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October 9, 2012

Lana Jones-Edwards
Division of Administrative Services
Alaska Department of Labor and Workforce Development
877 Commercial Drive
Anchorage, AK 99503

Subject: Condition of the Seward AVTEC Mechanic's Shop

Dear Ms. Jones-Edwards:

At your request, USKH Inc. (USKH) sent a structural engineer to 1916 Leirer Road, in Seward, Alaska to perform a condition study of the north portion of AVTEC Applied Technologies Campus. The north "half" of the structure is the Diesel/Heavy/Truck Equipment Technologies, Welding and Related Studies.

The purpose for this study is to assess the existing condition of the structures that comprise the Diesel/Heavy/Truck Equipment Technologies, Welding and Related Studies campus. The building is in need of a new roof, so this evaluation is to consider the condition of the building as it relates to replacing the roof assembly and to provide a recommendation on whether the building is structural sound and if a roof replacement would compromise the safety of the building. This report is based on a cursory review of the building and a few back-of-the- envelope type structural calculations used to verify some conclusions made while on site. The study is not considered an exhaustive evaluation of the building, so some of the conclusions rely on experience and judgment, in lieu of detailed structural calculations.

General Description

The Diesel/Heavy/Truck Equipment Technologies, Welding and Related Studies are housed in a pre-engineered metal building that was originally constructed around 1975. The primary building housing the equipment shop is a gabled structure framed with rigid steel frames spanning north/south. Light gauge "zee" purlins spaced approximately 5 feet on center span the 25 feet between frames supporting a sheet metal skin for both the roof and walls.

The sheet metal roof and siding panels are applied over a vinyl-backed batt insulation that is draped over the purlins or girts before the panels are applied. The batt insulation is approximately 2 inches thick, but the batt is compressed between the metal panel and the purlin which significantly reduces the insulating value of the wall or roof system.

The Diesel/Heavy/Truck Equipment Technologies portion of the building also includes a second floor that is framed with wood joists and wood load-bearing walls. The wood structure is not completely separate from the metal building system. Two classrooms and two offices on the second floor are enclosed in wood-framed walls. The floor framing for these rooms appears to bear on wood framed load bearing walls. The third classroom on the second floor is a mezzanine floor structure with no surrounding walls or ceiling. This classroom is open to the shop below. The mezzanine structure which comprises the floor of the third classroom appears to bear on a load bearing wall on the south edge, and on a steel beams that are welded to the steel columns in the metal building system on the north edge.

Similarly, several rooms on the main floor level are enclosed with the wood framed walls that support the second floor framing. The floor area beneath the open classroom above is also open to the shop area.

The welding portion of the program is housed in an independent structure on the north side of the original gable-framed building. The welding shop appears to have been a later addition to the original gable-framed building. The addition is a pre-engineered metal building system as well, very similar in construction to the main gable-framed structure that houses the Diesel/Heavy/Truck Equipment Technologies program. Although the two portions of the building function as a single facility, they are two independent structural systems that are linked by a common sheet metal roof assembly.

The welding program also has another small addition off the north of the welding shop used for fitting and grinding. The structure of the small addition is fully covered with wall and ceiling finishes, however the nature of the addition suggests the addition is framed with wood. The true nature of the grinding and fitting shop area is not significant related to the conclusions presented later in this report.

Another small addition was created off the north east corner of the truck shop, and it appears that it is used for storage. The addition consists of a CONNEX shipping container placed 6 feet outside the north wall of the shop, parallel to the north wall. A sloped roof (3:12) was framed using 2x4 dimensional lumber. The wood bears on the CONNEX unit, and it attached to the north wall of the gable frame building structure.

Observations and Discussion

The roof assembly consists of a low profile, thin gauge (26-gauge) steel roof deck that spans over purlins. Each roof panel is approximately 35 feet long and spans over eight individual purlins. The roof panels are lapped half way down the slope. The roof panel is very similar to an ASC Pacific product called “Super Span”. Based on some old (1984) ASC Pacific load/span tables, the capacity of the deck is 47 pounds per square foot.

There are some select areas on the roof where the roof panels have been structurally damaged by the weight of snow and ice. There are large areas near the eaves of the gable-framed structure where the panels noticeably bow (sag), and a large number of the deck flutes have buckled. The buckled flutes indicate the panels have been overloaded in the past, and they have lost their flexural strength.

Without flexural strength, they rely on tension in the plane of the roof deck to resist the weight of snow. The tension in the panels is pulling at the fasteners causing the holes to elongate. The elongated holes then allow water to enter the roof assembly, hence some of the roof leaks.

The sagging roof panels are most likely caused by snow sliding down the roof and accumulating at the eave. Generally, on metal buildings, the snow will slide down the roof and fall from the eave as is generally the case with this structure. The falling snow creates life-safety hazards and maintenance problems. There is ample evidence on the roof and on the walls to suggest that sliding snow is a significant problem on and around this building. For example, every roof penetration has a snow splitter installed above it.

A significant life-safety hazard exists on the north face of the building at the overhead door from the vehicle maintenance shop adjacent to the weld shop. The two man doors between the vehicle maintenance shop and the welding shop are protected only as long as persons are transiting from the main building to the welding shop. Building occupants should not exit the building on the north side when snow is falling from the roof. In certain weather conditions, the roof snow load can release quite violently, and with no warning.

The canopy above the overhead door on the north face is one area likely to experience sudden releases of roof snow. When Seward receives heavy snowfalls, the accumulation on the gable roof will start to melt due to the lack of insulation. The canopy is not heated, so the snow on the canopy is somewhat bonded to the cold deck. When the air temperature rises above freezing, the warm air under the canopy roof deck causes the snow to melt at the interface between the roof panels and the snow destroying the bond. When the snow finally releases, it likely streams off the roof followed immediately by the snow from the vehicle shop roof which is already unbounded.

In addition to the life safety hazard created by snow falling from the roof, falling snow becomes a building maintenance issue. The snow falling from an upper roof to a lower roof can damage the lower roof; or the head wall between the two roofs. Snow falling to the ground from a high roof can be deflected back toward the building wall causing damage to the base of the wall. If the wall structure is not damaged directly from the falling snow, it is often damaged when snow on the ground is removed by inexperienced operators using heavy equipment. There are many locations around the building where the siding has been damaged during snow removal operations.

In addition to sliding snow and falling snow, there is evidence that ice builds on the build eaves. The panels have numerous gashes that were likely made by an ice chipper as it was used to remove ice build-up. The ice forms at the eaves when snow accumulates on a poorly insulated roof, melts and the water flows down the roof and freezes at the eave. The resulting ice causes water to pond on the roof deck above the ice where it will, of course, flow through any holes in the roof assembly. The ice hanging on the eaves is represents a life safety hazard, and also a maintenance problem. It is extremely dangerous to have personnel on the roof removing ice at the eave. Snow and ice on a metal roof deck is especially slippery.

As mentioned earlier in the report, the roof deck is applied over vinyl backed batt insulation which is draped over the purlins before the metal deck is applied. The metal deck is then attached to the purlins using TEK style screws with rubber or neoprene washers, drilled through the deck into the purlins. With time, the exposure of the rubber washers to the sun causes the rubber to get hard and crack. When that happens, the roof begins to leak. Water entering through the roof panels falls to the vinyl backing on the insulation batts and then follows the batts down to hole, or to the eave. The problem is that roof leaks are virtually impossible to find. As a result, the building maintenance people spend an inordinate amount of time on the roof trying to find and seal leaks. The roof is covered with roofing cement repairs and there are patches on top of patches on top of patches.

Beyond the obvious condition of the roof deck, the sliding snow, and the ice dams, is the condition of the roof framing. One of the first observations made about the roof is the metal deck and purlin assembly is uncomfortably soft to walk on. The condition was noted, and later confirmed with structural calculations. The roof purlins appear to have been designed for a snow load of 30 pounds per square foot IF structural continuity is assumed to exist. The manner in which the purlins were installed does not conform to contemporary standards for structural continuity. As a result, the roof’s capacity to support snow is likely less than 30 pounds per square foot.

Working through the equations in the current building code adopted by the State of Alaska to calculate the design snow load for this structure yields a design roof snow load of about 35 pounds per square foot. The City of Seward has amended the code by local ordinance to change the design roof load from 35 to 80 pounds per square foot based on experience and recorded snow accumulations. The existing roof purlins are significantly deficient when analyzed using the current building code amendments enacted by the City of Seward.

The logical question that usually follows is, “How did a building with such deficient roof framing exist for nearly 50 years?” The answer lies in the minimal amount of insulation in the roof. The poorly insulated roof melts the snow before a significant amount can accumulate. Contemporary codes are written around energy efficient structures that tend to retain snow on the roof, not those that shed snow through melting and sliding.

The roof purlins are deficient with regard to unbalanced snow loads as well. Snow is deposited on a roof in varying depths depending on location. The snow is blown to various areas of the roof when it falls, or when the wind blows after the snow has been deposited. The result is, the snow is often deeper on the lee side of the roof ridge, and at the rakes of a building. The purlins in this building have not been designed to support this uneven load distribution.

In a similar fashion, the wind load on a roof varies depending on the location on the roof. Like the snow load, the wind pressure, in this case and uplift force, is greatest on the lees side of the ridge. In addition, the wind exerts significant pressures on roof rakes and eaves. The purlins were not designed for these varying load conditions either.

This report has made mention of the “lack of insulation” several times. Draping the insulation over the purlins as was used in 1975 is no longer permitted by the current code. The current building code requires more than 2 inches of insulation on the walls and roof of a structure. Metal buildings are required to have R-19 roof insulation (6 inch batts) over R-10 insulation (2 inches batts). The R-10 batts can be draped over the purlins, but an R-5 foam block must be inserted over the purlin before draping the batt insulation.

Summary

This condition study was initiated to determine if the building could be re-roofed. Although it is possible to replace the existing roof system in kind, it is not a prudent thing to do. The combination of the metal roof deck with very little insulation creates some significant life-safety hazards. Sliding snow and ice damming both cause leaks in the roof, and they increase building maintenance costs.

The minimal insulation in the roof is in part responsible for some of the life-safety issues associated with the roof, and it increases the cost of operating the building in terms of energy costs. Adding insulation to the roof would cause more snow to be retained on the roof. This investigation revealed that the roof purlins and the steel frames are deficient with regard to the current building code. Adding insulation to this structure could be detrimental to the building structure.

Conclusions

The existing roof can be replaced, but only in kind. Replacing the roof in kind only solves the leaking roof, it does nothing to solve the life safety problems, the structural deficiencies, nor does it reduce the cost of heating the building. The cost of replacing the roof in combination with making the necessary structural repairs to bring the structure into conformance with the current building code in our opinion, would exceed 50% of the cost of a replacement structure. USKH believes that a replacement structure may prove more economical than trying to retrofit the existing facility.

Sincerely,
USKH Inc.

Bruce Hopper, P.E.
Senior Structural Engineer

Attachment: "[List Attachments (or use As Stated if all attachments are mentioned in letter]"

c: Ms. Lana Jones Edwards, Alaska Department of Labor and Finance

Robert Koruna, USKH Inc.

Work Order: 1385100

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