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January 11-15, 2016
Washington Marriott Wardman Park
Washington, D.C.
BETEC Webinar
The Cold Hard Facts
About Ice Dams on Roofs

Peter E. Nelson
Simpson Gumpertz & Heger Inc.
Two Components of Ice Dam Leakage

- Warm roof deck melts the snow and cause formation of Ice Dams
  - Due to poor insulation, ventilation or roof geometry
- Leakage through Roofing System
  - Roofing system inadequate for ponding water
- Both are required for leakage to become a problem
- Typically separate causes and solutions for each component
Snow Melt Forms Ice Dams and Icicles
No Eave Vents
Fiberglass Insulation, No Eave Vent
Gable End Vents in the Attic
2015 - Record Snow Fall in Boston

• 110.6 in. of snow in 2015
• Boston average snow fall is 43.8 in.

• Anchorage, Alaska had 25.1 in. (unofficial)
• Anchorage average snow fall is 74.5 in.

• Boston had four times as much snow as Anchorage!
Heat loss through ceiling
Heat in attic melts snow
Water flows to eave
Water freezes at eave, creating ice dam
Leaks into building where water ponds and backs up at the ice dams.
Cold Attic Design

Eave Vent

Insulation and Air Barrier

Ridge Vent
1507.2.8.2 Ice Barrier. In areas where there has been a history of ice formation along the eave causing a backup of water, an ice barrier that consists of at least two layers of underlayment cemented together or of a self-adhering polymer modified bitumen sheet shall be used in lieu of the normal underlayment and extend from the lowest edge of the roof surface to a point at least 24 inches (610mm) inside the exterior wall line of the building.
Ice Dam Formation

- Control of ice dams requires attic ventilation to reduce attic temperatures to keep the roof deck cold
- The better the roof insulation and the better the air barrier, the less heat goes into the attic
- Roof geometry controls effectiveness of the ventilation system
- Ice dams can still occur at critical locations, even with proper ventilation
Other Benefits from Attic Ventilation

• Evacuate of moisture from attic
  – Reduce condensation on sheathing

• Reduce roof deck temperatures
  – Shingle warranty requirement
  – Perceived increase in asphalt shingle longevity (disproven by SGH)
Potential Sources of Heat in Attic

• Heat build-up from inadequate venting
  – Particularly dormer and valley areas: no eave vent available
• Losses in HVAC ducts and HVAC in attics
• Air flow or heat loss from building interior
• Solar gain through roofing
Air Flow From Interior

• Negative Pressure in attic from ventilation
• Positive Pressure in building from HVAC system (forced air)
• Stack pressure in building at ceiling level
• Discontinuities in air barrier allow interior air to flow into the attic
  – Light fixtures, ductwork, sprinkler lines, chases/chimneys, vents, other ceiling penetrations
Solar Gain Through Roofing

• Sun heats snow pack on southern exposures
  – Melting allows snow to slide off metal roofs
• Heat from sun transferred through roofing system, heating the attic
• Increased attic temperature causes melting on north exposures
• Snowmelt re-freezes at cold eave
Design of Attic Ventilation

- Building Codes - use “Rule of Thumb”:
  - 1 sf vent opening / 300 sf roof area with a vapor retarder
  - 1 sf vent opening/ 150 sf roof area without a vapor retarder
  - No scientific basis; used for condensation control
  - Suitable for typical residential buildings with simple geometry, steep slope roofs
  - Inadequate for large buildings with insufficient slope (not enough stack pressure)
  - Does not account for roof geometry
Design of Attic Ventilation

- Calculation of Required Ventilation
  - Based on research by CRREL*
  - Studied ice dams on buildings in Ft. Drum, NY
  - Provides guidelines for critical attic and outside temperatures needed for ice damming

* Army Corps of Engineers Cold Regions Research and Engineering Laboratory; Tobiasson, Buska, and Greatorex, “Interface”, January 1998
Figure 8: Lines of best fit for the three roofs shown in Figures 5-7, along with similar lines (dashed) for two other roofs also having "some" icing problems.
Design of Attic Ventilation

• Design Criteria to Prevent Snow Melting (Tobiasson):
  – If outside temperature is 22° or below,
  – Attic temperature should be 30° or below

• Using these guidelines, perform calculation of ventilation rate required
  – Similar to duct calculation (per ASHRAE) for compact vent spaces
  – 2-dimensional model needed for cold attic spaces
Ice Dams can be decreased by:

- Using cold ventilated attics
- Increasing the slope of the roof increases the stack effect in the vent space
- Using slippery surfaced roofs (metal and slate)
- Not using gutters or snow retention devices
- Reducing large eave overhangs
- Simplify the roof geometry
EXAMPLES
Cold Roof Deck Design

- Insulation and Air Barrier
- Eave Vent
- Ridge Vent
Batt Insulation
Polyethylene
Gypsum board
Baffle Vent
Standing Seam Metal Roofing (apply cont. sealant to seam 12' from eave)
2 Courses Ice and Water Shield Membrane
Roof Sheathing
PFB Roof Truss

Metal Wrapped 1x6 Fascia Trim
Metal Wrapped 1x8 Fascia
Sub-Fascia

2x4 at 2'-0" O.C.
Vented Vinyl Soffit
EFS 0/1/2" Cement Board

Batt Ins
Vapor Barrier
BLK BET Trusses
STL Beam
2 1/2" MET Stud
GPDW
PWD Shth

1 1/2" = 1'-0"
METAL CAP TO MATCH ROOF
2 LAYERS OF COR-A-VENT

PRESSURE TREATED NAILERS
METAL CLOSURE
STANDING SEAM SET IN SEALANT
5/8" FWD SHEATHING
30# FELT

RIDGE VENT DETAIL
3" = 1'-0"
Temperature Measurements

10 deg.

45 deg.

70 deg.
Ventilation Repair Schemes

• Natural Ventilation:
  – Not enough vent space within eave construction to overcome solar gain through metal roof
  – Dormers and valleys interfere with eave vents
  – Increasing ventilation may cause –P in attic, increasing air flow through ceiling – may not be effective

• Mechanical Ventilation:
  – Need to balance pressure in attic with pressure in building to prevent air flow through ceiling
Ventilation Repair
Thank You!