WEC File No. 044829.00

February 22, 2021

Larch Hills Nordic Centre
c/o Rob Van Varseveld, P.Eng.
3181 28th Street N.E.
Salmon Arm, BC V1E 3K8

Via Email: robvanv@telus.net

Attention: Rob Van Varseveld, P.Eng.

Subject: Ice Damming Investigation
Larch Hills Nordic Centre,
Salmon Arm, B.C.

As per your request, Williams Engineering Canada Inc. (WEC) conducted an investigation excessive ice damming occurring at the Larch Hills Nordic Centre near Salmon Arm B.C. The following lists our findings and recommendations.

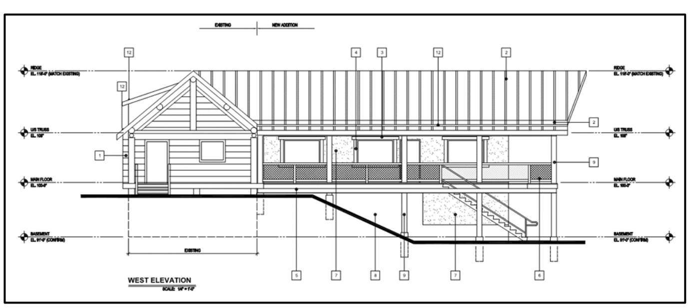
Background

The Larch Hills Nordic Centre is comprised of an original log chalet (constructed circa 1980s) with gabled roof and mezzanine. An addition was added to the building in 2016. Included in the addition was the installation of a shed dormer on the original building (see Sketch #1). The design of the addition was completed by New Town Services of Kelowna, B.C. Construction drawings were provided for our review.

Since completion of the addition, excessive ice damming has been reported on all elevations of the building, including the new shed dormer area.

Photo #1: East Elevation

Photo #2: Ice Damming

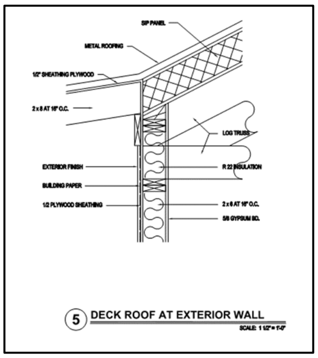


Sketch #1: West elevation (construction drawings)

Observations

A site visit was conducted on February 16, 2021, by Mr. Randy Smith P.Eng., Practice Leader, Building Science, from Williams Engineering Canada Inc. The site visit was also attended briefly by Mr. Rob van Varseveld, representative for the Nordic Centre. The weather at the time of the site visit was -3^{o}C and cloudy. The interior of the building was 13^{o}C with an interior relative humidity of 30%.

Examination of the construction drawings found the roofing system was not constructed as designed. The proposed structural insulated panel system (SIPS) slated for the new roof portion had not been installed.



Sketch #2: Proposed roof design

Photo #3: Common SIPS panel design

Instead the roof structure appears to be common 305 mm (12”) roof I-joists (TJIs) with expanded polystyrene block insulation (EPS) inserted between the joists. The insulation is held in place with wood blocking.

Photo #4: Open ceiling drywall

Photo #5: Insulation recessed between joists

On the west portion of the new roof, where the roof angle changes and extends over the exterior walkway, it appears 2x8 dimensional lumber joists were used instead of TJIs. The space between the dimensional lumber joists were completely filled with expanded polystyrene.

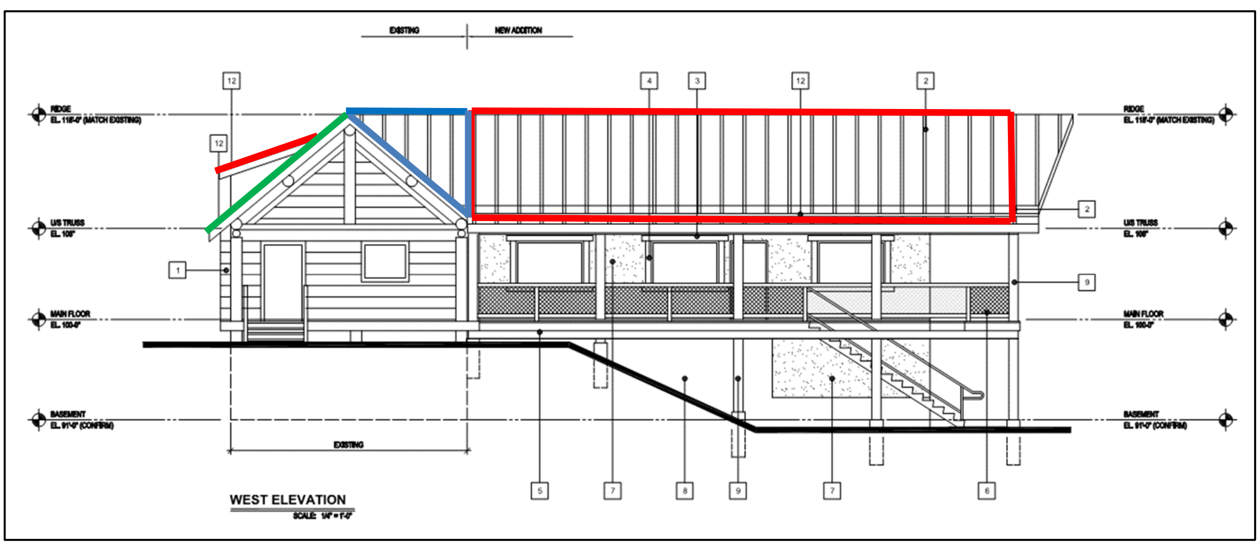
Photo #6: Framing and insulation at roof slope transition

Photo #7: Ceiling to wall junction

In the existing roof area, the remaining roof structure along the south slope appears to have been insulated with ½ lb/ft^3 density, open cell, spray-applied, polyurethane foam, with a 25 mm thick layer of foil-faced, polyurethane insulation installed inboard, over the new roof framing. Please note that this foil-faced insulation was not used behind the tongue and groove (T&G) ceiling finish.

At the time of the site review, the ceiling drywall where the new roof joins the existing roof, had not been installed. The north portion of the existing roof appears unmodified with fibreglass batt insulation and polyethylene vapour retarder. The shed dormer is constructed in a similar fashion to the roof in the new area although a carbon-infused expanded polystyrene has been used which has a slightly higher thermal resistance (R-value) per inch.

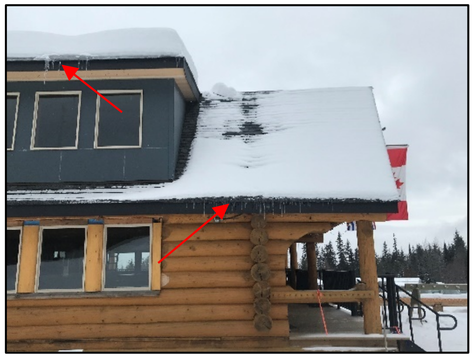
It should be noted that, in all new construction areas that were examined, no polyethylene vapour retarder was found between the insulation and interior ceiling drywall.



Sketch #3: Insulation in various roof areas

EPS Insulation between roof joists (addition)
Original Batt Insulation with Poly Vapour Retarder
Open Cell Spray Foam and Foil-Faced Polyurethane Board

The Ice damming observed during the site visit occurred on all elevations, except the south as no eave exists on that elevation. The amount of ice damming varied depending on location.



Photos #8, #9, #10: Examples of ice damming

Discussion

Ice damming can occur during cold weather when snow is present on the roof. If the roof sheathing is heated from below, the snow will melt at the shingle/snow interface. The meltwater runs down the roof to the eave. As the eave is typically outboard of the building envelope, the sheathing is at the outdoor ambient temperature. If the outdoor temperature is below 0^{o}C, the water will freeze to the shingles, Subsequent melting events will add layers of ice to the eave, eventually forming a dam at the eave edge. The melt water then backs up behind the dam which can then migrate under the shingles. Depending on whether underlayment has been installed below the shingles, and the type used, water penetration through the roofing system can occur.

Please note that, depending on the direction of roof exposure, icicle formation at the eaves can also occur due to solar heating of the shingles. This should not be confused with ice damming as the cause is completely different. Depending on the level of snowpack on the roof, and shingle colour, the shingles may be subjected to sufficient solar heat gain to melt the snow, producing runoff. If the water is not collected or controlled at the eave edge with eavestroughing or other water management systems, icicle formation will occur.

The control of ice damming requires the control of heat loss and air leakage through the roofing system. It is therefore important to construct a continuous thermal barrier with a suitable thermal resistance (R-value) as well as a tight air seal.

Conclusions and Recommendations

The current level ice damming on the building is caused by non-continuous thermal insulation and ineffective control of air leakage within the roofing system.

The portions of the original roofing system that still exist, with the batt insulation and polyethylene vapour retarder, are operating as designed but would still be inadequate to control warm air leakage to the underside of the roof sheathing.

The portions of the original roofing system that have been retrofitted with open cell spray foam insulation and foil-faced polyurethane insulation boards should perform significantly better than the original system however, the open cell foam does not provide an effective or durable air seal due to its open cell structure. Although a poly vapour retarder was not installed, the foil-facing on the foam board (with taped joints) will provide effective control of water vapour diffusion. It should be noted though that, although the board joints and terminations were taped, unsealed penetrations through the foam board will reduce its effectiveness as a vapour retarder.

The use of EPS insulation in the addition and dormer sections is acceptable from an insulation perspective however, little to no effort appears to have been made to make the underside surface of the EPS airtight at joints and connections. Further, given the position of the log framing, there would be certain areas where creating an effective airtight connection would be exceedingly difficult.

The restoration options fall into the three categories shown below and are based on the roof restoration design. A discussion of each option is provided. All options include replacement of interior finishes.

1. Unvented roof
2. Vented Roof
3. Insulated roof

Option #1: Unvented Roof

This option requires the removal of the existing drywall, interior finishes, and insulation materials to expose the roof structure and underside of the roof deck. The underside of the roof deck would then be sprayed with 150 mm (5”) of 1.8 – 2.0 PCF density, closed cell, spray-applied polyurethane foam insulation (BASF “Waltite”, Icynene “MD-C-200”, etc.). The insulation would be applied in maximum 50 mm lifts to ensure any cavities that form in the billowing foam are sealed. The thermal resistance of the roofing system would be approximately R-30. Please note that although spray foam is very effective in creating a tight air seal, vapour seal and thermal blanket, it is unreasonable to assume that all holes will be eliminated. The benefit of spraying to the underside of the roof deck is that, if a small hole (or “inlet”) in the foam exists, as there is no ventilation space between the foam and the underside of the roof deck, there is no “outlet” to allow for air to escape. Air flow is therefore significantly restricted if not completely eliminated. Another issue may pertain to the warranty of the shingles installed on the building. A number of shingle manufacturers will not warrant their products in an unvented application as it is believed that without the ventilation space below, excessive solar heat gain would reduce the life span of the shingles. This would have to be confirmed with the manufacturer of the shingles used on the building.

Estimated Cost Option #1: $14,000 - $18,000

Option #2: Vented Roof

This option is similar to Option #1 in that the roof structure and deck would be exposed and 1.8 – 2.0 PCF density, closed cell, spray-applied polyurethane foam insulation would be used to create the air barrier, vapour seal and thermal blanket. The difference here would be that cardboard baffles would be installed between the roof joists to create a 63 mm (2.5”) ventilation gap between the underside of the roof sheathing and insulation. This would have to be installed in conjunction with ridge and soffit ventilation required by the BC Building Code for a roof of this type. The ventilation area requirement is 1/300th of the insulated roof area relatively evenly split between the soffits and ridge. Therefore, a ventilated soffit and ridge venting would need to be constructed. As the soffit is currently constructed of T&G boards covering the structural elements, this would need to be removed so a vented soffit could be constructed. Further, as it appears there is horizontal blocking between the joists at the building-to-walkway roof transition on the west elevation, this would have to be modified to allow for air flow from the ventilation space through the soffit. At the roof peaks, a continuous ridge vent would need to be constructed as it appears that the roof sheathing was not strapped. Given the heavy winter snowpack, the ridge vent would need to be a raised “dog house” style to ensure the vent is not covered over with snow. As stated above in Option #1, some minor air flow through the spray foam is possible. As this methodology provides an “outlet” through the roof vent space, air leakage may occur. The requirement of the spray foam installer achieving a tight air seal is therefore much more critical. Please note this methodology can be used with simple batt and poly in lieu of spray foam insulation however, achieving a tight air seal is exceedingly difficult and is not recommended.

Estimated Cost Option #2: $22,000 – 26,000

Option #3: Insulated Roof

This option also requires the removal of the existing drywall, interior finishes, and insulation materials to expose the roof structure and underside of the roof deck. The shingles and underlayment would also be removed. A new self-adhered membrane would then be installed over the entire roof. One layer of 75 mm (3”) rigid insulation would be installed over the membrane, held in place with 75 mm (3”) vertical Z-girts. A second layer of 75 mm (3”) insulation would then be applied over top with the Z-girts installed horizontally to reduce thermal bridging. The thermal resistance of the roofing system would be approximately R-30. The assembly would be covered with an underlayment and the roof finished with a sheet metal system. Shingles could be applied, but an additional layer of exterior sheathing would be required over the Z-girts to allow for fastening of the shingles. This method effectively seals the roof and moves the roof joists to within the building envelope.

Estimated Cost Option #3: $45,000 - $55,000

CLOSURE

This report has been prepared based upon the information referenced herein. It has been prepared in a manner consistent with good engineering judgement. Should new information come to light, Williams Engineering Canada Inc. requests the opportunity to review this information and our conclusions contained in this report. This report has been prepared for the exclusive use of the client, and there are no representations made by Williams Engineering Canada Inc. to any other party. Any use that a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties.

Yours truly,

Williams Engineering Canada Inc.

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