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BergerABAM

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10 November 2011

Mr. Patrick Jones
Executive Director
Port of Moses Lake
7810 Andrews Street NE, Suite 200
Moses Lake, WA 98837-3204

Subject: Structural Observations Report and Recommendations on Hangar Structures
Grant County International Airport
Moses Lake, Washington

Dear Pat:

BergerABAM is pleased to have the opportunity to help you make capital improvement decisions by offering our recommendations based on the structural observations performed by two of our most experienced engineers. The cost numbers for roof and building replacement in the report were provided courtesy of our friends at Project Dimensions – a consulting firm specializing in construction cost estimates located in Bellevue, Washington.

The attached report is not strictly a technical document because it is based only on visual observations, but our extensive experience in building retrofit and remodels enables us to make the recommendations stated in the report.

Should you have any questions, please contact me at any time. We want to be of service.

Sincerely,

Ruba Zumut

Ruba N. Zumut, PE
Senior Project Manager

RNZ:nb
Attachment

STRUCTURAL OBSERVATIONS REPORT AND RECOMMENDATIONS ON HANGAR STRUCTURES GRANT COUNTY INTERNATIONAL AIRPORT PORT OF MOSES LAKE MOSES LAKE, WASHINGTON

INTRODUCTION

On 30 September 2011, Patrick Harrigan and Alexander Mihaylov, structural engineers with BergerABAM in Federal Way, Washington, visited three existing buildings located at Moses Lake Airfield. The buildings are designated as Building 401, 408, and 2203. The purpose of the site visit was to perform structural observations of the roof system and overall condition of the building and to provide an opinion and recommendations for retrofit schemes and cost associated with each scheme.

DESCRIPTION ON THE EXISTING STRUCTURES

The three buildings were constructed in 1942 and have since been continuously in use. Each building consists of a hanger portion measuring 200 feet by 160 feet and a timber-framed "lean-to" structure.

The roof structure consists of bowstring trusses (curved top chord, straight bottom chord) spaced at 20 feet on center, spanning 160 feet. The truss top chord is a single glulam piece comprised of eleven 2x6 laminates. The truss bottom chord consists of two 6x12 timbers spliced at six locations along the truss span; 2x12 roof purlins spaced at 2 feet on center span between the trusses; and 1x6 roof lumber decking perpendicular to the roof purlins is used for sheathing.

The roof structure is supported by cast-in-place reinforced concrete walls with pilasters at the interior face and counterforts at the exterior face at truss locations with concrete masonry unit infill panels. At gable-end walls, there are box-shaped buttresses. The walls are supported by shallow foundations. The floor is cast-in-place slab-on-ground.

A more detailed description of the structures was found in a series of structural assessment reports prepared in 1998 by The DOH Associates because original as-built drawings are not available.

STRUCTURAL OBSERVATIONS

The following are our observations specific for each building.

Building 401

- Limited damage due to water intrusion.
- Fewer loose truss bottom chord splices.

Building 408

- Used as a warehouse and office space afforded by wood-framed enclosures sitting on the concrete floor.

- Extensive damage due to water intrusion, including decking, purlins, and trusses.
- Many loose truss bottom chord splices.

Building 2203

- Building is currently being used by the U.S. Air Force for storage of equipment.
- Very little visible damage due to water intrusion.
- Repairs, such as splice bolt tightening and truss bottom chord retrofit, have been done.

The primary concerns are the loosening of the connections at the truss bottom chord splices, checking (cracks) in timber members, and roof member damage due to water intrusion. Timber checking was observed on all roof trusses. It should be noted that the slab-on-ground and walls are in excellent condition in all three buildings. Given their almost 70-year age, it is an indication of quality work and good soil conditions. It would be wasteful not to try to salvage some of it, especially the floor slabs.

BergerABAM reviewed the structural assessment reports prepared in 1998 by The DOH Associates, and agree with their findings.

PROPOSED RENOVATION SCHEMES

The three options considered are

1. Extensive roof repairs of the existing roof structure
2. Roof replacement and seismic upgrade of the lateral system, if required
3. Total building replacement

Each of the options represents a different order of magnitude of the costs that need to be invested to keep the buildings safe and operational.

Extensive Roof Repairs

Any project involving roof repairs will require extensive field investigation work to identify all components that need replacement or retrofit. It will then take a significant design effort to prepare construction documents with a complete inventory of the affected components and specific details for all different conditions. Temporary shoring, scaffolds, or both will be required during construction.

It appears to be the lowest-cost solution; however, there are some inherent risks, such as

- If portions of the roof decking need to be replaced, the roofing itself would have to be replaced and patched at the affected area, unless the project includes a total roofing replacement.

- In repair projects of this size and complexity, there are always instances where so-called "discoveries" are made during construction. Those are usually hidden defects or damages that are uncovered during construction. These "discoveries" can add significant costs to the structural repair as they are typically an added service to the contract.

- There are also instances where the available retrofit connections may not be effective in the long run. An example is the retrofit done to the bottom chord of a couple of trusses in Building 2203. It was closely inspected during the visit, and it was observed that a shear crack had developed in the timbers where the line of bolts connects the steel anchorage plates to the timbers. The material creep over time also reduces the effectiveness of solutions that involve prestressing components anchored to timber.

In any case, it would be problematic to try to assess the structural capacity of the roof components before or after the retrofit due to the great variability of the existing timber material properties and the connection conditions. There has been damage, such as water, stress cracking at connections, and settlement issues, to portions of each building roof structure that would make assessment of these properties very hard to quantify.

Due to the uncertain conditions existing, accurate construction costs for this method would not be possible to obtain until the investigation and the design work are completed.

Roof Replacement

A roof replacement is an alternative that can be easily quantified and cost estimated. There are several options for truss profile and roofing material, but conceptually the structural layout is similar.

- The existing timber roof trusses are to be replaced with steel trusses. The trusses may have the same profile (bowstring) or pitch (constant slope with a ridge line at midspan). Truss heights could be modified to provide adequate clearance to allow the use of the facilities for all of the 737 family or A320 family aircraft with minimal costs by either sloping the truss bottom chord or extending the existing pilasters to accommodate an additional 5 to 8 feet of clearance.

- The purlins may be cold-formed Z-shapes or open-web steel joists spaced at 5 feet on center.

- Standing-seam metal roof and built-up roof over steel deck are two of the roofing options. The standing seam metal roof costs are typically more than build-up but usually provides for a design life that is two times the built-up roof. The replacement cost of the 32,000-square-foot hangar roof, including metal roofing and replacement of existing utilities attached to the roof members, is estimated currently at $3.5 million per building. However, the steel roof will weigh more than the existing roof, thus a seismic evaluation and possibly upgrade of the existing facility will be required by code. Because those are governed by lateral loads (wind and seismic), they most likely will be adequate for the added gravity loads. The seismic aspect of the structural assessment will be the most important. In order to enable it, as-built drawings need to be obtained from the archives of the U.S. Army Corps of Engineers. If those are not available, a study would have to be commissioned to determine the wall reinforcement using ground-penetrating radar or similar equipment.

If the existing concrete structures are adequate "as-is" to meet the current building code requirements, the roof replacement may add another 50 to 75 years of useful life for the structures. If a seismic retrofit is required, there are several options available, such as adding concrete shear walls that could be shotcreted, to the existing exterior walls, or a series of steel braced frames at selected bays between the existing columns.

Building Replacement

It is difficult to estimate the replacement cost of a hangar building due the large number of requirements imposed by the current building codes on the building's systems and utilities. Consideration would need to be taken to the desired use of the new facilities. If the Port envisioned a new facility to be used for commercial aircraft heavy maintenance, then a fire suppression system for fueled aircraft would probably be required along with the necessary mechanical systems required for aircraft maintenance, such as overhead cranes, electrical, and communication systems. Assuming that the new buildings would have the same dimensions, it is estimated that replacement cost would be in the range of $10 to $15 million per building, depending on the hangar design criteria. For expenditures of this magnitude, it may be more cost-effective to construct a hanger that will handle larger aircraft, as the fixed costs associated with the new construction will not vary due to the size of the hanger and would provide the Port with a much wider maintenance market to target.

CONCLUSIONS AND RECOMMENDATIONS

All three options are viable; however, it is BergerABAM's opinion that the repairs of the existing structure cannot guarantee a long-term performance and reliability. Because the full extent of the repairs is unknown and roofing replacement is necessary, the final cost may actually be close to the cost of a total roof replacement.

Our recommendation is to replace the roof, perform structural assessment of the existing concrete walls and foundations based on as-built drawings (if available), in order to assess the ability of the existing structure to support the additional lateral loads due to the new roof structure.

It should also be pointed out that there are other 'hybrid" options, such as a roof replacement combined with adding bays and new hangar doors, which would be a good fit for Building 408. The addition of the new bays could serve as a seismic retrofit of the entire structure, and thus eliminating the need for seismic upgrades to the existing walls.