

Multifaceted Hail Research Initiative by IBHS

By Tanya M. Brown, PhD
and Ian M. Giammanco, PhD

The Insurance Institute for Business & Home Safety (IBHS), headquartered in Tampa, Florida, is an independent, nonprofit, scientific research and communications organization supported by the property/casualty insurance industry. In October 2010, IBHS opened the doors to its state-of-the-art, multiperil Research Center in Richburg, South Carolina. At the heart of the facility is a test chamber large enough to subject full-scale one- or two-story residential and commercial buildings to wind speeds exceeding 110 mph; wind-driven water simulating rainfall rates of up to 8 inches per hour; wildfire embers; and, most recently, impact of hailstones up to 2 inches in diameter. Additionally, the Research Center has a small laboratory space where individual components can be tested.

Although not generally thought of as a life-safety issue, hailstorms cause about \$850 million in property damage annually.¹ IBHS is undertaking a major multifaceted research effort to study hailstorms with the goal of reducing associated property losses. Researchers are evaluating current impact testing standards for roofing products, will be developing improvements to the test standards if warranted, and will be expanding testing to include other kinds of building materials. In addition, the research program seeks to understand modes and severity of

damage caused by impacts of hailstones with varying size, density, and hardness; to evaluate how aging and maintenance affect potential damage from hailstorms; and to develop and test repair and replacement methodologies.

There are four concurrent research programs at the IBHS Research Center:

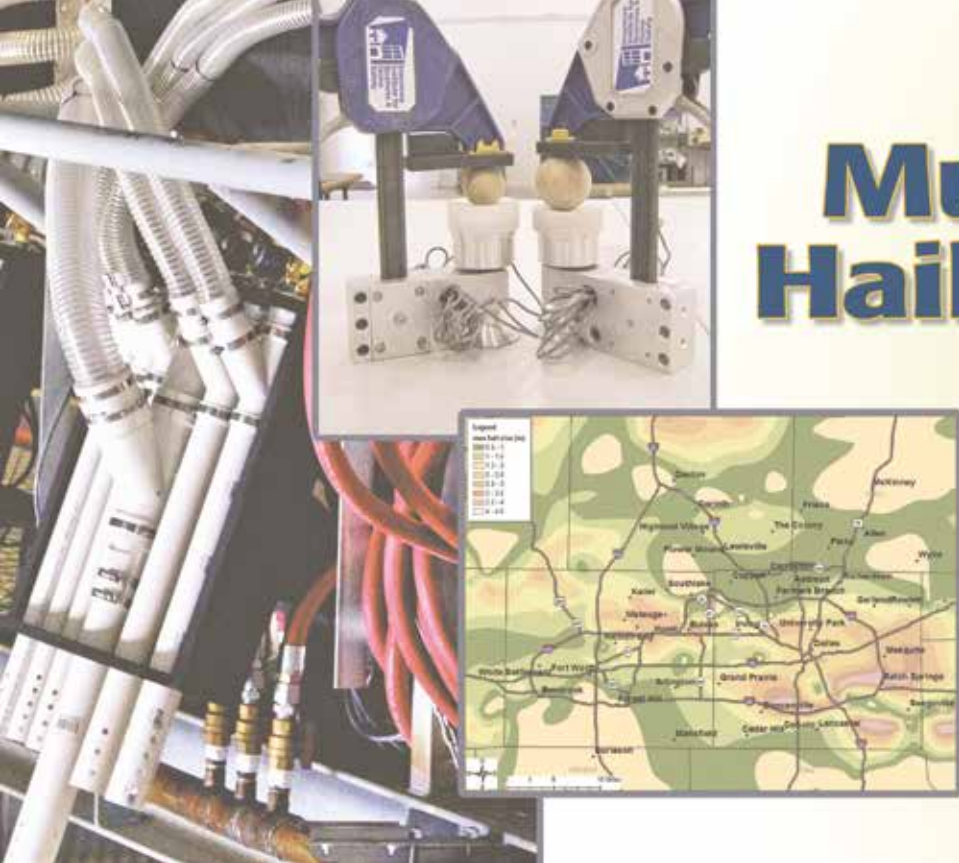
1. A closed insurance claims analysis of a 2011 Dallas-Fort Worth, Texas, hailstorm
2. The first full-scale hail demonstration, scheduled for February 2013, that includes potential opportunities for investigating repair and replacement methods
3. Hailstone characterization and fabrication in a laboratory setting utilizing field data for target densities and hardnesses
4. Small-panel impact testing of different configurations/products/ages

CLOSED INSURANCE CLAIMS ANALYSIS

IBHS is interested in identifying how buildings perform in the real world when subjected to severe hail. This information is vital to ensuring that IBHS research projects are tackling the true problems associated with hail damage, and serves as a baseline to ascertain that damage produced in the small-impact laboratory and full-scale test chamber is consistent with real-world conditions.

In 2011, IBHS engineers participated with the Roofing Industry Committee on Weather Issues (RICOWI) in a hail damage survey in the wake of severe thunderstorm activity on May 24 in the Dallas-Fort Worth area. The survey was intended to evaluate the performance of roofing materials and systems, particularly those that were impact-rated.² In addition, IBHS worked with its members to obtain closed property insurance claims and policy-in-force data for properties located in selected areas of Dallas-Fort Worth to study the importance of several factors, including roofing material type and age with regard to resiliency to hailstone impacts. The study also focuses on evaluating relative damage costs associated with roofing systems vs. wall systems, doors, and windows, and on providing a comparison of radar-estimated hail sizes to damage levels seen in the field as well as in claims data.

IBHS staff is analyzing claims and policy-in-force data, including more than 67,000 policies-in-force, of which more than 6,000 had a claim associated with the storm. From these data, IBHS will be able to produce analyses illustrating the frequency and severity of claims as related to different roof materials and ages and will also be able to compare frequency and severity of roof claims as opposed to other components. The spatial data contained in the claims and policy-in-force dataset will also allow IBHS



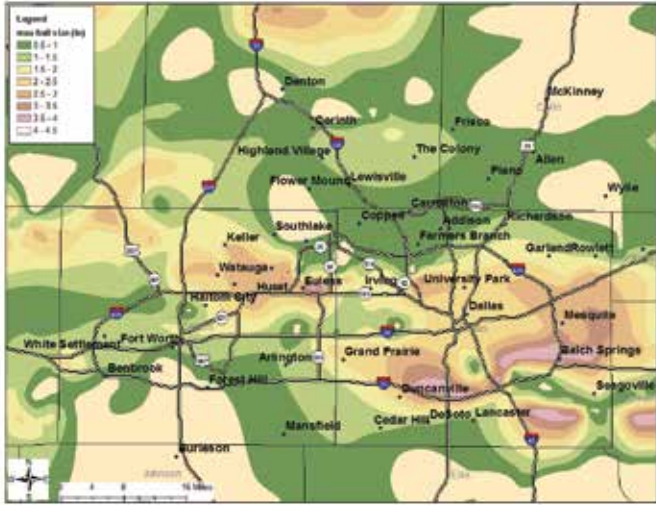


Figure 1 - The radar-interpolated hail swath from the May 24, 2011, hailstorm that affected Dallas-Fort Worth.



Figure 2 - One of 12 IBHS hail "pods" installed on the upper catwalk of the Research Center test chamber to create a full-scale, realistic indoor hailstorm.

researchers to evaluate the claims frequency and severity by creating maps to depict their relation to the radar-estimated hail swath shown in *Figure 1*,³ Local Storm Reports collected by the Storm Prediction Center, and field conditions surveyed with RICOWI.

FEBRUARY 2013 FULL-SCALE DEMONSTRATION

Since its opening, the IBHS Research Center staff has been conceptualizing, designing, prototyping, testing, manufacturing, and installing the components necessary to create a realistic, full-scale hailstorm demonstration. These efforts will be showcased in February 2013 during a media demonstration of the system, which will feature more than 8,000 hailstones measuring 1 in., 1.5 in., and 2 in. that will be fired from 72 different hail cannons. The cannons are grouped into stations called "pods" that consist of three 1-in. barrels, two 1.5-in. barrels, and one 2-in. barrel, as shown in *Figure 2*. The pods are computer-controlled to shoot at any desired interval and are designed to shoot at the correct terminal velocity for each hailstone size. Because of difficulties associated with melting ice, which can refreeze together, each pod is manned by a member of the IBHS staff, who fills the "hopper" tubes for each cannon as the automated control software fires them.

The 2013 demonstration is a comparative, qualitative test. The test structure is a residential building that features three different roofing products and a variety of soft metal products such as gutters, down-

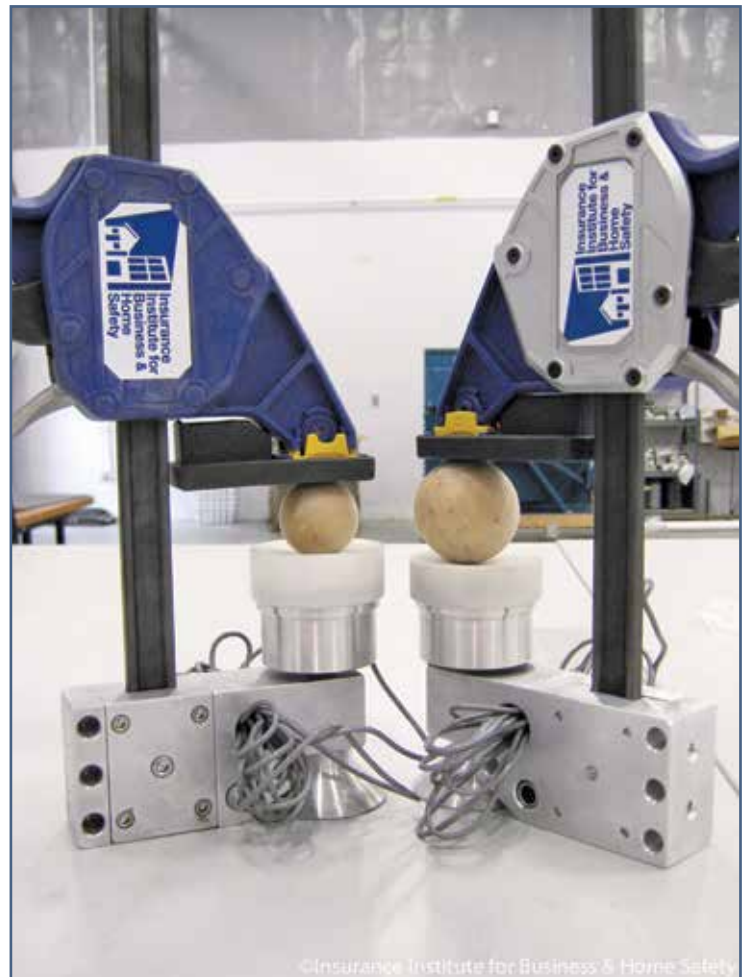


Figure 3 - This new, IBHS-designed instrument is a rugged and portable instrument used to crush individual hailstones to determine their compressive force at fracture. This provides a way to evaluate how "hard" the hailstones are.

sputs, and aluminum-framed windows. The roofing products are 3-tab asphalt shingles, impact-rated Class 4 architectural asphalt shingles, and standing-seam metal panels.

Eventually, IBHS will be able to use the hail pod system to subject a structure to a simulated hailstorm in the test chamber, along with the wind and wind-driven rain systems already in place, to evaluate whether hailstone impacts are cosmetic or functional by determining susceptibility to water entry. Another advantage of testing a full-scale structure is the ability for engineers to develop and test repair methodologies, allow the repairs to age, and then determine the susceptibility to water entry after some time has passed.

LABORATORY HAILSTONES

IBHS is dedicated to realistic and scientifically valid testing at its Research Center. A tremendous amount of time has been devoted to creating realistic hailstones for use in impact testing. The current test standards for impact rating of roof materials utilize either steel balls⁴ or freezer ice balls of pure water.⁵ While these methods are useful for evaluating the comparative performance of products, they do not accurately replicate the kinds of conditions—and, therefore, damage—that building materials experience in the field. IBHS researchers are attempting to improve the realism of laboratory hailstones by mimicking the density, shape, size, and hardness properties of real hailstones.

To understand these characteristics, IBHS staff conducted a pilot field study in May-June 2012 to measure freshly fallen hailstones. A digital scale was used to measure the mass; calipers were used to measure the dimensions; and a newly developed compressive force instrument (shown in Figure 3) measured the compressive force required to fracture a hailstone, which serves as a way to evaluate the effective hardness of the stone. This property is important because researchers expect harder hailstones to cause more damage upon impact than softer stones. During the project, IBHS staff measured more than 230 hailstones from nine severe thunderstorms in five states. The hailstones ranged from 0.16 in. to 3.05 in., as shown in Figure 4. Damage to building components generally begins with hailstone sizes of 1-in. diameter.

Although the dataset collected during the 2012 field study is small, it represents an important step in moving forward with laboratory hailstone production and, ultimately, impact testing. Back in the laboratory, IBHS researchers are using the field data, along with historical data from previous field projects, to develop new ways of

Figure 4 – The largest hailstone collected by IBHS researchers during the 2012 field project was over 3 inches in diameter and fell in Kingfisher, Oklahoma.

An advertisement for TRUFAST roofing solutions. The background is a collage of images including a blue vent cap, a metal roof fastener, a digital scale, and two construction workers wearing hard hats. The text "TRUSTED CONNECTIONS" is written in a stylized font, and "AMERICAN MADE" is written with a small American flag. The TRUFAST logo is prominently displayed in the bottom left. The overall theme is professional roofing solutions.

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making more realistic hailstones for impact testing. Experiments conducted thus far have included using spherical molds to make artificial stones with liquid tap, distilled, and seltzer water. Different molds have been used to make artificial stones by compacting crushed ice into spheres. Future experiments could include varying the freezing duration and temperature, and creating stones by layering different consistencies of ice. After developing more realistic ice stones, researchers will be able to eventually evaluate the standard test methods to determine if they are representative or if modifications are required to account for the more realistic laboratory hailstones. This evaluation of the test standards is extremely important in understanding the true damageability of products.

SMALL-PANEL IMPACT TESTING


IBHS has identified several factors that may influence the damageability of a particular roofing system and will be approaching testing of these variables in a systematic way. The testing program will address and compare:

- Material types (asphalt shingles, clay and concrete tiles, metals)
- Impact-rated vs. nonimpact-rated materials
- Aging effects
- Roof pitch
- Testing methods (UL 2218,⁶ FM 4473,⁷ modified methods)
- Structural vs. aesthetic damage

Although the scope of work is still being designed, initially there will be two parallel programs: one that allows for some comparative testing of new roofing materials using existing test methods, and an aging program in which the other variables (material, product rating, pitch) are held constant and the length of aging is varied. As budgets allow, additional aging specimens will be constructed to add in new materials, product ratings, and roof pitches, so that the combination of variables can be studied systematically.

Currently, impact-testing standards only exist for roof coverings. In the coming years, IBHS will be examining ways to conduct impact testing of other materials that are commonly damaged by hailstorms, including siding, soft metal products, doors, windows, and vents. The testing of other components is important in evaluating the full risk posed by hailstorms.

SUMMARY

IBHS is on a path toward understanding more about hailstorms and how they cause damage to the built environment. Researchers are taking a holistic approach to the problem by investigating field performance of building components impacted by hail, evaluating claims data following a hailstorm, simulating full-scale hailstorms to examine cosmetic and functional damage, testing repair methodologies and buildings as a system, and conducting small-panel testing to systematically examine the influence of variables such as material, age, and roof pitch. In addition, they are leveraging field data from real hailstones to try to better simulate them in the laboratory and improve current impact testing standards. This complex but necessary approach will enable researchers to fully understand the problem and to develop methods to mitigate damage to properties against the high costs associated with hailstorms. 

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7. FM Approvals.

Tanya M. Brown, PhD



Dr. Tanya Brown joined IBHS in August 2010 as a research engineer. Her research focus is on hailstone formation, impact testing, wind-flow characterization and testing, instrumentation, and field and damage assessment studies. Dr. Brown previously conducted research on the Witch Creek wildfire and development of the hail research agenda for the Research Center. She has also worked as an engineering consultant for LNSS & Associates. Dr. Brown was a National Science Foundation – Integrative Graduate Education Training Fellow while completing her PhD in wind science and engineering at Texas Tech. Dr. Brown also holds an MS degree in water resources science and a BS degree in atmospheric science from the University of Kansas. She is currently a faculty associate at Texas Tech and continues serving with the Texas Tech University Hurricane Research Team.

Ian M. Giammanco, PhD



Dr. Ian Giammanco joined IBHS in 2012 as a research scientist after consulting for IBHS on the design and construction of the ember generation capabilities, the radiant panel, the IBHS weather observing station, and hail delivery capabilities of the Research Center. He served as the field coordinator for the Texas Tech Hurricane Research Team and participated in numerous research projects, including VORTEX 2. Dr. Giammanco received a BS in atmospheric science from the University of Louisiana at Monroe. He also holds an MS in atmospheric science, as well as a PhD in wind science and engineering from Texas Tech, where he was appointed as a National Science Foundation – Integrative Graduate Education Training Fellow and served as an intern at NOAA’s Hurricane Research Division in Miami. He is currently a faculty associate at Texas Tech, where he continues to support its Hurricanes-at-Landfall Project.