W E T H E R H O L T A N D A S S O C I A T E S , I N C .

Roof Evaluation

Friday Harbor Elementary School
95 Grover Street
Friday Harbor, Washington

For

San Juan Island School District
PO Box 458
Friday Harbor, Washington 98250

Attn: Rick Thompson

Project No. 1007-07A1

August 19, 2010

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August 19, 2010
Project No 1007-07A1

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Attn: Rick Thompson

Ref: Roof Evaluation
Friday Harbor Elementary School
95 Grover Street
Friday Harbor, Washington

Greetings:

At the request of Rick Thompson, this writer visited Friday Harbor Elementary School in Friday Harbor, Washington on July 14, 2010 and August 4, 2010 to evaluate the existing roof and to provide reroof options.

On July 14, 2010 Bob Carrol (Facilities) met this writer on site to walk the interior of the building and roof and discuss roof issues.

On August 4, 2010, this writer performed destructive testing at sample areas of the existing roof (from the top) to further assess the existing roof conditions. Gary Stephens (Northwest Roof Solutions) performed roof openings and reinstallation.

Items of Understanding (Per discussion with Mr. Thompson and Mr. Carrol)

1. The building was reportedly constructed in 1986.
2. Due to reported ongoing leakage issues and areas of deterioration of the roof deck, the first roof was replaced approximately 9 years ago. Several pieces of deteriorated plywood decking were reportedly removed and replaced with new during the reroof project.
3. Reportedly, leakage has been an ongoing issue since roof replacement occurred 9 years ago but increased after extensive winter snowfall approximately 3 years ago. Leakage reportedly occurs during periods of rainfall and/or snow melt. Though leakage is relatively widespread, it has consistently occurred at several valleys.

4. Reportedly the mechanical and conditioned air system circulates the air in a continuous fashion during the school year but is turned off during the summer when school is not in session.
5. Some of the more recent roof repairs have reportedly been the result of insurance claims. Repairs have included removal of the existing roofing in the field, in several valley transitions, and several penetrations and reinstallation of new. Reportedly, some of the repair work has effectively reduced leakage.
6. The district plans to proceed forward with roof replacement in the near future, but would like to review reroof options that will address ongoing roof problems.

Observations

Friday Harbor Elementary is a wood framed single level structure with an asphalt shingle roof sloping approximately 3 inches per foot (with the exception of increased slope at several dormers).

The roof assembly includes laminated asphalt shingles manufactured by Pabco, one layer of #15 asphalt saturated underlayment, over ½ inch nominal plywood, over 2x trusses spaced at 24 inches on center and in-filled with batt insulation, over a reinforced polyethylene vapor retarder, over a hung ceiling. The vent gap between the top side of the batt insulation and underside of the plywood deck ranges from less than an inch to approximately 6 inches or more.

The shingles are fastened with approximately six 1 inch staples per shingle often positioned upslope of the manufacturer nail line.

Though the condition of the shingles is relatively good, the general condition of the roof is poor due to multiple soft spots noted in the underlying roof deck when walking the deck that appear to be the result of moisture related deterioration of the deck.

Deflection was noted in the roof deck at several areas, though was most evident at classroom walls, where the wall structures extend through the roof cavity to the underside of the roof deck.

Venting details include a continuous 2 inch wide metal strip vent at the soffit and what appears to be a Cor-A-Vent 300 type continuous ridge vent, or similar with a fiberglass liner attached to the underside. While walking the underside of the perimeter soffit and pointing a flashlight directly into the strip vent, several stretches of the vent appeared to be plugged with batt insulation. This was confirmed during a roof opening performed near the eave.

Roof-to-wall detailing at typical roof step-up transitions include metal step flashing integrated with the shingles (typically on a one-to-one basis) and integrated with the wood siding. Where the vertical legs of the step flashing were visible through an open gap in the wood siding, it was noted that the existing asphalt saturated building paper was reverse lapped with the step flashing. Deterioration of the wood siding was noted at several areas.

Roof penetrations predominantly consist of multiple skylights. The roof transitions at the upslope sides of the skylights include prefinished sheet metal crickets fabricated with lap seams, rivets, and sealant. Overall, the existing sheet metal curb flashings appear to be prone to leakage at corner and lap transitions which rely upon the integrity and longevity of the sealant installed.

Both the eave edges and rake edges include drip metal flashing and wood fascia.

Four roof openings were performed during the August 4, 2010 site visit in an effort to further review the existing roof conditions and gain a better understanding of the roof issues. Generally, openings included removal through the plywood roof deck. As previously indicated, roof openings were performed by Northwest Roof Solutions, who also reinstalled roofing once openings were complete. Roof opening locations and observations are listed below. For purposes of simplifying building orientation, the main front entrance elevation of the building will be considered the north elevation.

1. **Opening #1**, north slope, northeast roof area, field of roof, approximately 4 foot by 4 foot opening through the plywood deck.

   Observations: Two of the three separate pieces of plywood exhibited deterioration resulting in delamination of the plies and loss of structural integrity. A scratch awl was pushed through the plywood with minimal effort.

   What appeared to be surface organic growth was observed on the underside of the plywood sheathing and on a few truss cords, though appeared relatively minimal. All nails securing the plywood were rusted.

   The vent cavity below the roof deck measured approximately 6 inches and appeared relatively unrestricted.

   No evident water stains were noted on the top surfaces of the asphalt underlayment and plywood, which would typically be indicators of leakage from the top of the roof assembly.

2. **Opening #2**, north slope, central east roof area, downslope roof area, approximately 4 foot by 4 foot opening through the plywood deck.

   Observations: Deterioration of plywood resulting in delamination of the surface plies and loss of structural integrity.

   What appeared to be surface organic growth was observed on the underside of the plywood sheathing and on a few truss chords, though appeared relatively minimal. All nails securing the plywood were rusted.

The vent cavity below the roof deck ranged from approximately 2 inches to approximately 6 inches and appeared relatively unrestricted in the field.

The soffit cavity is in-filled with batt insulation which is blocking the existing strip vent and prohibiting ventilation. Wood blocking is installed between the top of exterior wall framing and the roof sheathing at every other truss bay, which may or may not pose a venting issue, depending on how well cross-venting can occur between rafters.

3. **Opening #3**, south slope, central west roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, downslope of skylight penetrations.

   Observations: The plywood appeared to be in good condition. Water staining was observed at a corner of the plywood that appeared to be the result of leakage through the roof assembly.

   The underside of the plywood appeared relatively clean.

   The vent cavity below the roof deck ranged from minimal to no gap (due to a raised piece of insulation) to approximately 8 inches.

4. **Opening #4**, south slope, southwest roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, approximately 4 feet upslope of a valley transition. Note the roof area opened is an area of recent roof repair, which included removal of the existing roof and areas of plywood, and installation of new matching the existing.

   Observations: The plywood appeared to be new and in good shape. The nails on the adjacent older piece of plywood were rusted.

   The underside of the plywood appeared relatively clean.

   The vent cavity below the roof deck ranged from no gap (due to a raised piece of insulation) to approximately 8 inches.

Satellite Image of Roof Showing Approximate Roof Opening Locations

Discussion

Ongoing moisture issues at the Friday Harbor Elementary roof appear to be the result of a combination of exterior leakage and interior condensation, resulting from the items listed below:

Problematic items resulting in leakage from the exterior:

1. Laminate shingles installed on slopes of less than 4 inches per foot can be prone to leakage, as cupping can occur at the transition between the exposed shingle edge and the underlying shingle where build-up occurs between the laminated shingle layers. Cupping of the shingle plane results in reduced slope and reduced drainage of water off of the shingle surfaces. Water may migrate under the overlying shingle tabs and traverse laterally over the underlying shingle until it finds an opening into the building, such as a fastener hole or shingle joint, resulting in leaks. This problem can compound when the shingle staples are improperly positioned and/or where further reduction in slope occurs, such as valleys, especially during periods of snow melt.

2. Transition flashings and crickets installed at various skylight penetrations rely upon sealant (which may be deteriorated or lacking) at corner transitions and laps, and appear to be vulnerable to leakage.

Problematic items resulting in probable venting issues and condensation:

1. Venting issues (restrictions) due to the following:

    a. Stretches of the soffit vents are blocked with batt insulation.
    b. Areas where the vent gaps below the roof deck are blocked with batt insulation, though minimal blockage was observed where openings were conducted.
    c. The ridge vent installed, including the fiberglass liner attached to the underside, restricts air flow.
    d. Multiple skylight penetrations restrict air flow within the vent cavity.
    e. Minimal to no soffit/downslope venting inlets at the southeast and southwest roof areas (south slope) due to the over-framed roof transitions at the east-most and west-most valleys. This condition likely occurs at the dormers, though some vent holes may have been installed in the over-framed structure below the roof plane.

Given the existing roof issues that are likely contributing to various moisture problems, we believe the most prudent course of roof replacement that would address both interior condensation issues and exterior leakage issues would include removal of the existing roof assembly and batt insulation (including vapor retarder) below the roof deck and installation of a new water-tight membrane system with rigid insulation and vapor retarder above the roof deck.

Removal of all of the existing batt insulation and vapor retarder from below the roof deck and relocating the insulation plane to above the roof deck with a properly installed vapor retarder would reduce probable condensation issues resulting from current venting restrictions. Installation of a waterproof roof membrane would reduce probable leakage issues through a shingled roof assembly on the existing slope.

All deteriorated plywood should be removed and replaced with new. Soffit vents should remain in place for venting of the soffit cavity but any vent inlet (at the openings above the wall plane) should be fully blocked and the insulation plane between the perimeter walls and roof deck should be made continuous. Ridge vents should be blocked as well.

The new roof assembly should include a continuous vapor retarder installed directly over the roof deck, two layers of rigid polyisocyanurate insulation meeting current R-value requirements, a mechanically fastened coverboard, and either a multi layer granular surfaced modified bitumen roof covering (basesheet, mid-ply, and granular capsheet) or a single ply membrane roof covering.

Proper detailing and flashing transitions should occur at all penetrations, roof-to-wall transitions, and perimeter roof details. Continuous blocking would be required at the perimeter edges, matching the height of the rigid insulation. Skylight curbs, roof penetrations and roof-to-wall transitions will need to be raised to a minimum 8 inches above the finished roof plane.

Modified bitumen roofing system manufacturers observed in the local market as manufacturing durable products are Siplast and Performance. These systems, typically more expensive, can provide the owner with a roof lasting roughly twenty years or more, if appropriately designed, installed, and maintained. Other less expensive manufacturers to consider are Certainteed and Malarkey.

Prior to moving forward with an asphalt roof assembly, fire rating requirements should be review to determine which assemblies meet the required rating.

A single ply roof assembly may be less expensive than the modified bitumen assemblies but also lacks the redundancy/layering of membrane and can be more easily punctured. Maintenance and repairs on a single ply roof can be more expensive as they generally require a professional roofer and can be more driven by warranty requirements.

On the other hand, single ply roof assemblies can be installed with weldable ribs that will emulate a standing seam sheet metal roof, potentially improving the aesthetics.

Due to the slippery nature of the single ply membrane, continuous snow stops should be installed along the eaves to reduce the possibility of snow slide and injury.

Single ply roofing manufacturers observed in the local market as manufacturing durable products are Sarnafil and FiberTite. These systems can provide the owner with a roof lasting roughly 20 years if appropriately designed, installed and maintained. Note a minimum 60 mil single ply membrane thickness should be utilized.

Note prior to proceeding forward with new insulation, coverboard, and blocking above the roof deck, the existing roof structure should be reviewed by a professional structural engineer to verify the added load will not be problematic.

Other roof related items that should be addressed:

1. The existing siding at roof-to-wall transitions should be removed and replaced with new, over a properly installed vapor retarder.
2. Review and remediation of any organic growth should be performed/directed by a certified industrial hygienist.

If requested by the owner we would be willing to discuss other roof options including leaving the existing batt insulation and vapor retarder in place, and attempting to modify the existing venting (where possible) in attempt to increase the ventilation below the roof deck. That said, some of the venting problems previously listed may not be easily remedied. In other words, some venting issues may transfer to a new roof if the insulation remains below the roof deck.

We would also be willing to discuss other shingle roof options, though given existing inconsistencies in the roof surface and limitations with the slope, leakage could occur, though on a reduced scale. It is also important to note that laminated shingle should not be considered, rather three-tab shingles only.

We trust the above discussion will be helpful. Please do not hesitate to call with any questions.

Respectfully,

Michael Caniglia, RRO, RRC
Field Engineer

Reviewed by:

Bob Card, RRC, RWC
Senior Field Engineer

Please note that this inspection is provided at the request of Rick Thompson, San Juan Island School District. No liability, warranty of merchantability, or guarantee of roof or building service life is accepted or implied. Wetherholt and Associates, Inc. is a neutral consulting firm specializing in roofing, waterproofing, and building envelope related issues.

Photo #1: South and east elevations.

Photograph Location
Photo #2

East elevation.

Photo #3

South elevation.

Photo #4

West elevation.

Photo #5

Classroom #17, southwest area of the building: Water stains on the ceiling tiles as a result of past leakage. Water stains generally align beneath a valley transition.

Photo #6

Southwest roof area.

Photo #7

Standing at the west end of the roof, pointing east.

Photo #8

Standing at the southwest roof area, pointing east towards the south roof area.

Photo #9

Standing at the west end of the gym roof, pointing east.

Photo #10

Roof opening #1, north slope, northeast roof area, field of roof, approximately 4 foot by 4 foot opening through the plywood deck.

Photo #11

Roof opening #1, north slope, northeast roof area, field of roof: Shingles are secured with 6 staples per shingle generally positioned upslope of the manufacturer nail line.

Photo #12

Roof opening #1, north slope, northeast roof area, field of roof, approximately 4 foot by 4 foot opening through the plywood deck: Observed deterioration and loss of structural integrity of the plywood sheathing. A scratch awl was pushed through the plywood with little effort at this location.

Photo #13

Roof opening #1, north slope, northeast roof area, field of roof, approximately 4 foot by 4 foot opening through the plywood deck: Observed what appeared to be surface fungal growth on the underside of the plywood roof sheathing, that may be the result of condensation.

Photo #14

Roof opening #1, north slope, northeast roof area, field of roof, approximately 4 foot by 4 foot opening through the plywood deck: Approximately 7 inch vent gap between the existing batt insulation and the underside of the roof deck.

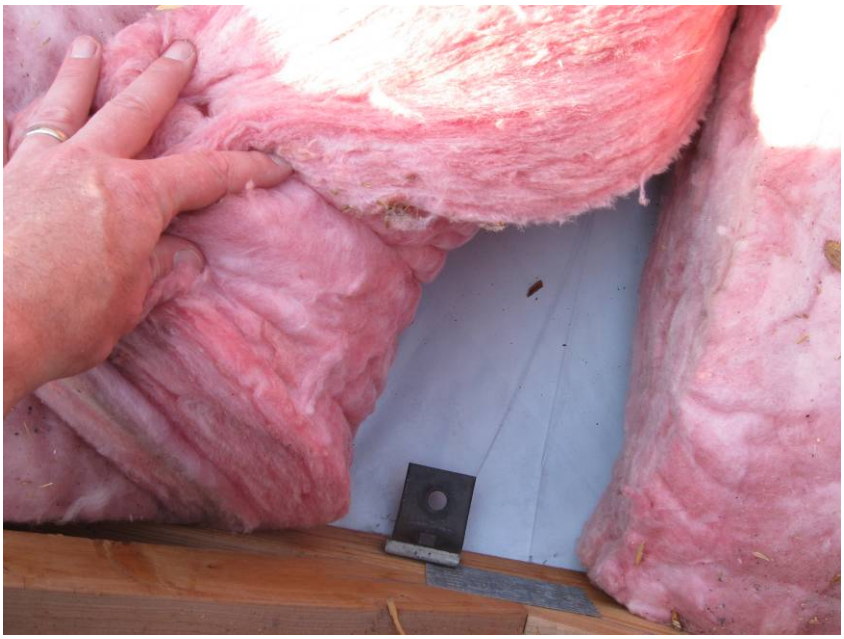

Photo #15

Roof opening #1, north slope, northeast roof area, field of roof, approximately 4 foot by 4 foot opening through the plywood deck: A piece of batt insulation was lifted to expose the visqueen vapor retarder installed on the inboard side of the insulation assembly, which is appropriate.

Photo #16

Interior view of the underside of the insulation assembly beneath the roof. Insulation and vapor retarder are integrated between the web trusses (spaced at 24 inches on center). Typical vapor retarder seams and transition points detailed with tape.

Photo #17

Roof opening #2, north slope, central east roof area, downslope roof area, approximately 4 foot by 4 foot opening through the plywood deck.

Photo #18

Roof opening #2, north slope, central east roof area, downslope roof area, approximately 4 foot by 4 foot opening through the plywood deck: Observed moisture staining and deterioration of the plywood roof sheathing.

Photo #19

Roof opening #2, north slope, central east roof area, downslope roof area, approximately 4 foot by 4 foot opening through the plywood deck: Observed what appeared to be surface fungal growth on the underside of the plywood roof sheathing, that may be the result of condensation.

Photo #20

Roof opening #2, north slope, central east roof area, downslope roof area, approximately 4 foot by 4 foot opening through the plywood deck: At the downslope eave, insulation was installed in the soffit cavity (arrow) and blocking the soffit vent. In this photo, the insulation that was installed in the soffit cavity had already been removed by this writer.

Photo #21

Roof opening #2, north slope, central east roof area, downslope roof area, approximately 4 foot by 4 foot opening through the plywood deck: Close up of the soffit cavity showing the top side of the strip vent which was blocked with batt insulation. Note the batt insulation installed in the adjacent cavity (top right corner of the photo) is blocking the vent as well.

Photo #22

Roof opening #3 south slope, central west roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, downslope of skylight penetrations.

Photo #23

Roof opening #3 south slope, central west roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, downslope of skylight penetrations: Observed water stainage on the downslope corner area of the plywood (arrow).

Photo #24

Roof opening #3 south slope, central west roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, downslope of skylight penetrations: Observed water stainage on the underside of the plywood (arrows).

Photo #25

Roof opening #3 south slope, central west roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, downslope of skylight penetrations: Approximately 6 inch vent gap observed between the top surface of the batt insulation and the underside of the plywood sheathing.

Photo #26

Roof opening #4 south slope, southwest roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, approximately 4 feet upslope of a valley transition.

Photo #27

Roof opening #4 south slope, southwest roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, approximately 4 feet upslope of a valley transition: Plywood sheathing appeared to be recently installed as part of a roof repair.

Photo #28

Roof opening #4 south slope, southwest roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, approximately 4 feet upslope of a valley transition: Wood blocking (arrow) installed over the beam at every other joist bay is restricting venting.

Photo #29

Roof opening #4 south slope, southwest roof area, field of roof, approximately 2 foot by 4 foot opening through the plywood deck, approximately 4 feet upslope of a valley transition: Batt insulation upslope of the opening is blocking ventilation.

Photo #30

Typical skylight penetration: Upslope cricket is consists of prefinished sheet metal that is reliant on sealant at the seams and transitions, and appears to be prone to leakage. Various maintenance/repair work has been performed on various penetrations flashings which typically includes application of sealant and asphalt roof cement.

Photo #31

Typical soffit vent includes a continuous ~2 inch strip vent. Several runs of strip venting at the soffit appear to be blocked with batt insulation.

Photo #32

Typical ridge vent includes what appears to be a Cor-a-vent 300 or similar which includes a fiberglass liner on the underside.

Photo #33

Typical roof-to-wall transition: Several areas of the wood siding are deteriorated and may be open to water entry during wind-blown rain.

Photo #34

Typical roof-to-wall transition: Several areas of the wood siding are deteriorated and may be open to water entry during wind-blown rain.

Photo #35

Typical roof-to-wall transition: Several areas of the wood siding are deteriorated and may be open to water entry during wind-blown rain. Note the step flashing is not properly integrated with the weather resistant barrier (behind the siding) in shingle fashion.