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Weesaw Township
13518 State Street
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New Troy, MI 49119

Re: Roof Ventilation Report

Dear Board Members,

I have visited the site on January 9th and February 27th of this year relative to the occurrence of ice forming on the perimeter roof edges. The majority of this occurs because of three issues.

- One is the chimney effect of the open stairwell to the attic space where fire department supplies are currently stored. This allow heat to pool up under the roof, causing the snow to melt.
- The second is the lack of proper air ventilation. The basic concept is to allow air to enter through the soffit of the mansard roof, then move up the underside of the roof sheathing and then vent at or near the top of the roof. This keeps the roof sheathing at a constant temperature. If higher portions of the roof sheathing are warmer, they melt the snow causing the water to freeze at the edges where the roof deck temperature is colder. Attached is an article (Attachment A) explaining this phenomenon.
- The last issue is any heat leakage into the attic from lights, flues, vents and etcetera.

I have attached a simplified drawing of the plan of the building (Attachment B). The green lines are the roof. The building has been constructed in three sections. The first was the original north section which houses fire trucks and vehicles as well as a break room. This is 40' x 60' (2400 SF) and had an original flat insulated roof. The second was a 20' addition to the south of the original. This houses a fire truck bay and the stair access to the attic. This is 20' x 60' (1200 SF) and had an original flat insulated roof. The third section is the south portion which houses two fire tuck bays, the hose tower and the township offices and meeting room. This 50' x 60' (3000 SF) addition also had a flat roof with minimal roof insulation. The total for the entire building is 6600 SF (square feet). At some time a shingled wood roof truss system with mansard sidewall section was installed over the flat roofs. This created a 3' deep soffit on portions of the building.

Recommendations:

The first recommendation is to seal off the stairwell to the attic with an insulated structure. Construct a 2 x 4 stud wall from floor to ceiling along the north edge. Install a 42” outswing insulated door at the first floor landing. Install a new insulated door in the east wall to the under stair storage. Insulate the entire two sides of the stair opening (including the existing east wall) with 3-1/2” of formed in place cellulose insulation or foam insulation. The doors should have weather stripping and a sealed sill.

The second recommendation involves opening up roof ventilation for a proper system that meets current code requirements. The current Michigan Building Code 2015 requires a Net Free Area (NFA) ventilation level of a ratio of 1/300 of the area served, although a ratio of 1/150 is recommended. With 6600 SF, a NFA venting area of 44 SF at both the soffit and the ridge would be required for the 1/150 ratio. Presently there is vented soffit at the north and part of the east mansard soffits. There is no ventilation on the soffits of the 30’ of east wall of the township offices/meeting room as well as the south wall (70 LF) and none along the entire west wall (140 LF). The current vented soffit has a NFA of about 1 per foot and occurs every 4 feet. There is about 160 LF (lineal feet) of this soffit. The current ridge vent (Photo 1) is about 90 feet long with a NFA of about 4.5 per foot for a total of 34 SF, 10 shy of the recommended. Also due to the roof being a hip style, there is minimal ridge ventilation near the north and south ends. The main problem lies in the connection of the roof trusses to the top of the walls where solid blocking from the top plate of the wall occurs up tight to the underside of the roof sheathing. See Photos 2 & 3. This is essentially blocking any airflow from the soffit to the roof. There is also no ventilation occurring on the south and west sides, although the west side has minimal overhang. To alleviate potential ice issues and improve the attic/roof ventilation system, we recommend performing the following:

- Bore 2 - 4” diameter holes in the vertical solid wood blocking between each of the roof trusses along the north, east and south walls to allow air flow from the soffit to the attic space (Photo 2)
- In areas where there is rafters in line with the exterior wall (Photo 3) bore 4” diameter holes at every 24” on center
- Remove the existing non ventilated aluminum soffit on the east (south 30’) and south walls and replace with an aluminum vented soffit such as Quality Edge TruVent Hidden Vent Soffit. http://www.qualityedge.com/soffit/truvent/
- Install two vented and screened 3’ x 3’ vinyl cupolas at the north and south ends of the roof ridge to compensate for the lack of venting along the hip ends. Provide a 2’ x 2’ square opening in the roof sheathing for ventilation (8 SF total). This will also improve the NFA area.
- Install a continuous strip of GAF Cobra IntakePro under shingle vent strip along the entire west roof edge and open up roof sheathing as required. http://www.gaf.com/roofing/residential/products/roof_vents/cobra_intakepro

The third recommendation involves adding additional insulation to the existing 6" blown in over the township offices/meeting space. The insulation should be 6" of blown in cellulose with an additional R value of about 24. It would be more beneficial to add insulation to this area only as it is heated and cooled, whereas the balance of the building is heated only to an average temperature of 60 degrees. Also insulate any vent stacks, exposed light fixtures on the attic side, any exhaust ducts or other similar items to reduce the amount of heat that omits into the attic.

Should you have any questions or require any further information, please call or email my office.

Very truly yours,

Christopher A. Brooks

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Attachment A

Ice dams

What is an ice dam?

An ice dam is a ridge of ice that forms at the edge of a roof and prevents melting snow (water) from draining off the roof. The water that backs up behind the dam can leak into a home and cause damage to walls, ceilings, insulation, and other areas. Figure 1 shows a cross section of a home with an ice dam.

What causes ice dams?

There is a complex interaction among the amount of heat loss from a house, snow cover, and outside temperatures that leads to ice dam formation. For ice dams to form there must be snow on the roof, and, at the same time, higher portions of the roofs outside surface must be above 32 ^{0} F while lower surfaces are below 32 ^{0} F. For a portion of the roof to be below 32^{0} F, outside temperatures must also be below 32 ^{0} F. When we say temperatures above or below 32^{0} F, we are talking about average temperature over sustained periods of time.

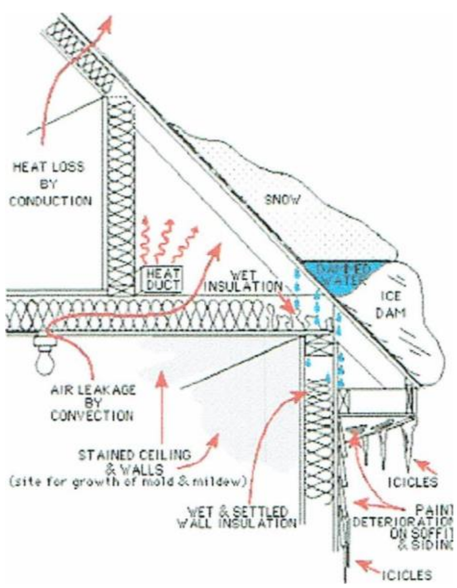

Figure 1

The snow on a roof surface that is above 32 ^{0} F will melt. As water flows down the roof it reaches the portion of the roof that is below 32 ^{0} F and freezes. Voila! - an ice dam.

The dam grows as it is fed by the melting snow above it, but it will limit itself to the portions of the roof that are on the average below 32 ^{0} F and the water above backs up behind the ice dam and remains a liquid. This water finds cracks and openings in the exterior roof covering and flows into the attic space. From the attic it could flow into exterior walls or through the ceiling insulation and stain the ceiling finish.

Nonuniform roof surface temperatures lead to ice dams.

What causes different roof surface temperatures?

Since most ice dams form at the edge of the roof, there is obviously a heat source warming the roof elsewhere. This heat is primarily coming from the house. In rare instances solar heat gain may cause these temperature differences.

Heat from the house travels to the roof surface in three ways: conduction, convection, and radiation. A good example of this is the heating of a cast iron frying pan. The heat moves from the bottom of the pan to the handle by conduction. If you put your hand above the frying pan, heat will reach it by the other two methods. The air right above the frying pan is heated and rises. The rising air carries heat/energy to your hand. This is heat transfer by convection. In addition, heat is transferred from the hot pan to your hand by electromagnetic waves and this is called radiation. Another example of radiation is to stand outside on a bright sunny day and feel the heat from the sun. This heat is transferred from the sun to you by radiation.

In a house, heat moves through the ceiling and insulation by conduction through the slanted portion of the ceiling (Figure 1). In many homes, there is little space in regions like this for insulation, so it is important to use insulations with high R-value per inch to reduce heat loss by conduction.

The top surface of the insulation is warmer than the other surroundings in the attic. Therefore, the air just above the insulation is heated and rises, carrying heat by convection to the roof. The higher temperatures in the insulation's top surface compared to the roof sheathing transfers heat outward by radiation. These two modes of heat transfer can be reduced by adding insulation. This will make the top surface temperature of the insulation closer to surrounding attic temperatures directly affecting convection and radiation from this surface.

There is another type of convection that transfers heat to the attic space and warms the roof. In Figure 1, the winding arrow beginning inside the house and going through the penetration in the ceiling, from the light to the attic space, illustrates heat loss by air leakage. In many homes this is the major mode of heat transfer that leads to the formation of ice dams.

Exhaust systems like those in the kitchen or bathroom that terminate just above the roof may also contribute to snow melting. These exhaust systems may have to be moved or extended in areas of high snow fall.

Other sources of heat in the attic space include chimneys. Frequent use of wood stoves and fireplaces allow heat to be transferred from the chimney into the attic space. Inadequately insulated or leaky duct work in the attic space will also be a source of heat. The same can be said about knee wall spaces.

The photograph below left shows a single story house with an ice dam. The points of heat loss can be clearly seen as those areas with no snow. The ceiling below this area needs to be examined for air leakage, missing or inadequate insulation, leaky or poorly insulated ductwork, and the termination of a kitchen

The photograph below illustrates unusually high heat loss from the roof. There is very little snow left on the roof and at its edge is both an ice dam and a "beautiful" row of icicles.

The unusually high heat loss on this roof has caused both an ice dam and icicles.

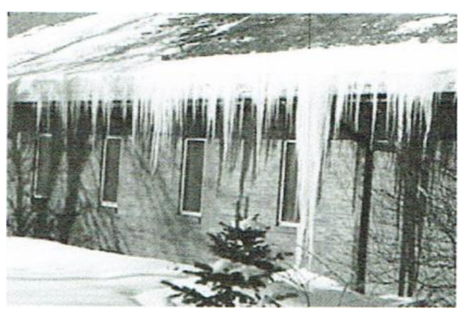

Photo 1 – current ridge vent

Photo 2 – truss blocking ventilation at exterior wall

Photo 3 – rafter blocking ventilation at exterior wall

Attachment B