	Specification
Class 1	1.25	12	No crack
Class 2	1.50	15	No crack
Class 3	1.75	17	No crack
Class 4	2.00	20	No crack

There are many different types of materials available for roofing applications, and metal is one of them. While metal roofing is primarily used for commercial applications, it has become an attractive alternative for residential roofing because its relatively lightweight, meets UL2218 Class 3 or 4 specifications, and may have a Class A or B fire resistant rating. Metal roofs have good impact resistance and are very likely to survive hailstones without functional damage, but can be vulnerable to aesthetic damage since hail can cause permanent indentations in the roofing panels.

<sup>1</sup> Federal Alliance for Safe Home, "Blueprint for Safety: Hail", [www.blueprintforsafety.org](http://www.blueprintforsafety.org)

<sup>2</sup> Institute for Business & Home Safety, [www.ibhs.org](http://www.ibhs.org)

<sup>3</sup> Underwriters Laboratory, UL 2218, "Impact Resistance of Prepared Roof Covering Materials", 2002.

## DENT RESISTANCE OF HOT-DIP GALVANIZED AND GALVALUME® COATED SHEET STEEL

There are many different types of metal roofing materials. Although they might have the same UL2218 rating, the dent resistance could be different. Most common metal roof materials are hot-dip galvanized (HDG) or GALVALUME®<sup>4</sup> Coated Sheet Steel, which are either zinc or aluminum-zinc alloy coated steel respectively. The dent resistance of the coated sheet steel is proportional to the square of the yield strength multiplied by the fourth power of the sheet thickness of the steel substrate, and is independent to the metallic coating:

$$\text{Dent resistance} \propto (\text{Yield Strength})^2 \times (\text{Sheet Thickness})^4$$

Figure 1 shows the approximate relative dent resistance of various sheet products. For this plot, the relative dent resistance of a given coated sheet steel was calculated by varying the yield strength and sheet thickness in comparison to the dent resistance of a steel sheet with 33ksi (ksi=1000psi) yield strength and 0.014 inch of thickness. Increasing the sheet thickness has a significant effect on increasing dent resistance at higher yield strengths.

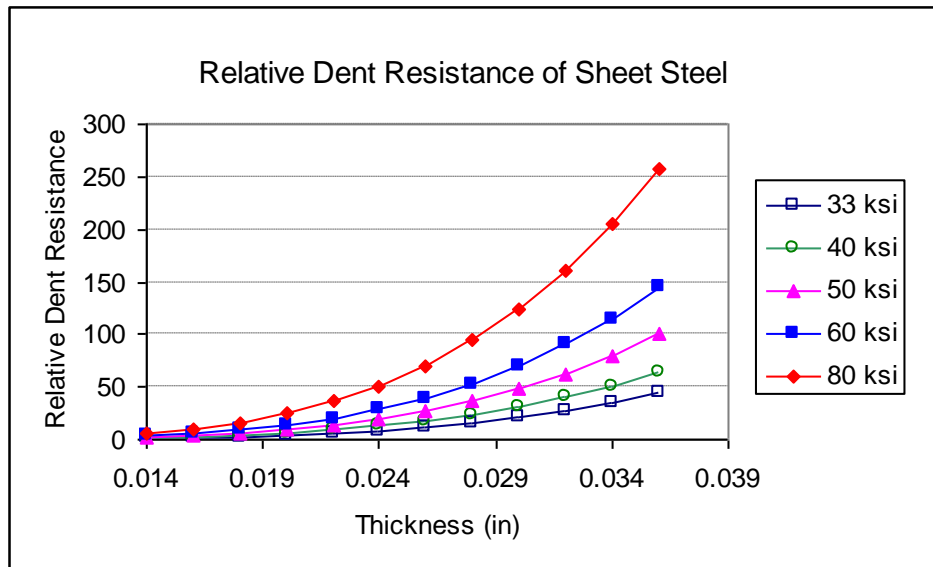


Figure 1. Relative dent resistance of sheet steel.

GALVALUME® Coated Sheet Steel is offered in a number of strength levels or grades. Common ASTM designations for the construction industry are Commercial Steel (CS) Types A and B, Forming Steel (FS), and Structural Steel Grades 33, 37, 40, 50 and 80. GALVALUME® Sheet Steel may be temper passed and/or tension leveled to improve sheet shape and surface finish. Grade 80 product, full hard steel, has the highest yield strength among the various sheet products for metal roofing applications. Figure 2 plots the effect of strength level on dent resistance at four common thickness of coated sheet steel, 0.0142", 0.018", 0.023", 0.029", which shows that one of the most effective ways to further increase the dent resistance of the Grade 80 product is to increase its thickness.

<sup>4</sup> GALVALUME® is an internationally registered trademark of BIEC International, Inc. and some of its licensed producers.

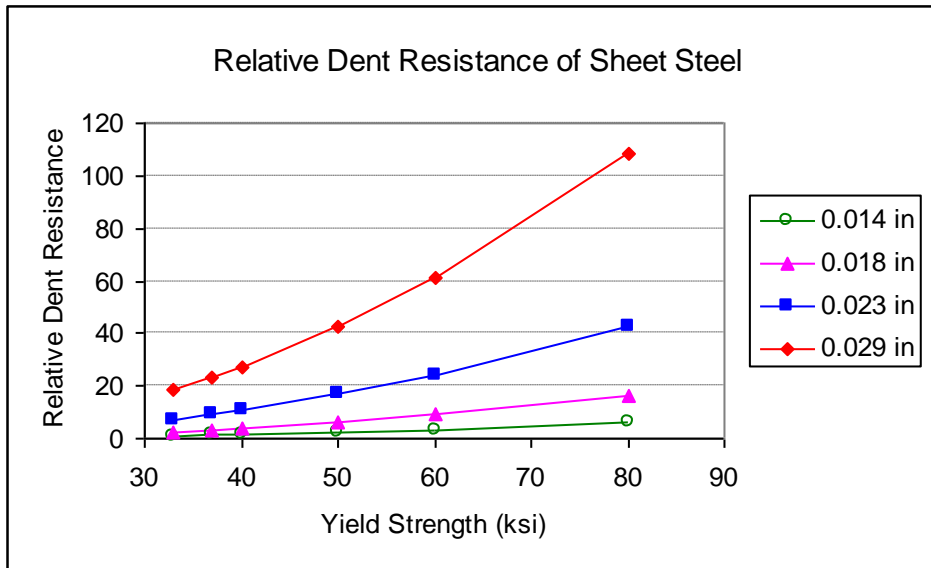


Figure 2. Relative dent resistance of sheet steel.

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