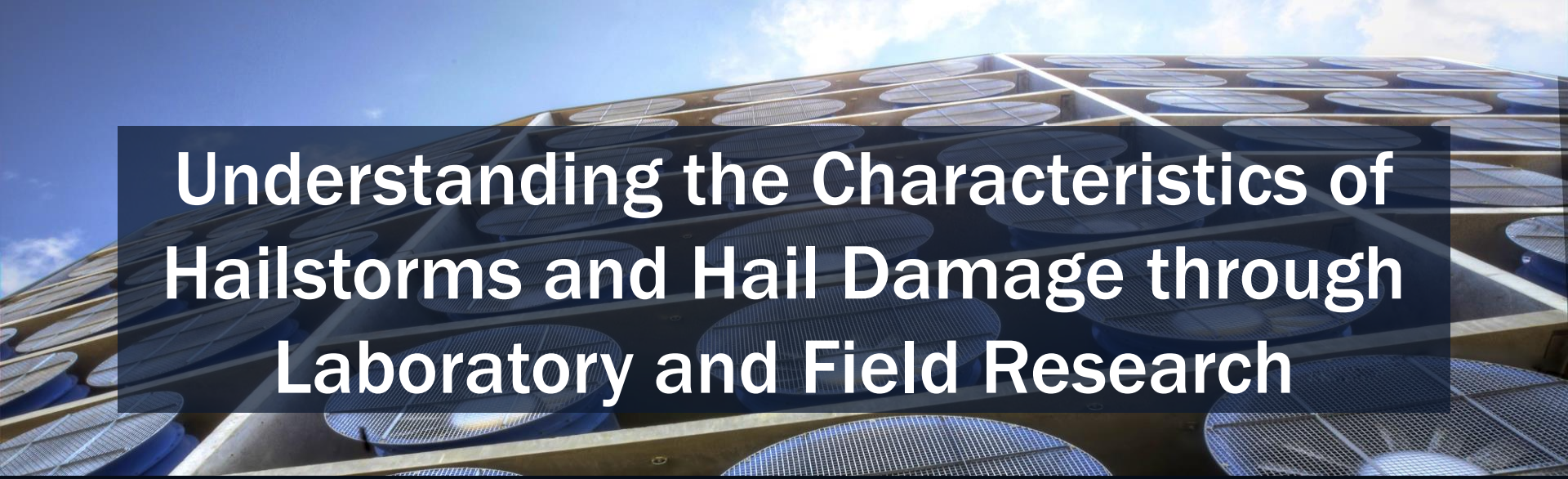

# Understanding the Characteristics of Hailstorms and Hail Damage through Laboratory and Field Research


Tanya M. Brown-Giammanco, Ph.D.
IBHS Lead Research Engineer & Director of Hail Research

Ian Giammanco, Ph.D.
IBHS Lead Research Meteorologist


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# IBHS Mission:

"To conduct objective, scientific research to identify and promote effective actions that strengthen homes, businesses, and communities against natural disasters and other causes of loss."

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# Outline

- Weather Related Risks
- IBHS Hail Field Measurement Program
- Building Vulnerabilities
- Asphalt Shingle Impact Resistance Performance
- Loss Mitigation
- Roofing Industry Best Practices
- Q&A

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# Insurance Implications

- Underwriting – better understanding of vulnerability and how to reduce it
- Pricing – more accurately assessing the interaction between weather and the built environment
- Claims – providing new tools for adjustment
- Identifying and reducing fraud

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# Loss Estimates

- 2015
  - US losses > $25 billion ($15 billion insured)
  - Winter storm losses = $2.1 billion insured
  - Severe thunderstorm losses >$9.4 billion insured
  - Drought = $1.2 billion insured

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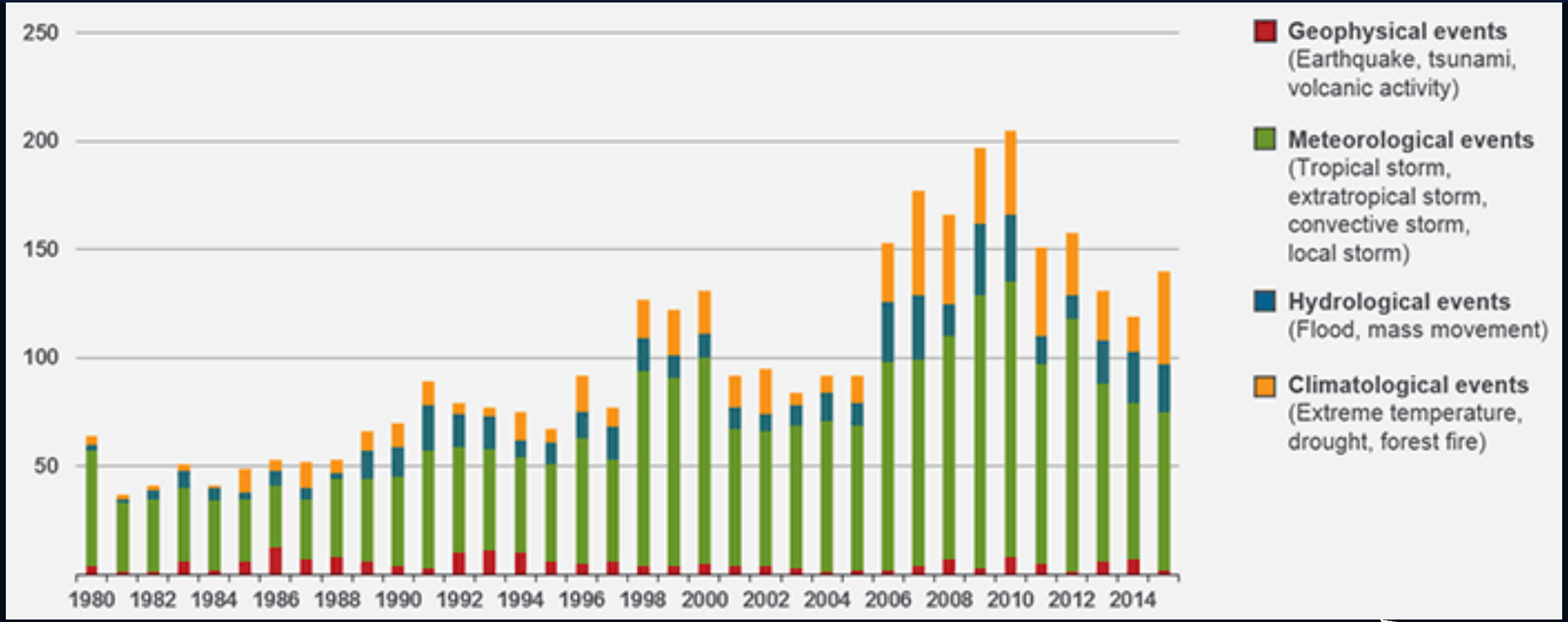
# Loss Events in the U.S. (1980-2015)




Source: © 2016 Munich Re, NatCatSERVICE. As of January 2016.

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# Average Annual US Hail Losses

- Crop-damaging hail = 158 days
- Property-damaging hail = 123 days
- Crop losses = $580 million
- Property losses = $850 million
- At least 13 days per year with crop losses > $1 million
- At least 15 days per year with property losses > $1 million

Source = “Hailstorms Across the Nation” (Changnon et al 2009)

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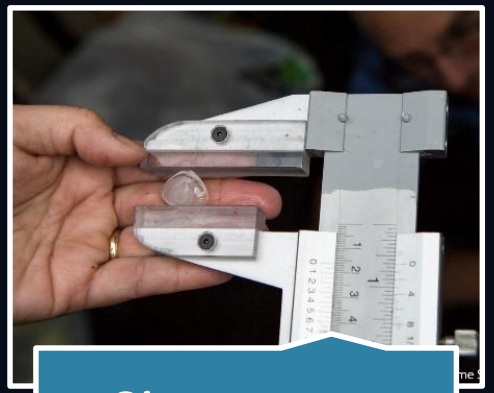
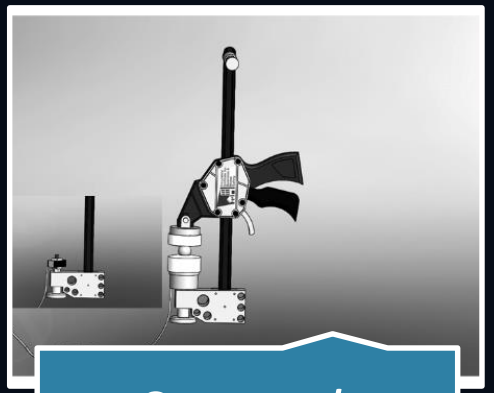
# IBHS Hail Field Measurement Program: What do we need in the lab?

*Kinetic energy*



*Size - mass*



*Strength*

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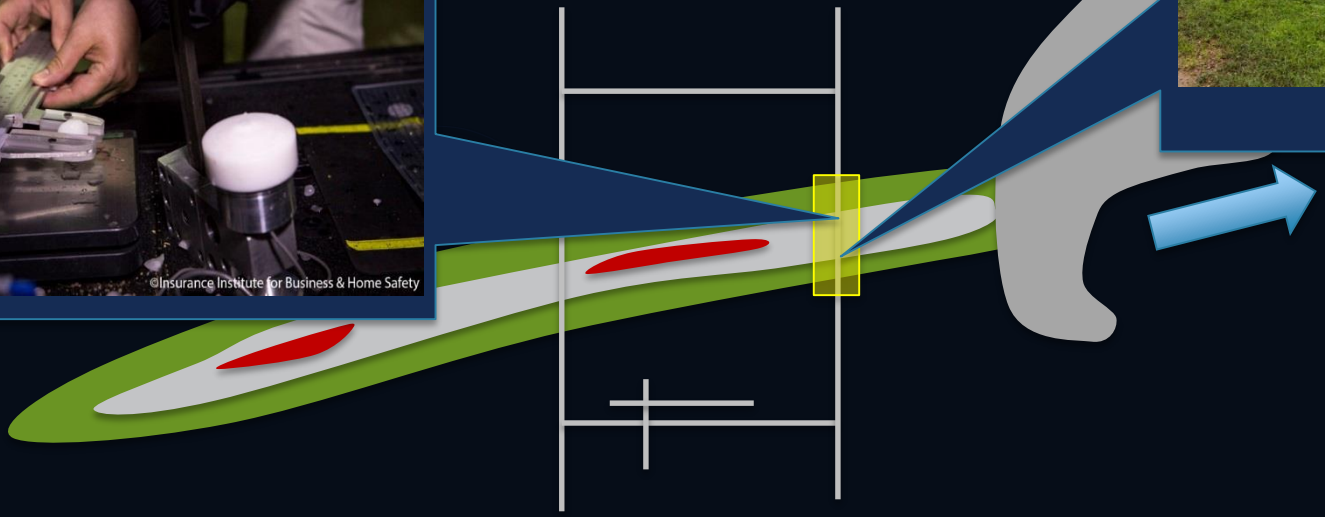
# IBHS Hail Field Measurement Program

- **Mission**: Safely collect measurements of the physical properties of hail





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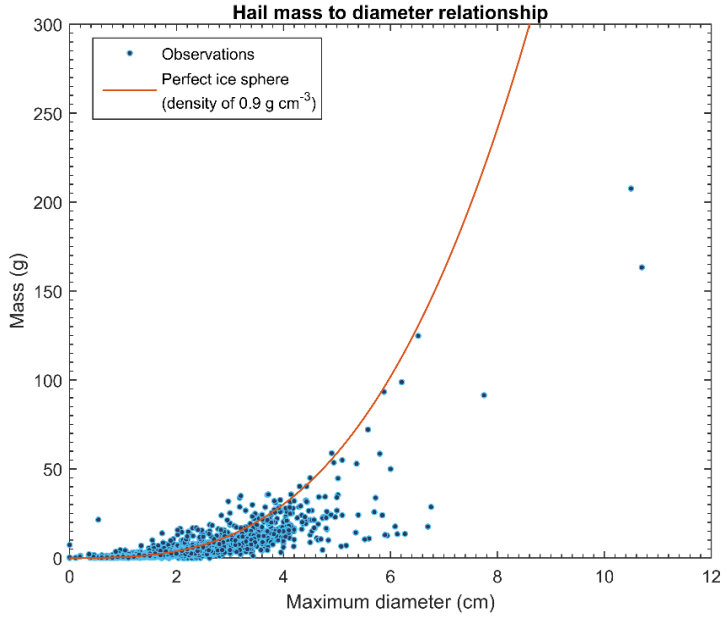
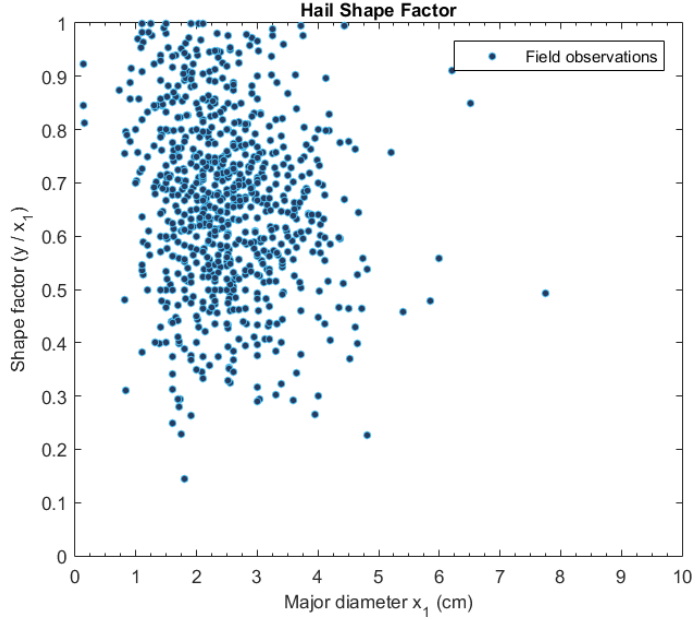
# IBHS Hail Field Measurement Program: Size – Mass Relationship

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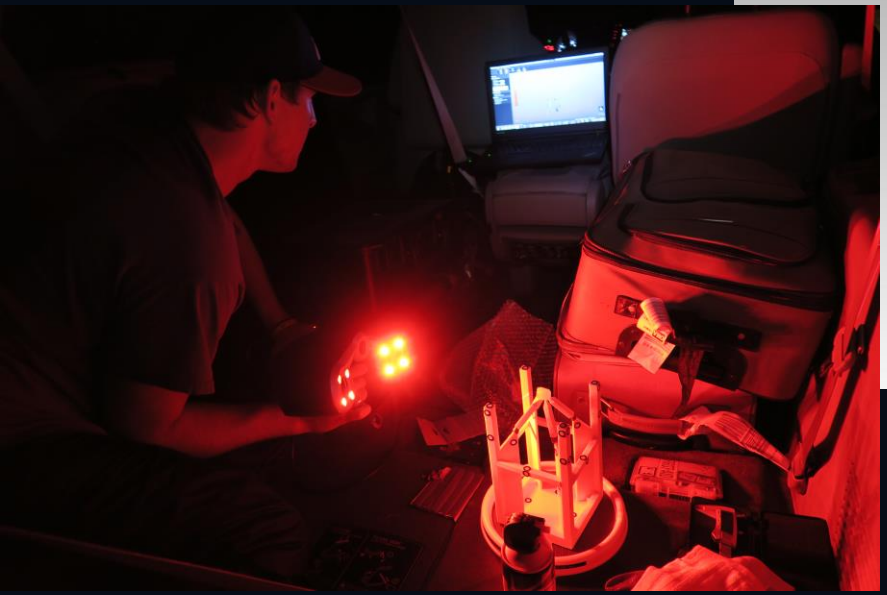
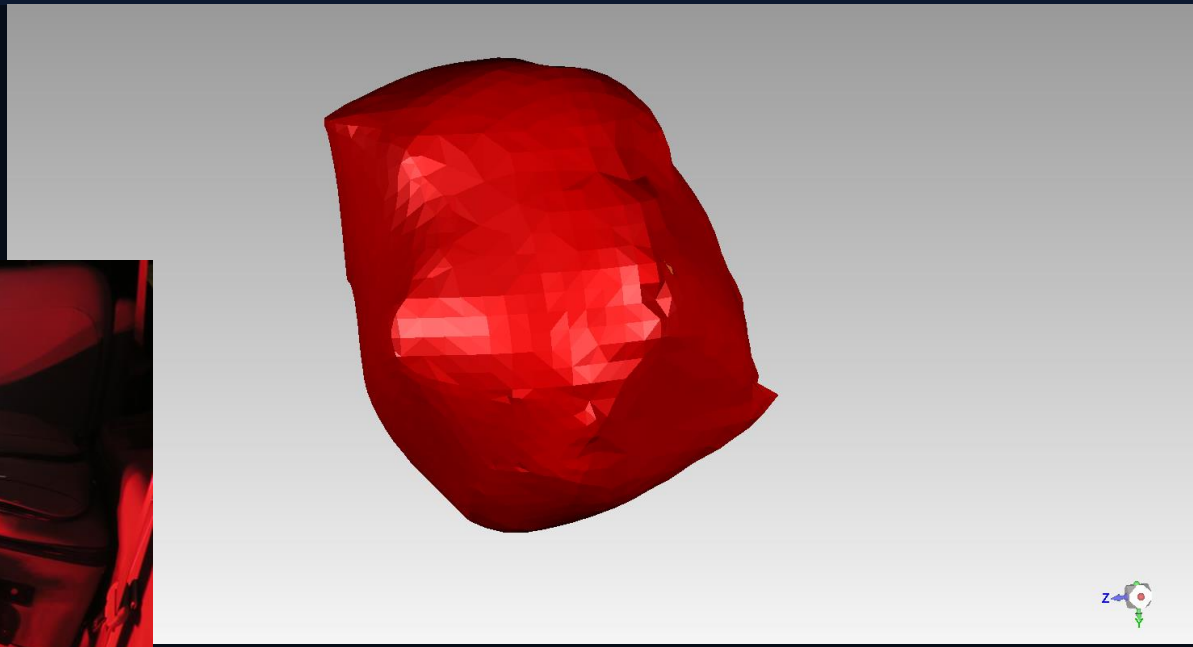
# Evaluating hailstone shape



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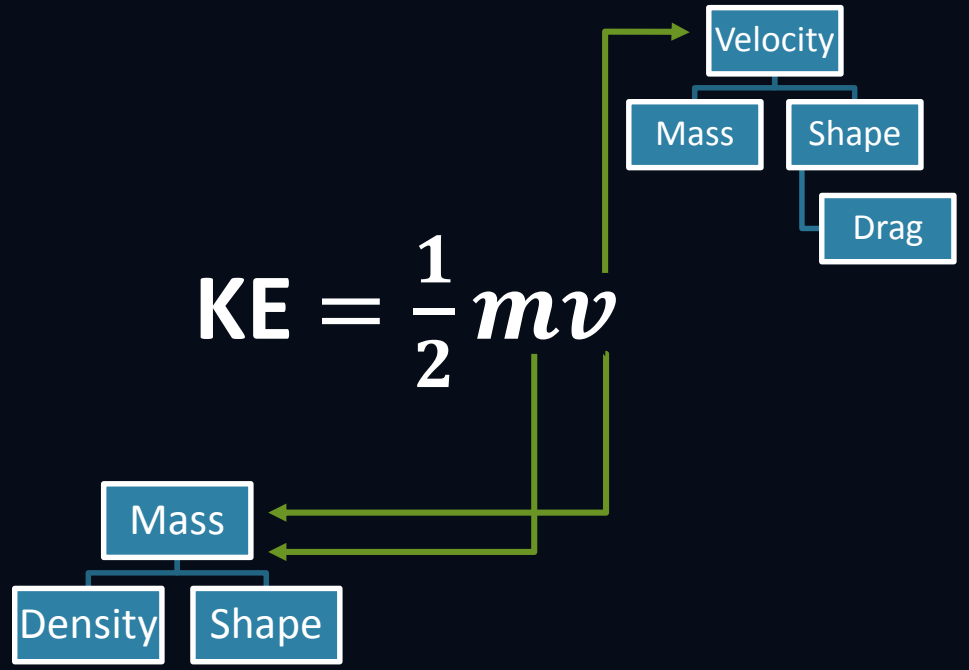
# Hail Size, Shape, Mass: Effects

- Applying new understanding of aerodynamic drag on hail (Heymsfield and Wright 2013)
- Impact test standard KE likely too high (based on Laurie 1960)
- Departure from spheres drives this

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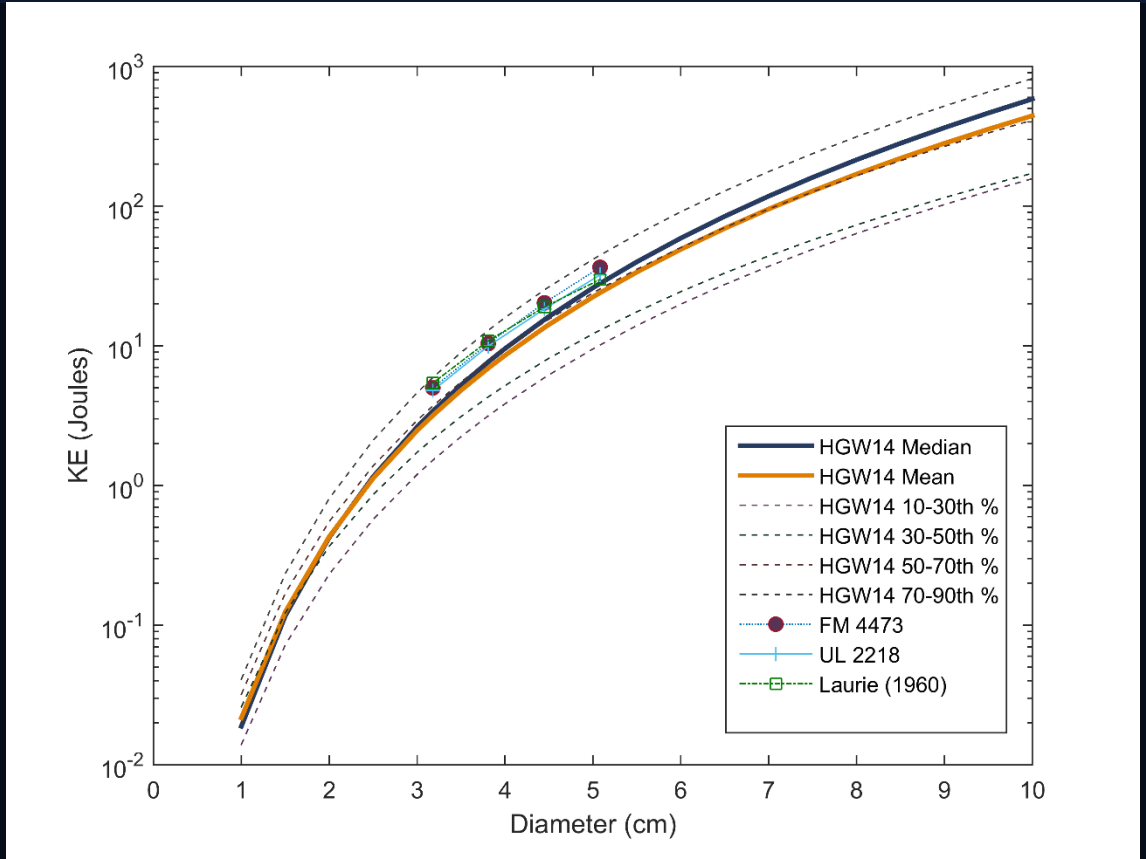
# Hail Size, Shape, Mass :Kinetic Energy

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# Hail size, shape, mass – Kinetic energy

- Lacking in-situ kinetic energy measurements
- KE inferred from hail pads, drag assumptions etc…
- “You can learn a lot by looking”


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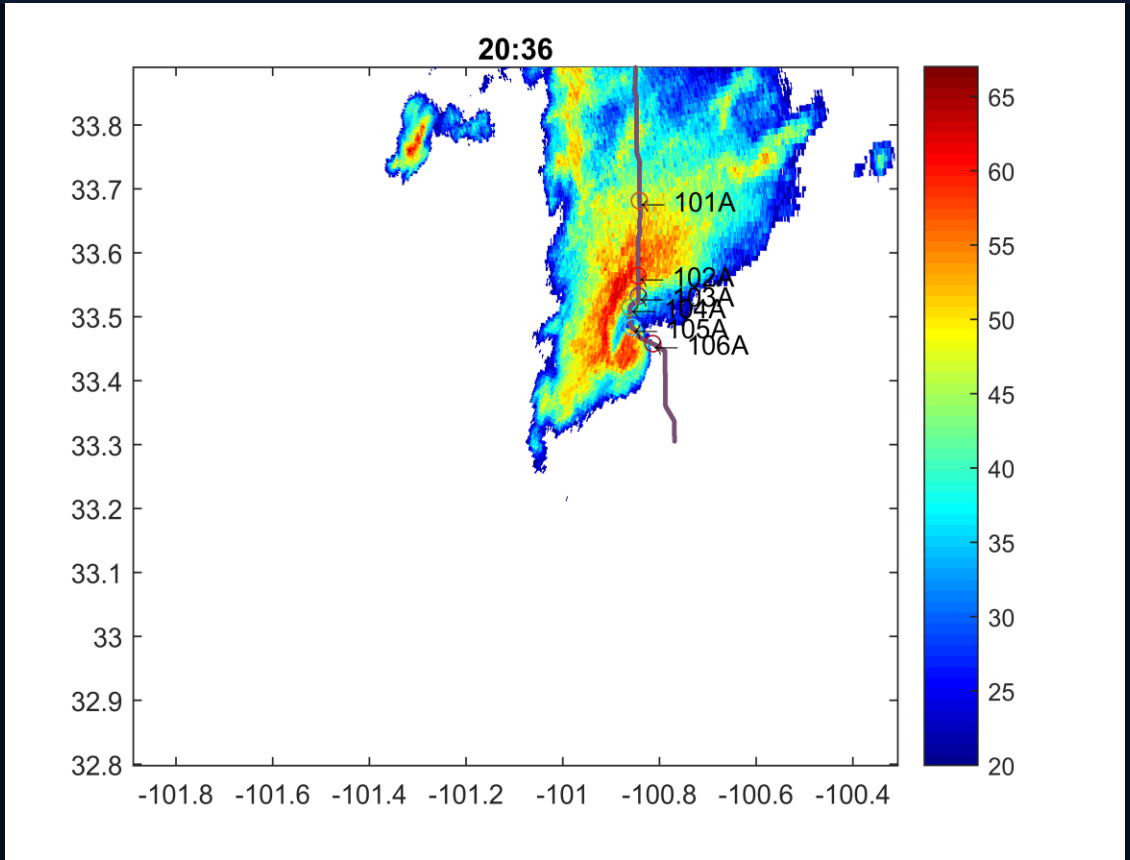
# IBHS Hail Field Research Disdrometers

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# What else do we need to replicate?


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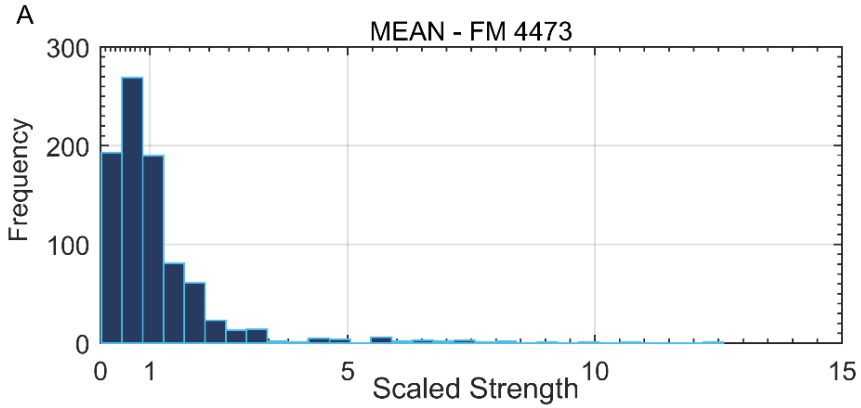
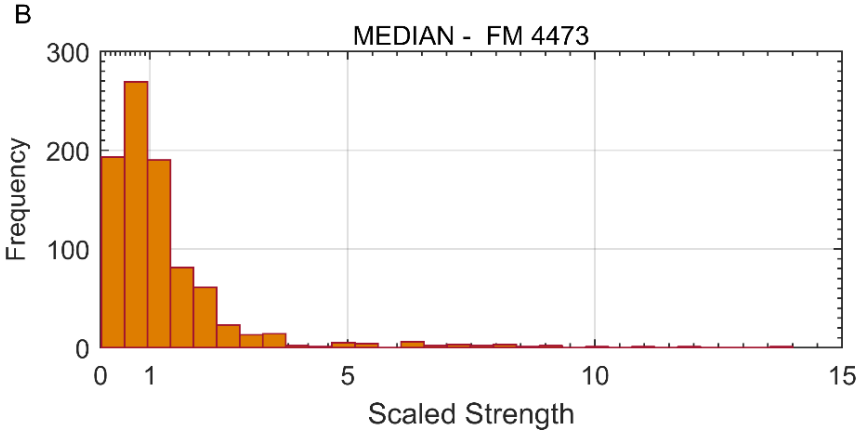
# Comparing Strength of Hail to Lab Test Standards




- Natural hail on average slightly stronger than average FM 4473 spheres
- Wide range for natural hail
  - Process of FM 4473 produces variability
- Large sample sizes needed for impact testing

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# Comparing Strength of Hail to Lab Test Standards

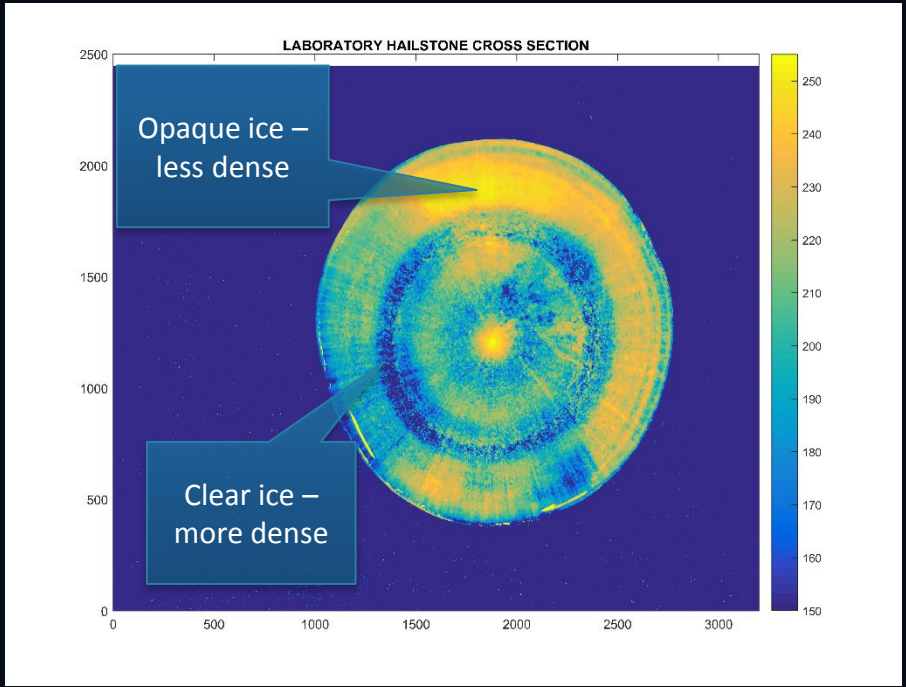
- **QUESTIONS**

Does “more dense = harder”?

Are strength and density really related?

In the lab, can change strength without changing density.

**Hypothesis:** *Hailstone strength is better correlated with radial distribution of density, not bulk density*

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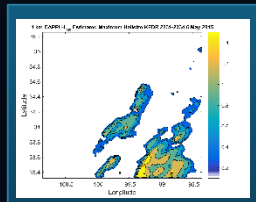
# Ongoing Research Collaborations

## Texas Tech

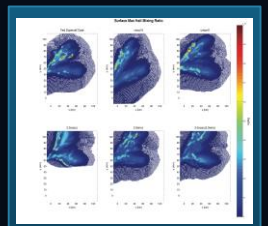
HAIL DISDROMETERS

## Penn St.

DUAL-POL RADAR HAIL DETECTION

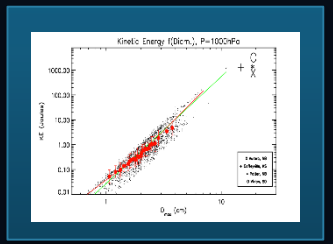


STORM-SCALE MODELING OF HAIL

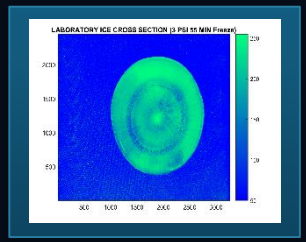


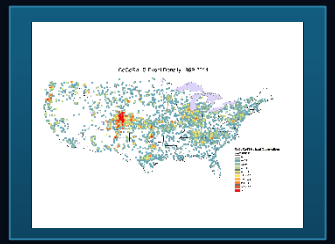
## NCAR

HAIL AERODYNAMICS



MICROPHYSICS





HAILPAD DATABASE

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# Building Vulnerabilities: Factors Affecting Hailstorm Risk

- Building materials
- Material age/condition
- Impact resistance rating of roofing materials
- Wind speed/direction
- Sheltering of the building
- Hailstone hardness

Source = “Evaluating Hail Damage Using Property Insurance Claims Data” (Brown et al 2015)

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# Component Vulnerabilities to Hail

## Components

- Roof
- Siding
- Windows and screens
- Doors
- Trim
- Railings
- Decks
- Fences
- Equipment

## Damage Modes

- Spatter marks
- Dents
- Cracks/tears
- Paint/finish/coating removal

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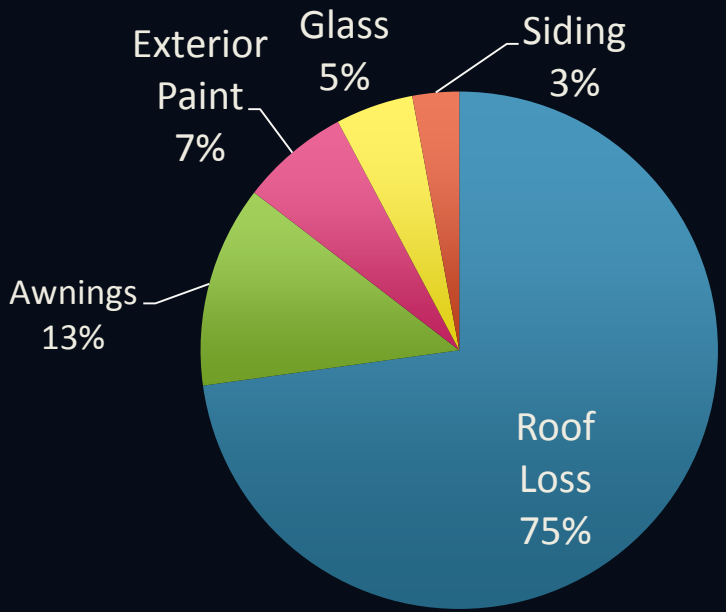
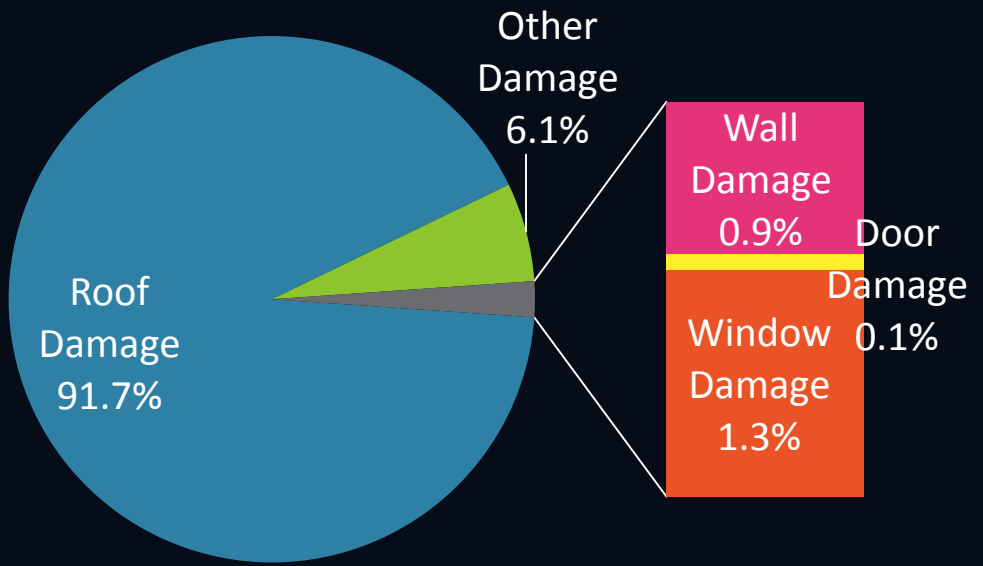
# Component Vulnerabilities to Hail

## Property Damage Rates




From "Weather and Extended Coverage" (Collins & Howe 1964)

## Damage Payout by Component




From "Claims Analysis Study of May 24, 2011 Hailstorms in Dallas-Fort Worth" (Brown & Pogorzelski 2013)

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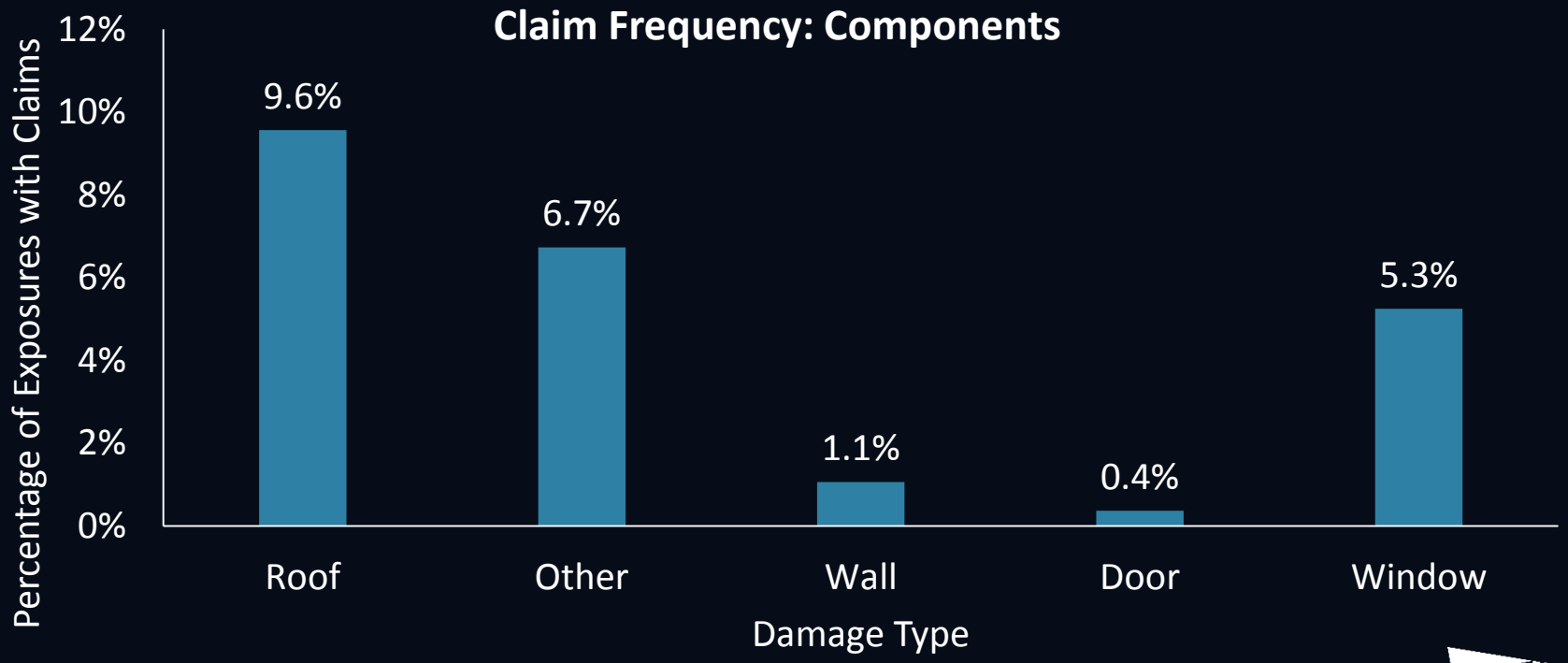
# Component Vulnerabilities to Hail




From "Evaluating Hail Damage Using Property Insurance Claims Data" (Brown et al 2015)

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# Roof Vulnerabilities to Hail




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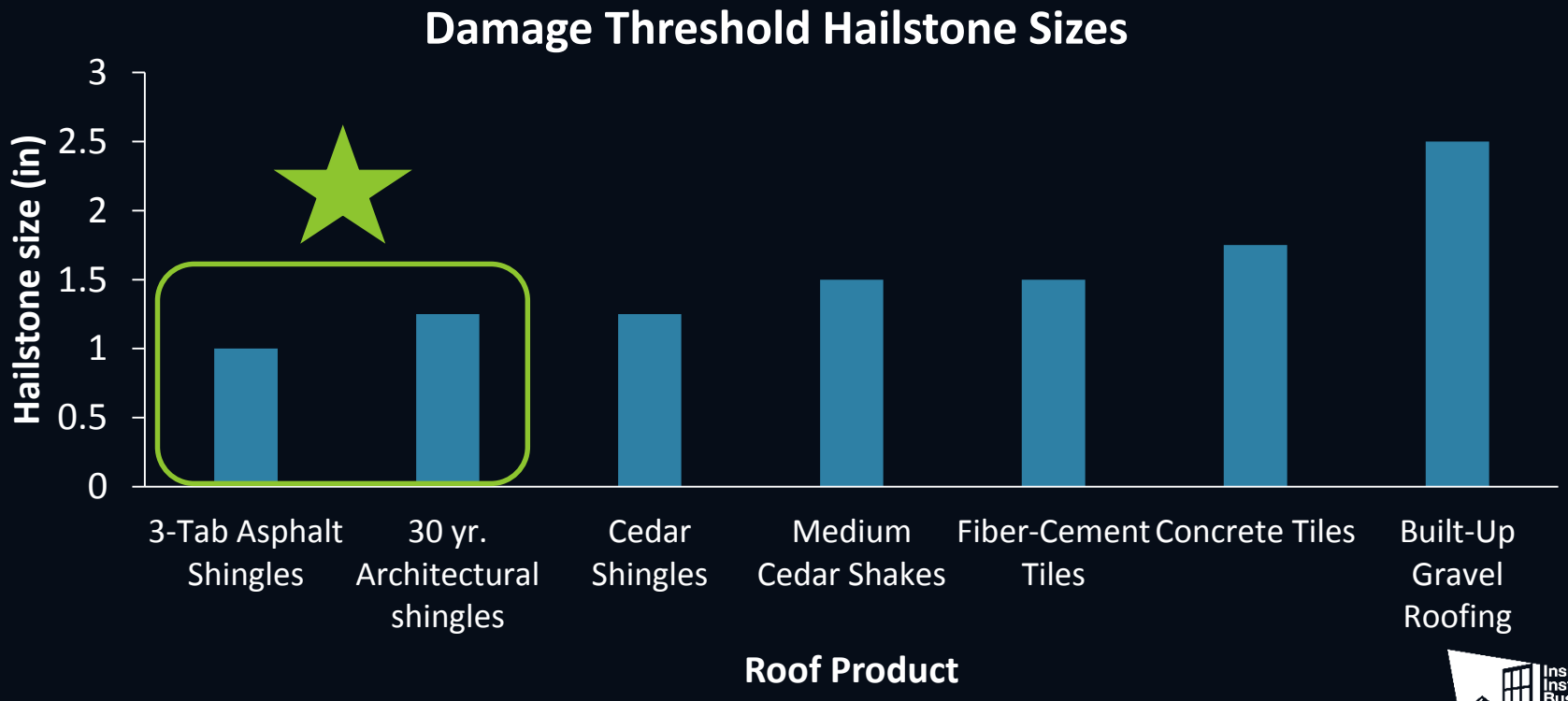
# Roof Vulnerabilities to Hail




From "Hail Damage Threshold Sizes for Common Roofing Materials (Marshall et al 2002)

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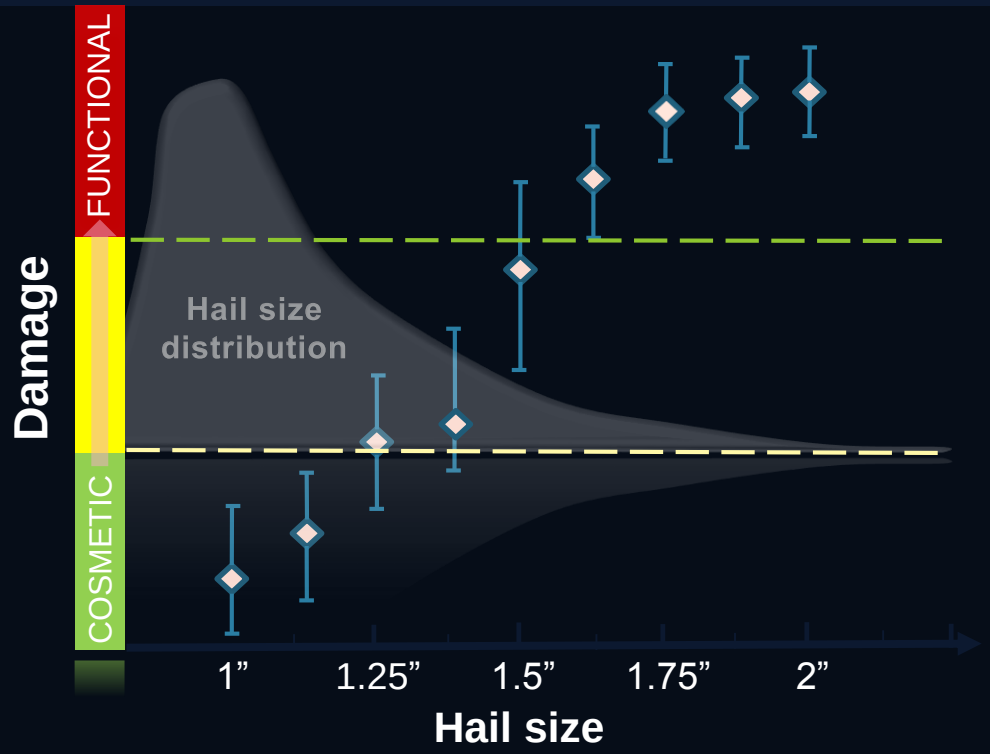
# Asphalt Shingle Impact Resistance:
## What we need to know




*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?*

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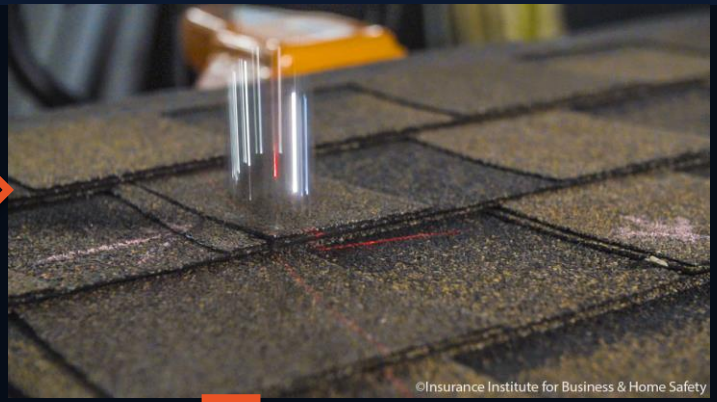
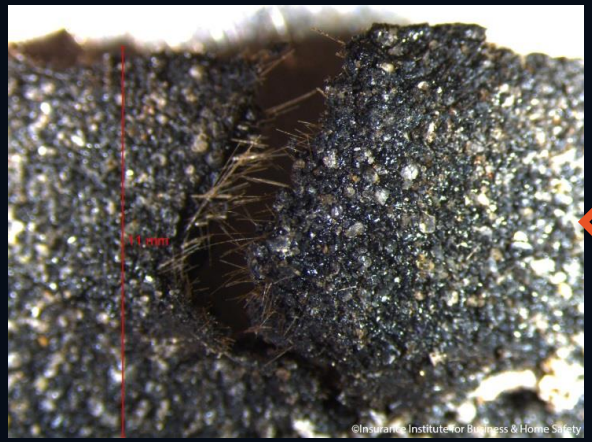
# IBHS Hail Research: Steel Ball Impacts



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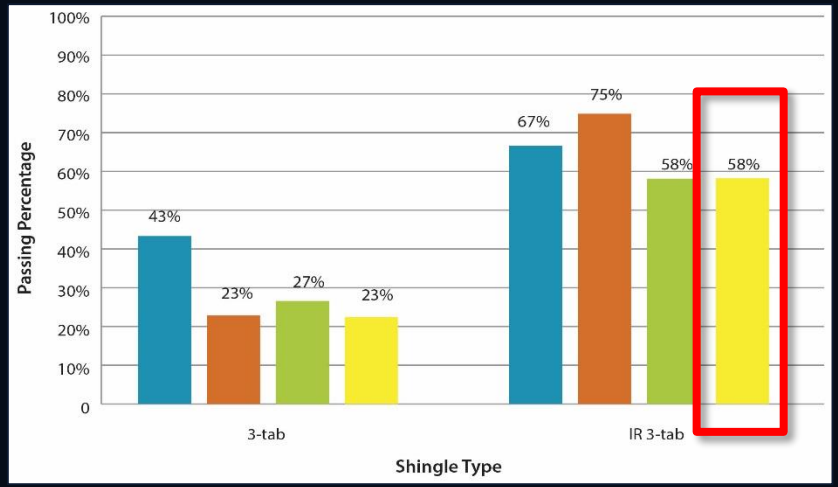
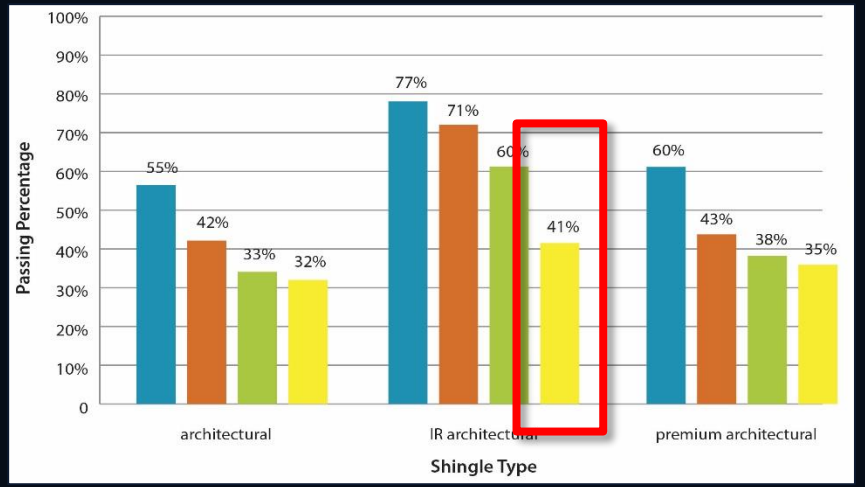
# Asphalt Shingle Impact Resistance

**UL 2218 Impact Location Passing Rates:**
3-tab vs. IR 3-tab Shingles




**UL 2218 Impact Location Passing Rates:**
Architectural, IR Architectural and Premium Architectural Shingles




Class 1 Impacts

Class 2 Impacts

Class 3 Impacts

Class 4 Impacts

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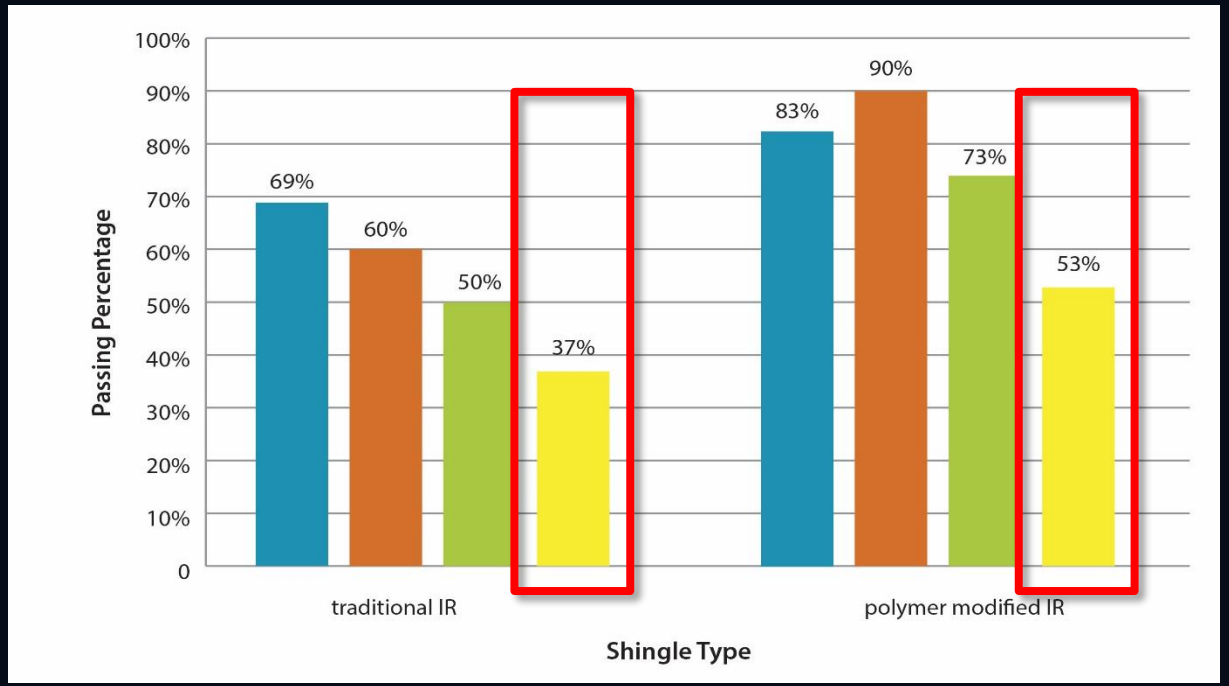
# Asphalt Shingle Impact Resistance

**UL 2218 Impact Location Passing Rates:**

Polymer Modified IR

vs.

Traditional IR Shingles




Class 1 Impacts

Class 2 Impacts

Class 3 Impacts

Class 4 Impacts

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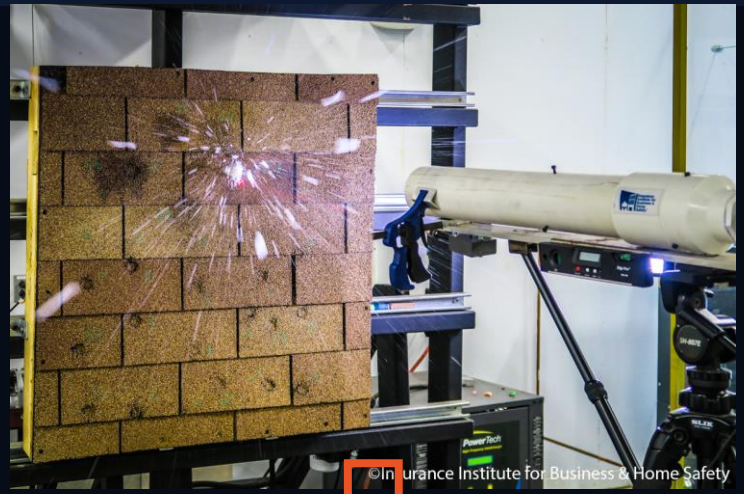
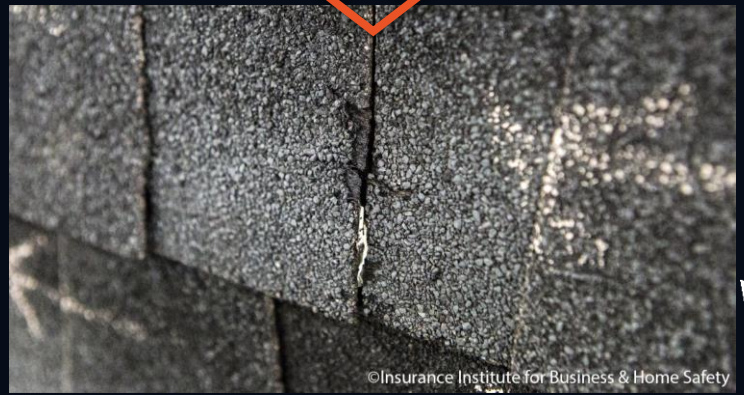
# IBHS Hail Research: Ice Ball Impacts



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# Concerns with Standard Impact Tests

- *None of the IR shingles passed!*
- Some damage modes from steel balls are not realistic
- Kinetic energies may be too high
  - Pure ice density assumption
  - Incorrect terminal velocity assumptions
- Inconsistencies among ice balls
- Only evaluate new products

Steel ball

Same impact energy!

Pure ice ball – new shingle

IBHS ice ball aged shingle

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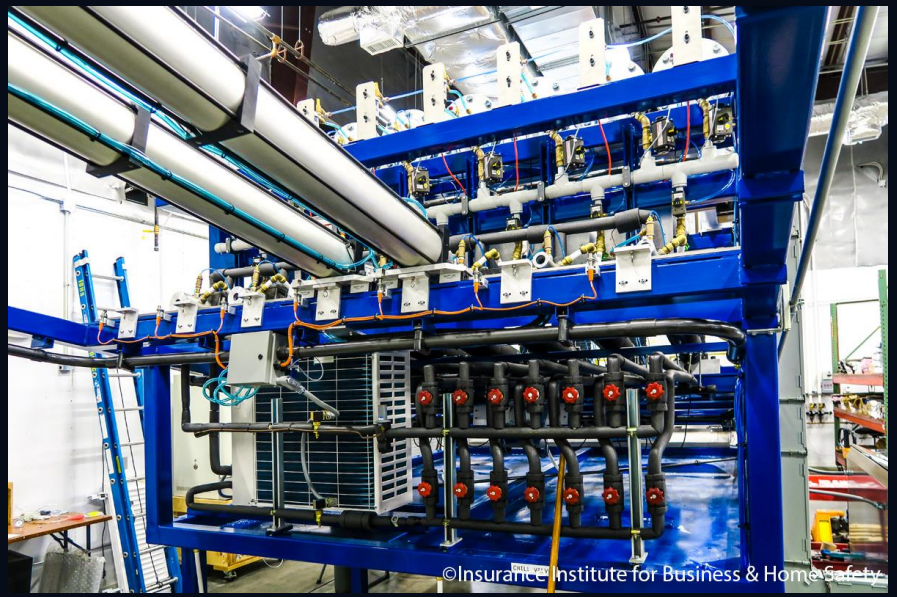
# Where do we go from here?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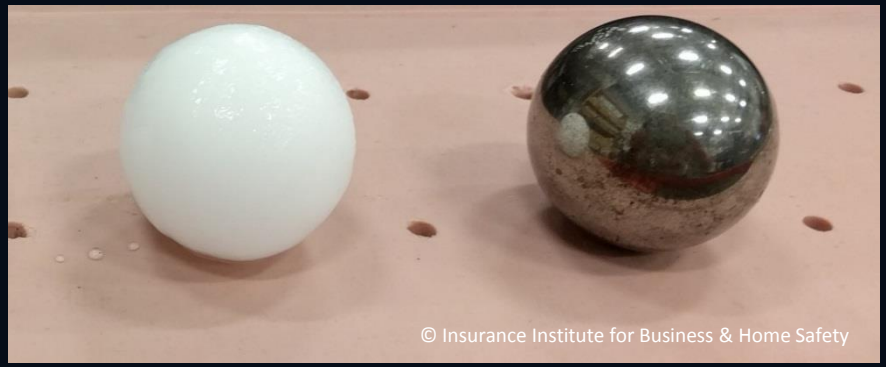
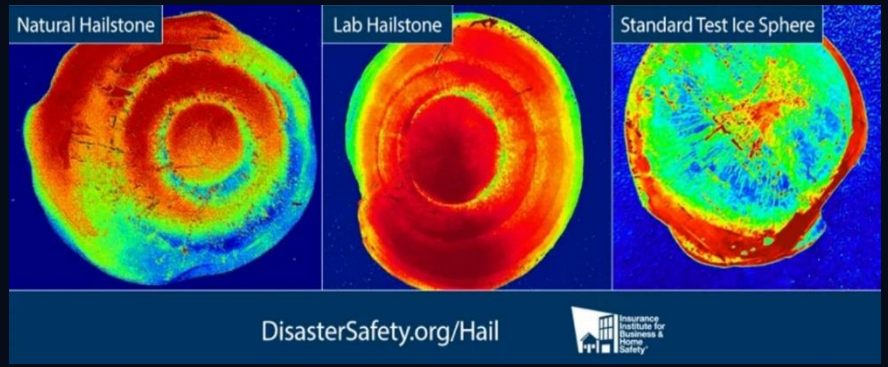
# Automated Hail Machine



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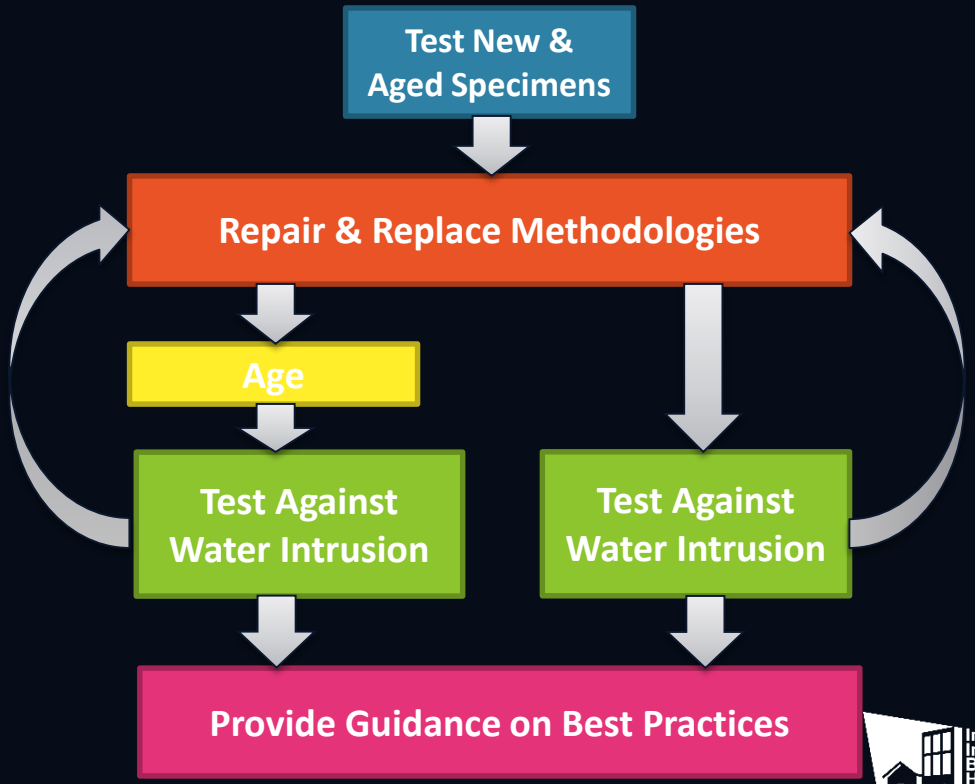
# Future Full-Scale Research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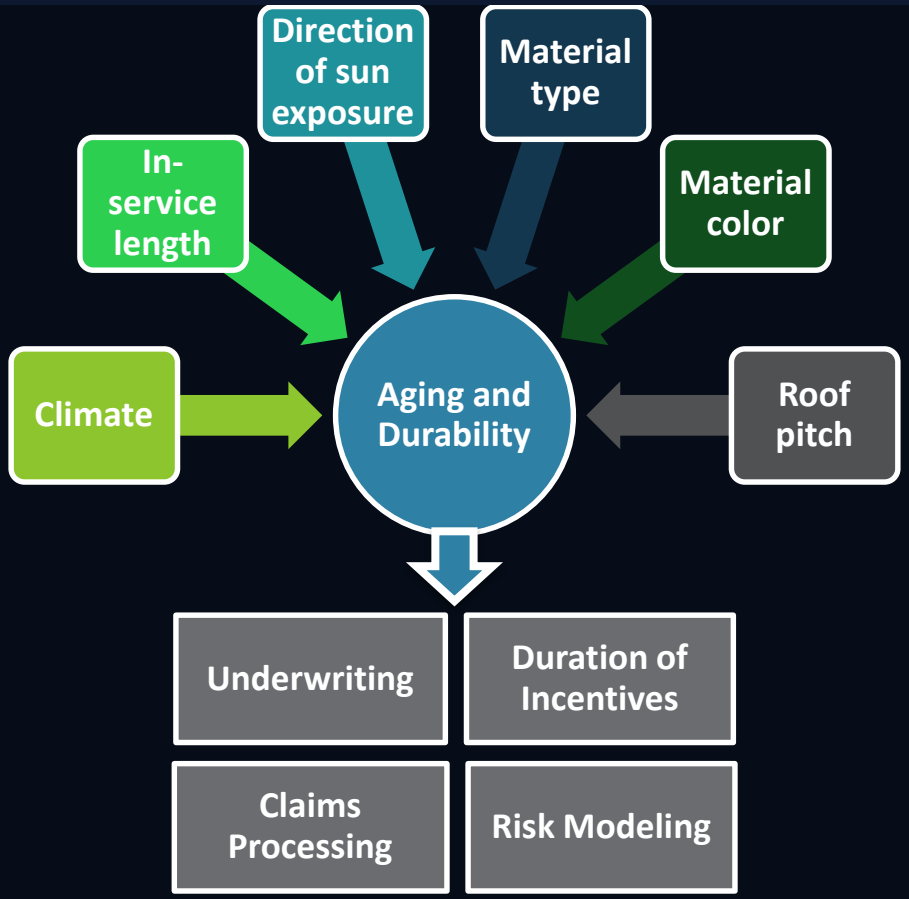
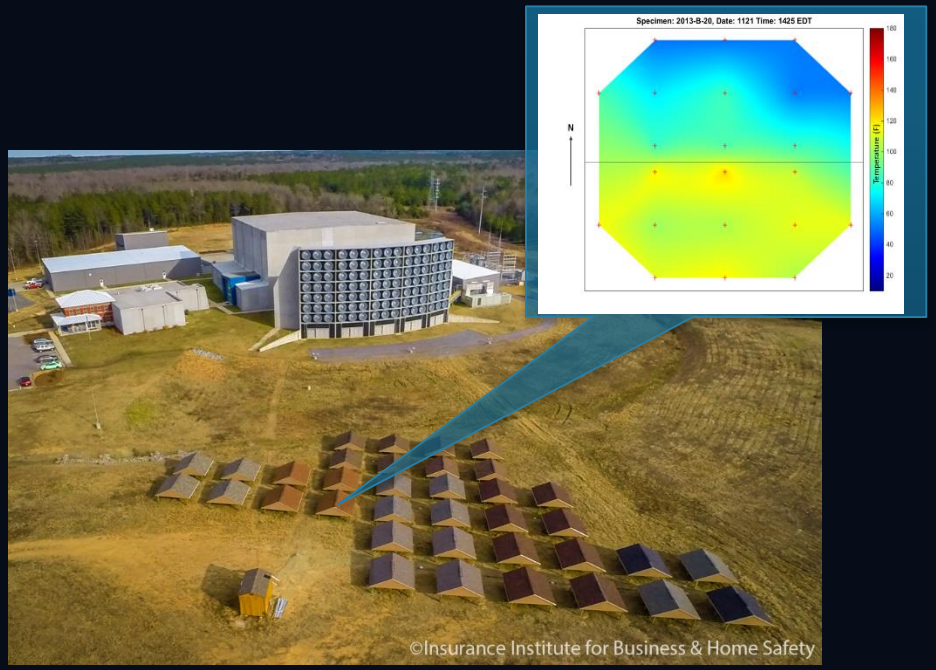
# What about Aging/Weathering?

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# Aging/Weathering Implications

- At what point does the hail performance of IR shingles degrade? How much?
- Are there initial conditions that must be met to assure shingles seal at time of installation?
- At what point do shingle sealants lose adhesion?

How does climate impact these?

How to model these, develop vulnerability curves?

Can we use imagery to detect?

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# Where Does it Land? FORTIFIED Home

| Hurricane | High Wind and Hail |
| --- | --- |
| Roof and Attic Vent System | Roof |
| Openings, Gables and Attached Structures | Gables, Porches, Carports and Chimneys |
| Structure (CLP) and Chimney | Garage Doors and Structure (CLP) |

*Location and Design Wind Speed are key determining factors in deciding which standard(s) apply.*

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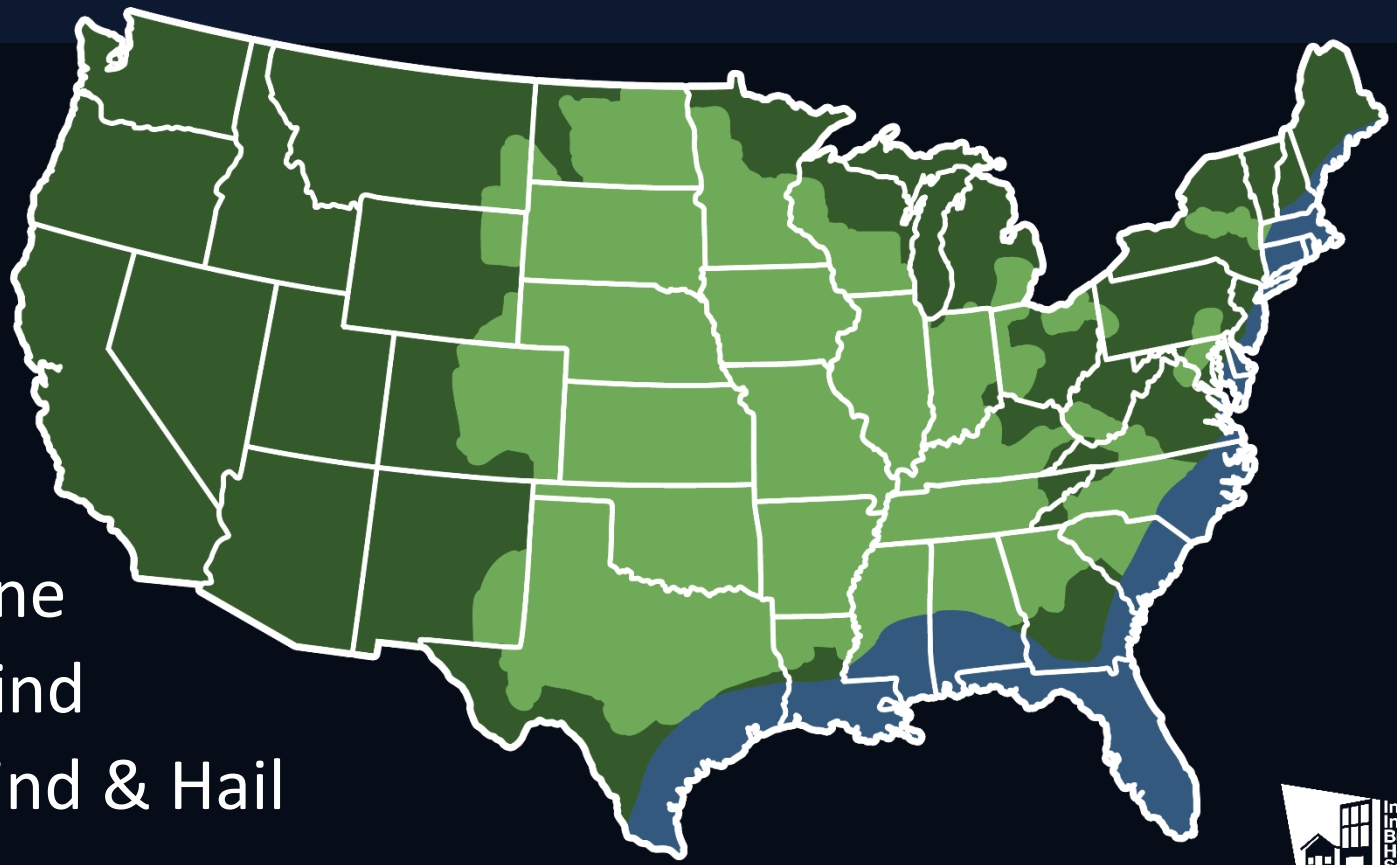
# FORTIFIED



Hurricane

High Wind

High Wind & Hail

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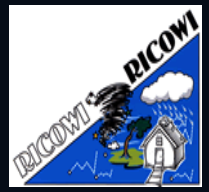
# Roofing Industry Collaborations












# Roofing Best Practices

Partnership between IBHS, RICOWI, & several roofing industry trade associations


## Topics

- Installation
- Maintenance
- Damage ID
- Repair vs. Replace
- Product Manufacturing & ID

## Audiences

- Contractors
- Inspectors & Code Officials
- Roofing Consultants
- Insurance Professionals
- Building Owners

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# Thank You!

Please visit www.disastersafety.org

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@tanya_bg_wx @igiammanco33

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