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ENGINEERS, INC.

January 14, 2022 PND 222019

Ms. Patricia Hutcherson, Ph.D.
Superintendent
Yakutat School District
P.O. Box 429
Yakutat, Alaska 99689

Re: Yakutat High School Roof Snow Load Assessment
Structural Engineering Report

Dear Ms. Hutcherson:

Per your request PND Engineers has performed a limited structural inspection of the high school gym trusses, a representative inspection at the high school low roof framing, roof framing inspection at the elementary school and at the swimming pool. The inspection was deemed necessary due to the high snow accumulation on the roofs and some damage to finishes in the buildings. This letter contains some background, a description of our inspection, our observations, findings, and our recommendations.

Background

The original high school building, including the gym, was constructed in 1971 and 1972 according to plans prepared by architects Sands and Ackley. The high school addition was constructed 1n 1977 in accordance with plans by architects ECI Hyer and structural engineers SHCR-Barkshire. The elementary school was constructed in 1977 in accordance with plans by architects Lane Knorr and Plunkett and engineers Tryck, Nyman Hayes.

In the inspection reports from the 2007 and 2013 investigations, PND recommended to perform a snow removal program when roof snow accumulation was near or at the design snow loads on the buildings. According to available plans, the design snow load on the original high school building is 50 psf, at the high school addition is 105 psf and at the elementary school 125 psf.

The latest available snow load design guidelines are included in the April 2018 *Snow Cover in Alaska*, by Glenko, Lang, and Hammel of University of Alaska Anchorage. In this publication they state that the design snow load should be based on a ground snow load of either 178 or 186 psf depending on which statistical analysis used. This would be the ground snow load for a 2 percent chance of exceedance in 50 years. In accordance with the current edition of the Uniform Building Code, the roof design load would be 70 percent of this that would be then adjusted for importance, wind exposure and thermal conditions of the roof construction. Due to the variation in statistical information a ground snow load of 180 psf is used in this report. If the buildings are considered emergency shelters, which we understand is the case for the school buildings, the buildings are to have snow loads 1.2 times that of a typical residential, commercial or office building. For these buildings the resulting flat roof snow design load is 151 psf. If the buildings are not part of emergency shelters, then if the largest rooms can accommodate more than 250 people the Importance factor is 1.1 and the roof snow design load is 139 psf. If rooms have less than 250 people and are not emergency shelters the roof design snow load is 126 psf.

According to the current building code, using a ground snow load of 180 psf the predicted density of the snow is 30 pounds per cubic foot.

Based on the 30 pounds per cubic foot snow density the following snow depths are equal to the design snow load

Design Snow Load	Snow Depth at 30 pcf density
50 psf	20 inches
105 psf	42 inches
125 psf	50 inches

The above depths are very conservative due to the fact that snow density increases with the depth of snow accumulation. To get a more accurate determination of snow load at a certain depth, load measurements should be taken. It is recommended that to get reasonably accurate snow load information carve a 1 foot wide by 1 foot long by the snow depth high column of snow on the roof. Place that snow in a plastic container and weigh it, subtract the weight of the container and that is the snow load on the roof. For practical purposes the scale can be a bathroom type scale and need not be calibrated for legal trade.

Snow removal should be done to not damage roofing surfaces. A then layer can remain.

Inspection

On January 13, 2022 Chris Gianotti, P.E. and Mr. Chris Cook of the Yakutat City Schools repeated the limited inspection performed in 2007 and 2013 of the roof trusses at the high school gym and at the high school low roof, the framing at the elementary school, the swimming pool roof and the damaged surfaces of the walls at the elementary school. Inspection techniques included visual observations and taking digital photographs.

Observations

Observations made during the limited inspection include:

1) The high school gym trusses appear to be serving their function and are not damaged more than noted in the previous study. The high school low roof framing, both at the portion that was built under original 1971 construction and that built under the 1977 addition, also appears to be functioning adequately.

2) There is cracking in finishes at the lobby/hallway adjacent to the superintendent's office and in the receptionist office. The damage is not a structural concern, but is evident even under low to moderate load on the roof as structural framing deflects.

3) There are bent web members in a steel joist over the receptionist office. It is not know whether these were caused by excessive snow loads or were damaged during construction and have not been noticed until this inspection.

4) Wall surfaces are damaged in the elementary school where roof framing above was compressed or deflected under the large snow loads. This is a condition that was present in the 2007 investigation. The roof structural framing compressed and deflected under roof snow loads and no allowance was made to allow the roof framing to move independent of the wall finishes at load bearing and non-

load bearing walls. Gypsum wall board was compressed and was damaged. The damage does not appear to be due to any structural deficiency.

A vertical crack in the gypsum wall board above a second floor door was observed. This may indicate that the door header may have deflected more than the wall board could accommodate.

5) The pool roof structure appears to be functioning adequately and is not under distress.

Recommendations

Based upon the above observations, we make the following recommendations:

1) Continue the snow removal program. As noted in the 2007 and 2013 investigation reports the following guidelines should be used:

"A snow removal program should be executed when snow loads exceed the design roof snow loads listed on plans, that is ~~105~~ 125 psf at elementary school, 50 psf at the original roof of the high school and ~~125~~ 105 psf at the roof of the high school addition. Using an estimated density of saturated snow of 30 pounds per cubic foot the snow depths for these loads are approximately ~~3.5~~ 4 feet at the elementary school, 20 inches at the original high school roof and 4 3.5 feet at the high school addition."

(It is noted that in the 2013 report the design roof snow loads for the Elementary School and High School Addition were revered. They are correct in this report.)

"Snow removal should be in a manner that does not damage the roofing. Sharp tools should not be used."

"Snow removal should not be done in a manner that loads the roof greater than the design snow load. Snow should not be temporarily stored in plies on the roof. Any method should not increase the snow load in localized areas."

"Snow removal can be by mechanical means or other methods including heating the roof deck and melting the snow on the roof, melting the snow by spraying water. Roof drains should be operative and not clogged with ice or snow if heating or water application methods are used."

"Some ice or snow can be left on the roof as the roof need not be completely clear after snow removal. The remaining snow needs to have a load less than the design snow load."

If this snow removal program is followed, the building is safe to occupy.

The economy of permanent improvements to remove snow or reduce snow loads compared to building replacement is beyond the scope of this report. Adding sloped roof framing over the existing roofs will involve structural upgrades to the existing framing. Creating a salt-ware deluge system such as the one at Hidden Falls Hatchery Building will require construction of piping and pumping. Adding electric or hydronic heating systems for snow melt to the roof may have limited life or require significant maintenance. All these and other options should be carefully studied in

engineering/economic feasibility studied before any funds are dedicated to construction of such improvements.

2) Continue to monitor the condition of High School gym roof trusses. If the bottom chord of the trusses begins to move laterally (in a horizontal direction) the snow load at the roof should be measured and snow removal should be started if it has not already been started. If the seems of vertical and diagonal truss members open to larger widths than in their current condition a structural engineer should be consulted.

3) Alter the construction of the ceiling transition at the hallway/lobby adjacent to the superintendent's office. There is a gypsum wall board covered 2x wood stud assembly that looks like a box beam that is not structural. At this locations under moderate loads roof joists deflect and these joists push down on the 2x wood framing and that moves down and causes cracking in the gypsum wall board finishes.

   Notch the wood plates under the trusses to allow for an inch to 1.5 inches of truss deflection so the finishes will not crack when the roof joists deflect.

4) Remove the false header at the reception room. There is a gypsum wall board finished, 2x4 framed, false header below the suspended acoustical ceiling. It is an aesthetic feature that has no structural value. It is moved and loaded when roof framing above deflects. It is not structural and it un-necessarily causes concern when roofs are loaded with a moderate load (below the snow design load).

5) The steel joist with bent web members should be repaired. Either the bent sections of the diagonal web be heated and then mechanically pushed into a relatively straight condition or new additional bars be welded either side of the bent section and welded to the top and bottom cord. The bending to straight alternative should only be done by an person experienced in that type of work. Welding additional pieces should be done by an experienced welder with certification to perform fillet welds. The paint at the weld area needs to be removed by grinding. Place a 5/8 inch diameter bar on each side and parallel to the bent member then weld each end with a ¼ inch flared bevel weld on each side of the bar. The bars should be bare steel or have their paint removed at the weld area.

6) Monitor the crack above the second floor door in the Elementary School. If the door becomes wedged or will not close then the wall surfaces should be removed and the header inspected. If the header is split or damaged it should be replaced. If the header is damaged some consideration should be made to increase the header size.

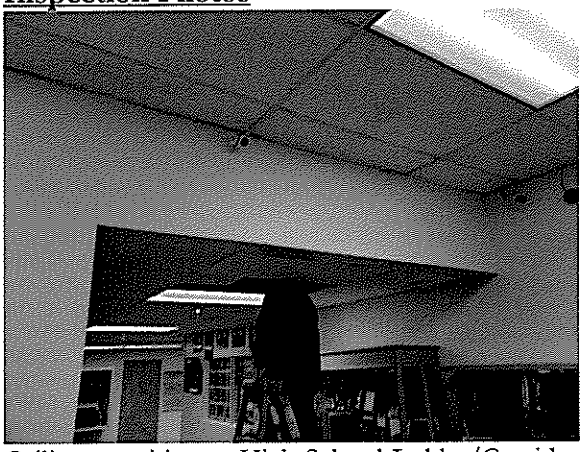
Hopefully, this report suits your needs. If you have questions or need additional information, please feel free to contact me.

Sincerely,

PND Engineers, Inc. | Juneau Office

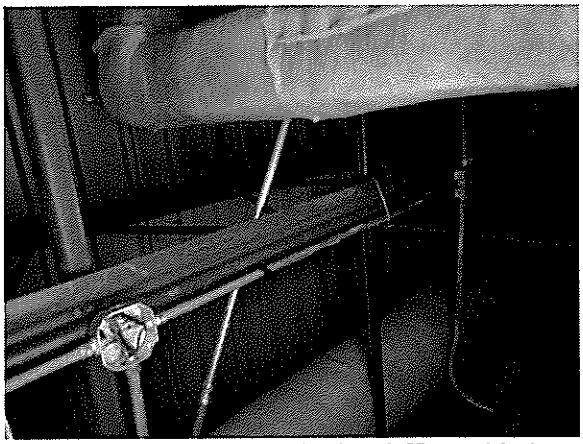
Chris Gianotti, P.E.
Senior Engineer

Inspection Photos



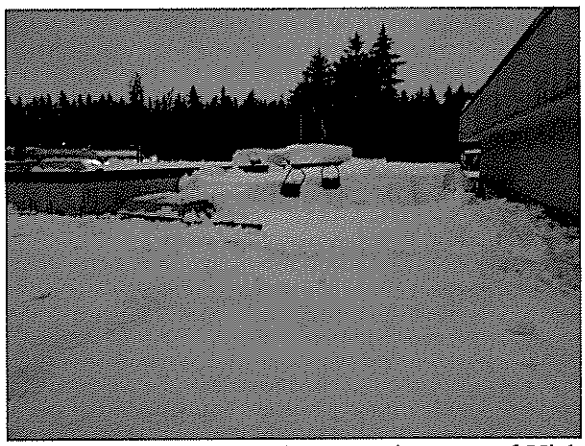
Ceiling transition at High School Lobby/Corridor has cracks on each end: Roof trusses are not supported by this but when they are moderately loaded the trusses push this 2x framed box beam down and the gypsum wall board cracks

False Header in Receptionist Office: Not a structural member and can be removed. This is pushed down when roof trusses are moderately loaded



Roof joist above Receptionist Office with bent web members.

Snow removal at Elementary School, south side of building. 4 feet of depth was measured.



Extent of snow removal over main entry of High School. Depth similar to Elementary School.

Snow mostly removed from east side of High School