Narrowing the Swath – Reducing Hail Losses

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Tanya Brown, Ph.D., joined the Insurance Institute for Business & Home Safety in August 2010. She is a lead research engineer and director of hail research at the IBHS’s Research Center. Her responsibilities include providing engineering leadership on hail-, wind-, water-, and roofing-related research projects. Her research focus is on hailstone formation, hail-impact testing, wind-flow characterization and testing, instrumentation, and field measurement and damage-assessment studies.

Tanya serves as the IBHS representative on the Roofing Industry Committee on Weather Issues board of directors. Prior to joining IBHS full time, Tanya served the institute as well as LNSS & Associates as an engineering consultant.

Tanya was a National Science Foundation – Integrative Graduate Education training fellow while completing her doctorate in wind science and engineering at Texas Tech University. Her dissertation topic was “Development of a Statistical Relationship between Ground-Based and Remotely-Sensed Damage in Windstorms.”

While at Texas Tech, she was an instrumental member of its field research teams, leading a team in thunderstorm and tornado intercepts during VORTEX 2, participating in hurricane intercepts with the Texas Tech University hurricane research team, and conducting numerous post-disaster damage assessments.

Tanya holds a master’s degree in water resources science and a bachelor’s degree in atmospheric science from the University of Kansas. She served as a teaching assistant and academic advisor while at KU. She is currently appointed as a faculty associate at Texas Tech University to continue serving the Texas Tech University hurricane research team.

Session Description:
Hailstorms consistently cause some of the highest losses for property insurers and reinsurers, as they often exceed $1 billion annually. But we’re learning more about how to reduce those losses. In 2010, the Insurance Institute for Business & Home Safety opened its full-scale, multi-peril Research Center, which includes hail research capabilities. IBHS engineers and scientists use a combination of field research, claims studies, and small- and full-scale experiments to lead the way toward reducing the hail losses. Results from these studies will be shared, and videos from the first-ever realistic hailstorm demonstration will be shown.
Top Three Session Ideas
Tools or tips you learned from this session and can apply back at the office.

1. ____________________________________________

2. ____________________________________________

3. ____________________________________________
Narrowing the Swath – Reducing Hail Losses

NAMIC Annual Convention
September 23, 2014

Tanya M. Brown, PhD
South Carolina Wind and Hail Underwriting Association Junior Chair
Lead Research Engineer & Director of Hail Research

“Where building safety research leads to real-world solutions.”
Accomplishing the Mission

- Conduct building science research
- Identify mitigation solutions for all aspects of the building process
- Improve public policy
- Identify and promote voluntary standards and guidance
- Communicate research findings

Insurance Operational Implications

- Lower loss exceedance curve
- Better understand building vulnerability and how to reduce it (underwriting)
- More accurately assess interaction between weather and the built environment (pricing)
- Improve catastrophe models
- Provide new tools for claims adjustment
- Focus on priorities (“getting the roof right”)
Topics for Today

• IBHS Research Center
• Hailstorm risks—how do we study this with the goal to reduce losses?
• 2011 Dallas-Ft. Worth claims study
• Hailstone characteristics field project
• Laboratory testing
• Aging
• Focus on roofing and collaboration

IBHS Research Center
Laboratory Building for Small Tests

- 145ft. W x 145 ft. L x 70 ft. H test chamber
- 60 ft. W x 30 ft. H wind inlet
- 105 fans, each with 350 hp motors
- Enough power for 9,000 homes
- Flow volume = 20 X GREATER THAN Niagara Falls
- High-definition cameras and TV lighting

Large Test Chamber
Gain a better understanding of the:

- Risks themselves through field work/environmental analysis
- Realistic impact of storms through damage surveys and claims analysis
- Existing test methods and true applicability to actual performance
- Cosmetic vs. functional damage through full-scale testing
- Repair methodologies through full-scale testing after aging
- Effects of long-term aging on various materials
- Materials comparisons
Hailstorm Risks

- Severe hail (1 in. diameter or larger) most commonly occurs in thunderstorms
- The largest hailstones occur in supercell thunderstorms with strong updrafts (tornadoes also can be present)
- Risk extends east of Rocky Mountains
- More than 75% of U.S. cities experience at least one hailstorm a year
- On average, annual hail losses are nearly $1 billion

Hail Activity in the United States
Average Number of Hail Reports per 100 Square Miles
2009 - 2009 Reports of Hail 1" or Larger

Legend:
- 0+1
- 1+3
- 4+6
- 7+9
- 10+
IBHS RESEARCH CENTER HAIL PROJECTS

FIELD RESEARCH
Hail Events & Characteristics

ANALYSIS
Making Realistic Hailstones
Damage to Roof & Building Components Testing
Aging Studies

STANDARDS
New / Improved Hail Impact Test Methods
Improved Product Performance Standards

GOAL:
IMPROVED PERFORMANCE OF BUILDING PRODUCTS

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IBHS RESEARCH CENTER HAIL PROJECTS

INDUSTRY DATA
Closed Claim Studies

ANALYSIS
Correlate Radar & Ground Hail Observations
Correlate Testing Damage with Hail Event Characteristics
Aging Studies

PREDICTION
Improved Estimates of Hail Events

GOAL:
IMPROVED PREDICTION OF HAIL RISK & LOSSES
IBHS Hail Research
Pushing the Boundaries of Building Science

- Full-scale hailstorm simulation of three sizes of hailstones
- Small roof and component panel impact testing
- Field work to validate laboratory findings and improve hail forecasting and detection

May 24, 2011 DFW Claims Study

- Hailstorms caused more than $875 million in insured losses
- More than 67,000 policies in force
- More than 6,600 claims filed
- Claims study compared:
  - Roofing material performance
  - Aging
  - Relative difference in roofing damage vs. walls/windows/doors/trim damage
  - Radar-estimated hail severity vs. claim severity
Roof Damage 91.7%
Other Damage 6.1%
Other 2.2%
Wall Damage 0.9%
Door Damage 0.1%
Window Damage 1.3%
May 24, 2011 DFW Claims Study

**Claim Frequency: Roof Damage**

<table>
<thead>
<tr>
<th>Roof Cover Type</th>
<th>Percentage of Claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shingles/Arch Comp</td>
<td>11%</td>
</tr>
<tr>
<td>Metal</td>
<td>28%</td>
</tr>
<tr>
<td>Slate</td>
<td>7%</td>
</tr>
<tr>
<td>Tile</td>
<td>11%</td>
</tr>
<tr>
<td>Wood</td>
<td>22%</td>
</tr>
<tr>
<td>Unknown</td>
<td>1%</td>
</tr>
<tr>
<td>Total</td>
<td>10%</td>
</tr>
</tbody>
</table>

*Very small sample sizes of non-asphalt products*

May 24, 2011 DFW Claims Study

**Normalized Claim Severity: Roof Damage**

<table>
<thead>
<tr>
<th>Roof Cover Type</th>
<th>Average Claim Cost as a Percentage of Coverage Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shingles/Arch Comp</td>
<td>3.8%</td>
</tr>
<tr>
<td>Metal</td>
<td>9.2%</td>
</tr>
<tr>
<td>Slate</td>
<td>4.3%</td>
</tr>
<tr>
<td>Tile</td>
<td>2.9%</td>
</tr>
<tr>
<td>Wood</td>
<td>9.6%</td>
</tr>
<tr>
<td>Unknown</td>
<td>0.3%</td>
</tr>
<tr>
<td>Total</td>
<td>3.9%</td>
</tr>
</tbody>
</table>

*Very small sample sizes of non-asphalt products*
May 24, 2011 DFW Claims Study

Hailstone Characteristics Field Project

Collect scientific information on properties of severe hailstones:

1. Size
2. Mass
3. Hardness
Hailstone Characteristics Field Project

• Develop relationships between hailstone characteristics and environmental/radar data
• Understand spatial and temporal variability in hailfall
<table>
<thead>
<tr>
<th>Year</th>
<th>Storms</th>
<th>Days</th>
<th>Sizes</th>
<th>Compressive Stress</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>9 storms</td>
<td>7 days</td>
<td>0.16 in. - 3.05 in. sizes</td>
<td>9 psi - 620 psi compressive stress</td>
</tr>
<tr>
<td>2013</td>
<td>12 storms</td>
<td>7 days</td>
<td>0.04 in. – 4.21 in. sizes</td>
<td>1 psi – 1097 psi compressive stress</td>
</tr>
<tr>
<td>2014</td>
<td>11 storms</td>
<td>7 days</td>
<td>0.05 in. – 2.66 in. sizes</td>
<td>0 psi – 2958 psi compressive stress</td>
</tr>
</tbody>
</table>
Observed Hail Shapes 2012-2013
20 different parent thunderstorms

- 63% Conical
- 26% Sphere
- 5% Disk
- 6% Other

Hailstone Characteristics Field Project

Loss Reduction

- Predict damaging hailstorms
- Accurately delineate hail swath using improved radar data
- Reduce “neighboritis” and claims at fringe of swath
Making Realistic Hailstones

Density
- Artificial hailstones—varies from 0.45-1.1 g/cm³
- Natural hailstones—varies from 0.1-0.9 g/cm³ (historical studies)

Compressive Stress
- Artificial hailstones—varies from 3-308 psi
- Natural hailstones — 1-1097 psi (limited field dataset)

Lab-Field Comparisons

2014 NAMIC Connect Differently - Brown
Small Lab Comparative Testing

Systematic approach to compare

- Different classes of materials
  a) 3-tab vs. architectural shingles
  b) Standard vs. IR
  c) Standard vs. premium
  d) Traditional IR vs. polymer modified IR
- Standard test methods: UL 2218 / FM 4473
- Altered test methods: different density and/or hardness of stones
- Aging and climate effects

Goal = Develop statistically based damage curves for size, density, and hardness of hailstones

UL 2218 Shingle Impact Test Method

- Official method for rating shingle impact resistance
- 3 ft. x 3 ft. panels constructed with shingles installed by manufacturer’s guidelines
- Conditioned for 16 hours @ 135-140 °F
- Steel balls dropped from height necessary to achieve same kinetic energy as similarly-sized hailstone would have:
  - Class 1 ball = 1.25 in.
  - Class 2 ball = 1.50 in.
  - Class 3 ball = 1.75 in.
  - Class 4 ball = 2.00 in.
UL 2218 Shingle Impact Test Method

- Two impacts at each of six locations on 3 ft. x 3 ft. test panel
- Resulting impact marks inspected under microscope
- Any evidence of opening—tearing, cracking, fracturing, or rupturing—visible on back of shingle considered test failure
Test Observations

Common impact marks

- Crushed granules—visible on all panels, not seen in real-world
- Dents—most severe at midspan 2 x 4 brace
- Flattening of shingles—particularly at edges, joints, corners

Test Observations

Common performance criteria failures

- Cracks—through 3-tab and single-ply portion of architectural shingles; both plies of double-ply
- Tears—at edge of 3-tab and single-ply portion of architectural shingles; both plies of double-ply
- Unclear if one damage mode is more detrimental
Shingle Impact Resistance
What We Need to Know

HYPOTHETICAL LAB TEST: SHINGLE “XYZ”

At what point does the shingle lose its water shedding ability?
What does the relationship actually look like?
How do the effects of aging play a role?

Full-Scale Impact Testing

12 hail cannons on upper catwalk
- Computer-controlled firing system
- Fully-controllable shooting speeds
- Fully-controllable shooting frequencies
Full-Scale Impact Testing

- Three sizes:
  - 1 in.
  - 1.5 in.
  - 2 in.
- Adaptable for different sizes
- Structural vs. aesthetic damage
- Repair vs. replace methodologies
Full-Scale Impact Testing

Test new & aged specimens

Repair & replace methodologies

Age

Test against water intrusion

Test against water intrusion

Provide guidance on best practices

Future Research
(after automatic hailstone production)
Effects of Aging

Older Roofs = Higher Claim Frequencies + Higher Claim Severities

Impact of Aging on Insurance Industry

- Aging and Durability
  - Climate
  - Material type
  - Material color
  - In-service length
  - Directionality of sun exposure
  - Roof pitch

- Underwriting
- Duration of Incentives
- Claims Processing
- Risk Modeling
Aging Studies

• Naturally age small roof specimens for wind and hail testing for up to 20 years
• Test at five-year increments (baseline = new)
• Multiple test panels for each age, north and south facing

Aging Farm Construction

• 50 in. x 66 in. panels
  - Two north-facing
  - Two south-facing
• 36 in. x 36 in. panels
  - One north-facing
  - One south-facing
Areas of Focus

• 6/12 roof slope
• Similar colors
• In-Service Length
  – Control (baseline)
  – 5-year
  – 10-year
  – 15-year
  – 20-year

• Materials
  – 3-tab asphalt
  – Architectural asphalt
  – Traditional IR
  – Polymer Modified

Aging Farm Construction

• Both roof slopes instrumented with thermocouples
• Adjacent weather station
Aging Farm Data

Protection from the Top
Focus on the Roof

RESEARCH
CODE PROPOSALS
COMMUNICATIONS
OUTREACH & TRAINING

Roofing the Right Way

Steps to Improving Your Roof the Right Way

FORTIFIED®

INTEGRITY OF THE ROOFING SYSTEM

Roofing Industry

Questions?

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