

NISI Standard: Managing Changing Snow Load Risks for Buildings in Canada's North



Heather Auld, Risk Sciences International
***For Changing Snow Loads Standard Working Group &
CSA, AANDC, Standards Council of Canada***

SNOW and METEOROLOGY

Meteorologists have many words for snow:

- **Snowfall** (*new snow that falls and measured on a snow board*)
- **Snow on the ground** (*depth of the accumulated snowpack*)
- **Snow water equivalent** (*mm of water equivalent or weight of snowpack*)
- **Snow density** (*weight per unit volume, kg/m^3*)
- **Snow Loads** (*weight of the near extreme snowpack on an object, usually the roof of a building*)
- **Snow cover, snowfall accumulations**
- Light-Moderate-Heavy snow, lake effect snow, snow burst,
- Wet snow, wet snow accretion (*sticks & accumulates on objects*),
- Blizzard, snow squall, snow flurries/snow shower,
- Snow grains, snow pellets, blowing snow, drifting snow,
- Snow drift, ablation, sublimation, and many more...

Buildings, Roofs and the Depth and Weight of Snow

- **National/Territorial/Building Codes use snow loads for design:**
Weight of snow expected to be exceeded once every 50 years
- **Buildings designed to withstand the weight of this snow load**

Two Snow Load terms:

- **Ground Snow Load** (on ground somewhere in community) and
- **Roof Snow Load** (specific to different parts of a building roof)
- Adjust Ground Snow Load for specific roof using code factors
- Environment Canada calculates these Ground Snow Loads
- Can vary significantly from one community to another
- Builders, engineers design roofs and building systems to withstand the near extreme snow load on a specific roof and building



Quebec, 2008: 3 dead



PEI, Feb, 2011



Sask., Mar, 2013



Alberta, Jan, 2011

Changing Snow Conditions in the North

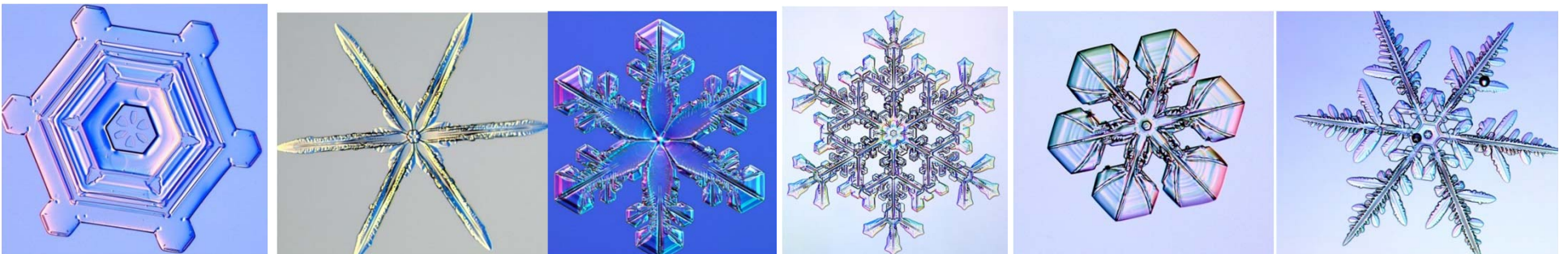
Northern snow – Traditionally, dry and wind packed

But, winters are changing and snow is becoming wetter, heavier and/or deeper during some winters

Rain and freezing rain (ice storms) also falling on the snowpack

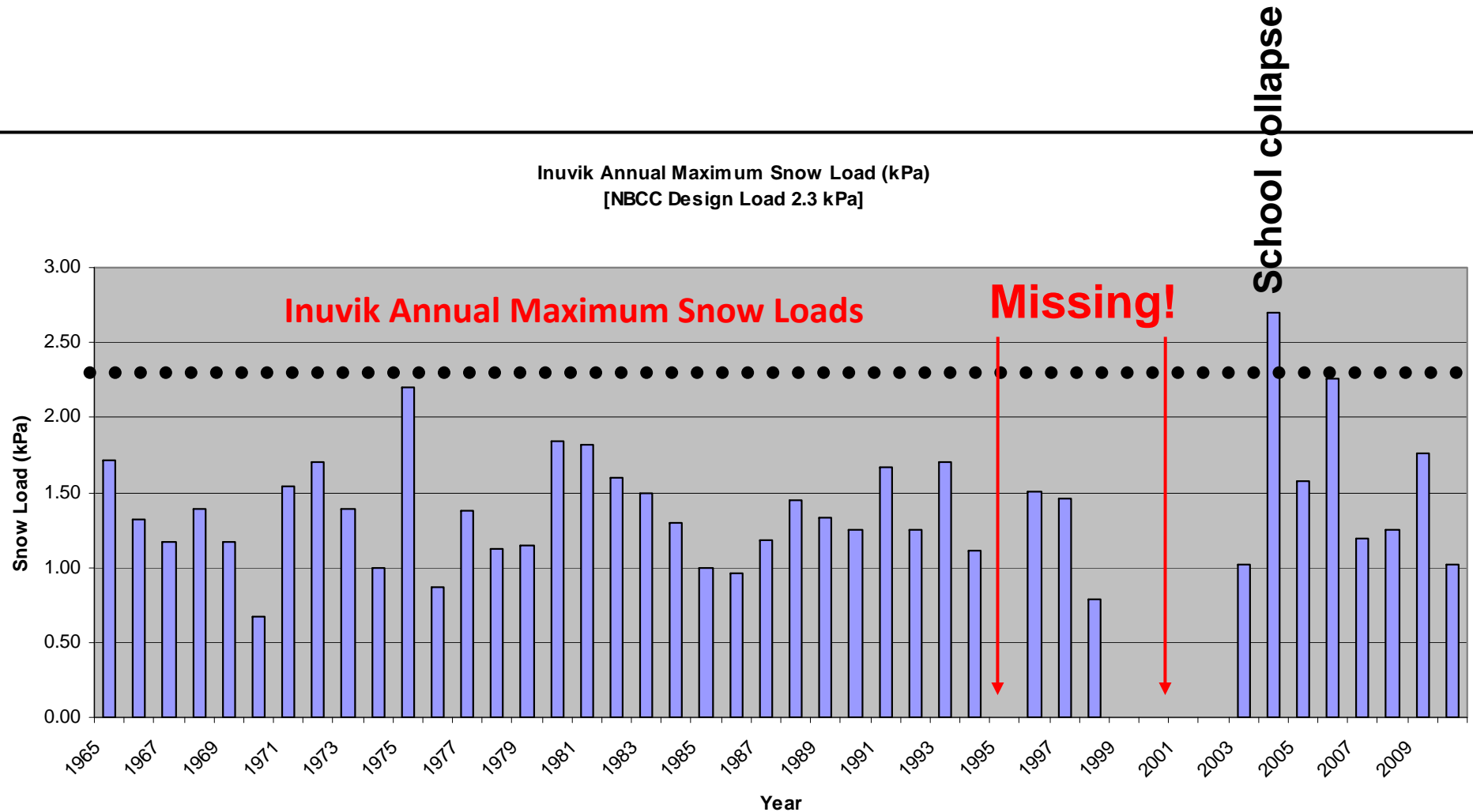
Northern snow is changing:

- Snowpack depths are increasing in some regions
- Snowfall accumulations are increasing in some regions
- Snow densities are increasing
- Rain on snow events are increasing
- Length of snow season and snow cover is decreasing
- Mean snow and extreme snow conditions are changing differently – can have an extreme in an low snowfall year



Increasing Heavy Snow in Canada's North – Inuvik Example

(note: while snow cover extent and snow season decreasing)



Increased snow loads/weights for new buildings in North for upcoming 2015 National Building Code of Canada

- Environment Canada – Meteorological Service calculations
- Updated snow loads in North going UP or staying the same – based on extreme snow depths only
- Changes in snow densities likely very important – but not investigated

New Increases – indicate growing risks for existing buildings:

Territory	Number of Code locations	Percentage of locations increased	Average increase in snow loads for these locations
Yukon	9	> 40%	Smallest increases so far
NWT	17	25%	Significant increases in these locations – snow densities need investigation
Nunavut	16	75%	Moderate increases so far

Measures included in new Changing Snow Loads Standard

- **Reduce snow overloading risks over the *longer* term**
 - *pre-snow season planning for roof snow removal*
 - *building and roof maintenance*
- **Monitor and *detect* “heavy snow” years and determine when to safely *remove* roof snow**
 - *Monitor community snow on the ground conditions*
 - *Monitor roof snow conditions*
 - *Assess and detect critical snow overloading risks*
- **Measures to safely *remove* snow from roof**
 - *How to clear roof snow safely*
 - *When to seek engineering assessments*
- **Protect occupant lives from *imminent* roof collapses**
 - *Warning signals, Safe building evacuation*
 - *Marking the building or parts of the building for closure*

Protecting Lives & Buildings: Detecting High Risk Snow Conditions

- ❖ Risk of collapse of existing buildings may be increasing regionally
- ❖ Detecting high risk winter snow conditions
- ❖ Removing snow reduces overload risks, BUT
- ❖ Roofs fail under snow overloading for a variety of reasons:
 - Built to earlier and lower snow loads
 - Poor maintenance or construction issues
 - Added equipment on roof, additions to building
 - Errors in installation of the roof framing members
 - Wood cut for installation of light fixtures or heat ducts

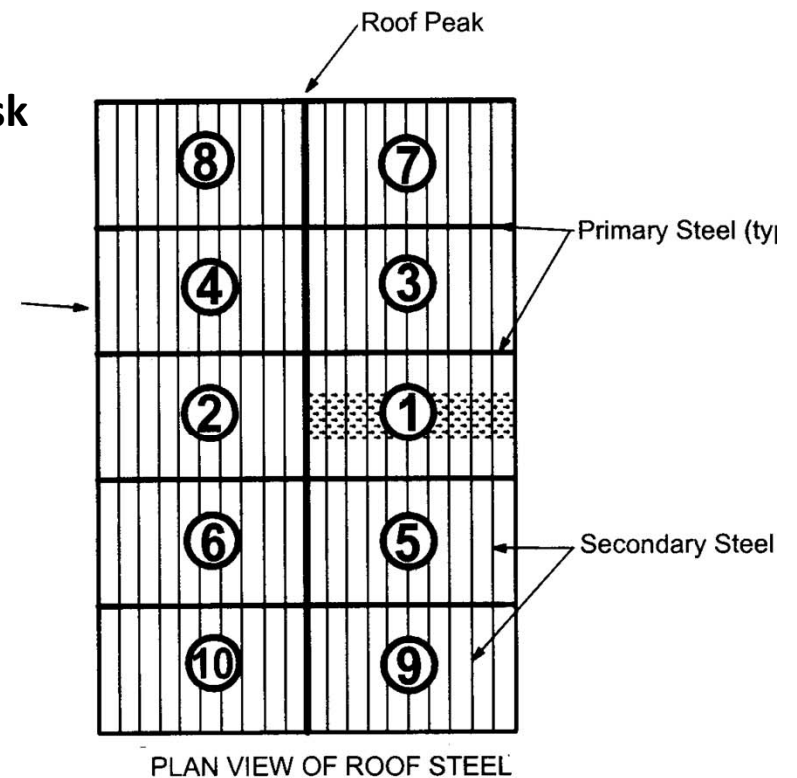


Safe Roof Snow Removal

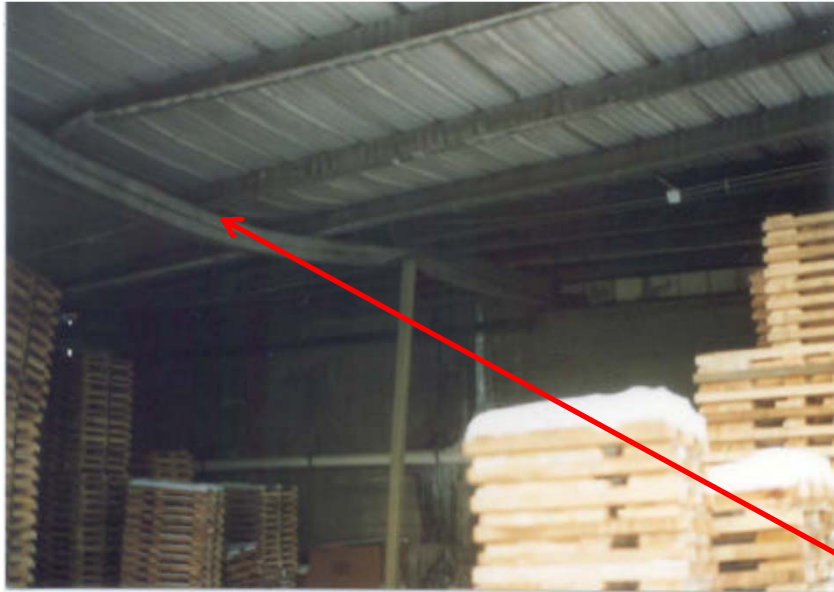


Snow Removal Procedure

Removal of roof snow removes/reduces the overload risk



Warning Signs – Collapse could be imminent without actions



Deformed metal



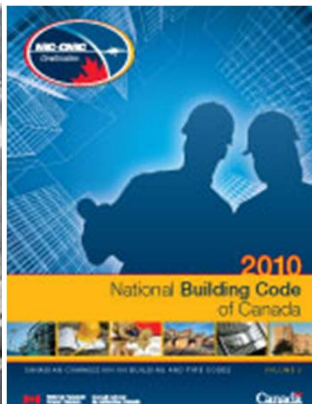
Broken wood truss



Deformed

Potential Challenges in Implementing the Changing Snow Loads Standard

- Snow measurements (of right type) are scarce to non-existent
- Risk of collapse also depends on building construction, maintenance
- Snow densities highly variable - usually not monitored
- Rain falling on snow is important – often an unknown
- When is too much snow a problem? Minimal guidance
- Clearing snow from roof is dangerous too!



Potential Solutions:

- Community snow monitoring for heavy snow (e.g. 3-4 times/winter in a consistent location)
- Snow weight or water equivalent measurements - use snow tubes and scale, bucket



Advantages:

- Safer buildings today and into future;
- Detection of at risk snow loads – snow removal when *needed*
- *Data for snowmelt flooding risks – support NISI drainage and permafrost standards*

Measuring Snow, Detecting Higher Risks for Potential Roof Collapses



Snow depth



Snow Water Equivalent



The Northern Climate is Changing during all seasons

- Changing snow conditions
- Tornadoes moving north
- Updated Canada's confirmed tornadoes up to 2010
- More tornadoes in past two decades in NWT
- Tornado sited near Inuvik in 2012!
- Heavier rainfall events, ice storms, shifting wind patterns

