Impact Investigations of Damaging Hail Events in Canada

ICLR Friday Forums
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Overview

- Northern Hail Project Recap
- Importance of on-site damage documentation
- Forensic methods
- Performance of roofing materials
- Multi-hazard risk amplification
- Successful resilient materials
- Preliminary findings summary
- 2024 Season Goals
What is the Northern Hail Project?
Hail Impact Damage Challenges

- *Impact standards and instrument calibration*
  - Use *steel* or *wood* balls
- Large hail is…
  - Made of ice – deforms on impact
  - *Not* spherical
- Evidence disappears rather quickly!
Forensic Surveys

- **Vulnerabilities → Impacts**
  - Investigate what happened!
- Often executed for other hazards (e.g., wind, earthquake)
- Engineering/Meteorological rare for hail:
  - Canada (NHP; 2022 to TBD)
  - Romania (Calotescu et al., 2024);
  - Italy 1960s (Griffith, 1973).
Geographical Extent

Alberta

Saskatchewan

Manitoba

Ontario

13 Cases 2022/23
Forensic Methods - Borrowing from “CSI”

Soil Impression Analysis

Toolmark Analysis

Scene Documentation & Interviews

High velocity spatter

Reconstruct event → Develop response measure to reduce risk

Ballistics
July 1, 2023 – Multi-Hazard T-Storm Event

Killam/Hwy 13 Hailstorm
- Wind-driven hail; >> 200 km² crop & building damage

Didsbury EF4 Tornado
- Hail up to 80 mm
Meteorological Parameters

- **Max hail size** – samples, forensic indicators, event imagery
- **Hailfall density/distribution** – scuff marks, post-event photos
- **Wind speed** – instrumented data, EF-Scale damage-based estimates

Oak River, MB  
June 7, 2023

Killam, AB  
July 1, 2023

Falcon Lake, MB  
July 26, 2023

Oak River, MB  
June 6, 2023

Wind Speed

Max Size

Hailfall Density  
(& impact angle!)
Roof Damage

- Asphalt roofing
  - IBHS – degradation well before 30-year lifespan!
  - Increased damage aged roofing (e.g., 16- vs 6-y.o., same house)
Roof Damage

- Composite products
- Brittle failure – aging?
Roof Damage

- Metal roofing systems

Impacts on seams = leaks
EFFECT OF WIND ON IMPACT ENERGY

\[ v_r = \sqrt{v_w^2 + (v_t + v_d)^2} \]

- 2 cm hail falling in 70 km h\(^{-1}\) wind => double impact energy
Wind-Driven Hail Effects

- Likely responsible for some of the most intense damage
- Calgary 2020 Hailstorm; other major historical events
- Several $ Billion events in U.S. (e.g., Norman OK 2021 events)

Sloped Surface
Multi-Hazard Impacts
Aug 3, 2023 Lindsay Ontario Storm

Hail

Flash Flood

Wind

Public Library

Pottinger & Lindsay St N
Meteorological Findings & Hail Risk

- "Ground truth" impacts - extent, duration, severity
- Differences - Eastern versus western Canada

**Port Bolster, ON Aug 12, 2023**

- **D_{MAX} = 74.5 mm**
- **D_{MAX} = 86.3 mm**

Outdoor Festival
Est. ~40k attendees

Area of 50+ mm hail

Tornado Warned

29 km
Resilient Materials - Roofing

• Killam, AB Case – July 1, 2023
Resilient Materials - Roofing

• Killam, AB Case – July 1, 2023
Resilient Materials - Siding

- **Ponoka, AB** – July 16, 2022
- Widespread high-intensity hail damage
  - Also flash-flooding, wind damage
- Home w/ resilient siding
  - Lost windows
  - No damage to siding!

Source: Larry Charles

Source: Ponoka News
Damage Survey – Preliminary Findings

• Building Material Performance
  • Asphalt shingles, vinyl siding, older windows
  • Numerous existing materials regularly outperform these

• Max hail size often under-reported
  • Critical for determining impact thresholds and design values!

• Most intense damage (crops, buildings) from combination of large hail, large volumes of hail and wind.
2024 Damage Survey Work

- International Hail Damage Survey Protocol/Guidelines
  - UAV Roof Damage Survey Guidance
- Development of Hail Intensity Scale
- Sub-Projects:
  - “Non-severe” high-volume hail roof impacts
  - Material harvesting
  - Homeowner follow-up
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Oak River, MB
June 7, 2023