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May 16, 2024

Via: Email (akissi-antwi@kawarthalakes.ca)

Mr. Anthony Kissi-Antwi
Senior Engineering Technician
Public Works Road Operations
City of Kawartha Lakes
89 St. David Street
Lindsay ON K9V 5K2

Dear Mr. Kissi-Antwi:

Re: Quonset Hut Review, City of Kawartha Lakes (Revision 1)
603 Sandringham Road
Project No.: 300058345.0000

R.J. Burnside & Associates Limited (Burnside) was requested to complete a structural review of the existing Works Department utility building at the above address. The building has a semi-circular-shaped corrugated roof with cast-in-place foundations and is commonly known a "Quonset Hut". The purpose of this review and report is to visually review the structure, advise on its condition, and provide some general recommendations for further consideration. On March 26, 2024, Burnside attended the site to undertake the review and met with some of the City of Kawartha Lakes staff who also came out to the site.

1.0 Background

It is our understanding that the Quonset Hut structure has been used for utilitarian storage and related uses. Burnside received a copy of the original design drawing from the City of Kawartha Lakes, which was produced by Totten Sims Hubicki and Associates Ltd. Revision #2 and dated July 20, 1967. The building is currently partially insulated and is generally unheated during the winter season.

There were some brief discussions on site during the review and it was confirmed that there were also discussions about providing power and lighting to the building. Those non-structural aspects are not being covered in this report.

The picture below provides a general view of the southeast corner side of the utility building.

2.0 Observations

The original design drawings indicate the superstructure is made with corrugated steel panels 2' x 10' x 7-1/2" profile (610 mm x 3,048 mm x 190 mm), 18-gauge (1.21 mm) material bolted at 6" (152 mm) on centre. The overall plan size is 41'-11 -3/4" wide x 62'-4" long at the base. This is 12,795 mm wide x 19,000 mm long in metric.

Wood strapping runs perpendicular to the ribs of the arch on the interior, and these are connected to the structure with light steel straps. These wood strips in turn are used to fasten sheets of expanded polystyrene foam boards (EPS) and along the sides, these insulation panels are covered with plywood sheathing. Over time, most of the insulation panels have fallen or come off from the wood strapping and are no longer present. Along the walls or sides of the arch, the plywood extends about 2,400 mm or two sheets laid horizontally above the concrete floor. Most of these remain in place.

There are a few translucent, possibly fibreglass, panels near the high ridge of the building to allow in some natural light. These panels replace the structural ribbed steel panels and are the same profile. Otherwise, there are no ceiling-level lighting fixtures.

The drawings indicate a concrete slab on grade 6" (152 mm) thick reinforced with 6 x 6 x 6/6 welded wire mesh (152 x152 mw 18.7 x mw 18.7). This mesh is shown as being lapped at least 1'-6" (450 mm) with #4 reinforcing steel bars at 12" (300 mm) on centre horizontally extending out of the footings. The cross-sectional area of this reinforcing is approximately 430 mm^2 per metre, and the mesh area is approximately 123 mm^2 per metre.

The footings are shown poured monolithically, or integrally with the concrete slab. The footings are shown as continuous and are set approximately 150 mm below grade on native material with 150 mm of gravel below the slab. The footings are in good condition, and we did not notice movement due to significant frost heave. We did not notice major cracking, spalling, or delamination of the concrete footings.

The corrugated steel roof panels are set in a continuous keyed recess in the top of the footing at 4" or 100 mm deep. Once the steel panel is secured, the recess is noted on the drawings as being filled with grout. The construction generally appears to match this scheme.

The drawings show a double door each 10' wide x 14' high (6,100 mm total width x 4,267 mm high opening) on the south end of the building, along with one man door just to the west and another man door at the north end of the building. The drawings also note a centrally located exhaust fan at the peak of the roof and some basic ceiling lights. There are some variations, in that there is a roll-up overhead door also on the north side of the building, and there is a man door at both the north and south ends. Both man doors are on the east side of the large doors. The drawings show the man door on the south end on the west side. On the south end, the double large doors are no longer present and there is a large roll up door now in its place. Thus, the light exterior steel frames for exterior roller support of the original doors are no longer being used.

We observed that the corrugated steel panels were as noted and bolted together. Some roof panels have lost their galvanized coating protection and are showing some corrosion. It appears these lightly corroded panels account for 10% to 15% of the roof area.

There are more heavily corroded panels along the base of the Quonset Hut walls, where the panels are set in the grout bed. The most significant corrosion is along the west side, where some panels have completely corroded through at the interface between the concrete and the wall. There are similar panels on the east side. There are corroded panels on the north side and at the base of the man door, but these are not as structurally significant. These north and south end walls must only resist wind loading and do not carry roof snow load to any significance.

Based on a walk around and at eye level, the bolts fastening the sheets together are intact and do not appear to be corroding. The bolts do not show signs of loosening or elongation of the holes, as would be the case in an overstress or severe corrosion condition.

The interior slab on grade is in fair condition. There are some cracks in various directions, which could be due to some frost heave or due to heavy loads, as we understand some vehicles are parked inside in the winter. However, the concrete surface is steel-trowelled, hard, and not scaling or delaminating. The cracks are not vertically stepped and overall, we did not see signs of reinforcing steel corrosion. There were no longitudinal cracks that we could see along the east and west sides that would be parallel to the direction of the loaded footings. Some materials and signs are stored inside the building, covering some floor areas.

There is no exterior concrete apron slab in front of the large overhead doors.

The grade around the building is generally flat and at, or slightly below, the top of the exterior footings.

3.0 Assumptions and Constraints

The following items were considered.

- The review is based on a visual assessment and is meant to address the overall condition and performance of the building structure.
- This review does not address other building systems such as electrical and mechanical.
- There may be individual members that have some deterioration that is not readily apparent.

- There are no geotechnical reports so we cannot establish the ultimate capacity of existing footings.

4.0 Conclusions, and Recommendations

The following discussion outlines our conclusions and suggested options for the utility building:

The existing walls and footings appear to be performing well, based on the original loading it was subject to. There are no deflected or buckled panels or major cracks indicating overloading or vehicle impacts.

The welded wire mesh reinforcing in the concrete slab is meant to reduce the amount of shrinkage and temperature-induced cracking in the concrete slab, but it also critically acts as a tension tie member between the lower ends of the steel panels. This tie must be in place to stop the footings from moving horizontally outwards, especially when the roof has high snow loads on it. Cracks in the concrete slab can allow water and moisture to penetrate down to the layer of reinforcing steel. The tie force across the slab is limited by the wire mesh area. The steel grade of the mesh is not known or stated but would typically be in the 300 MPa yield for that era. This would maximize the tension capacity as a tie to 36.9 kN/m or 2,529 lbs/foot.

Welded wire mesh is often supplied in rolls, but preferably in sheets. This mesh is made with small diameter wires, and it can be difficult to place and hold accurately in place. Thus, the mesh steel could vary in its location within the depth of the 150 mm thick slab. If close to the top or bottom, it could corrode quicker with less concrete cover protection.

The strength of the tie capacity at the slab level may or may not be the limiting factor in the overall building capacity to resist loading. The whole structure would have to be re-engineered. Not all of the properties of the steel materials are noted on the drawing, which would make this process iterative and approximate at best. However, based on the Ontario Building Code Part 11, the capacity of an old building does not have to be reinforced or strengthened to current standards if the general use of the building remains unchanged. Thus, if the material condition of the structure is not adversely changed, then it remains suitable for re-use. OBC Section 11.3.1.1 indicates that repairs must achieve a Performance Level equal to the capacity prior to the repair.

New building extensions must be designed to the current standards of other parts of the OBC. Thus, it is important to maintain the capacity of the original structural elements that make up the structure, that being the steel super structure, the foundation including the foundation ties, and the slabs.

In this case, the slab on grade cannot be isolated from the walls and roof structure but is an important part of the overall system which is different from many other buildings which are not essentially a tied arch construction.

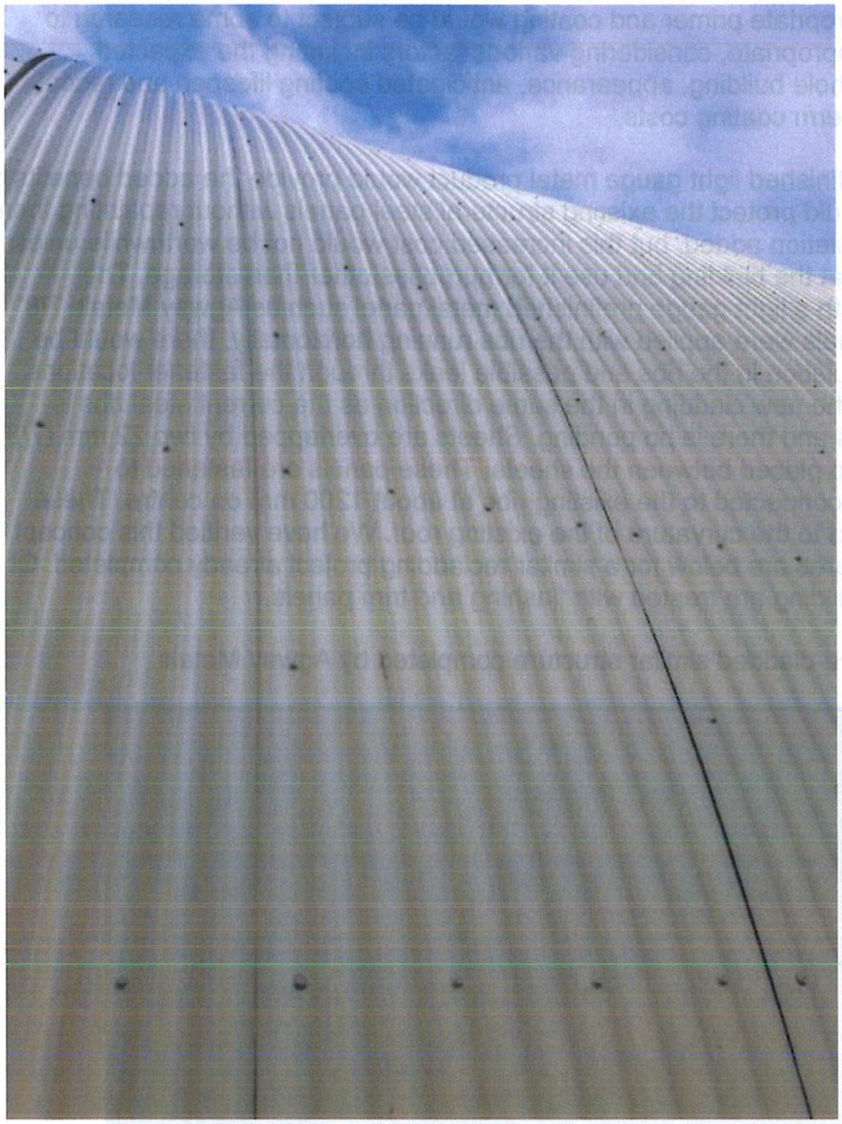
The tie action of the slab appears to be intact and functioning well. We would, however, suggest some crack sealing to reduce moisture penetration through these locations. Otherwise, the concrete slab on grade is in a serviceable condition for the present and expected use of the building. It would be suggested to keep de-icing salt out of the building as much as possible to avoid concrete and steel deterioration.

The steel panel corrosion will accelerate in areas where rusting has begun, and the galvanizing is now depleted. Such steel would have to be cleaned and painted to extend the lifespan of the panels. Determining an appropriate primer and coating would be subject to some research to determine what would be appropriate, considering various factors including the expected remaining lifespan for the whole building, appearance, anticipated coating lifespan and recoat time, initial costs, and long-term coating costs.

Cladding the roof with a prefinished light gauge metal product would provide the added benefits of improved aesthetics and would protect the existing structural steel panels without repainting them. The exterior could have insulation added, but this increased cost would not be worthwhile unless there was an intention to heat the building and use it for purposes other than storage. The recladding could be done with a light gauge prefinished metal panel such as Agway Metals 7/8" corrugated profile. If the panels were applied with the ribs running horizontally, there would be problems with water accumulation in the ribs and possible leaks through the fastener locations. Running the corrugation of the new cladding in the same direction as the current steel ribs is much better for water issues and there is no ponding. Sheets are overlapped by two 22 mm (7/8") cladding ribs with a seal strip placed between the sheets. These panels are fastened to galvanized "Z" shaped girts connected to the existing ribs at about 1200 mm on centre. These new panels are factory-rolled to the curvature of the existing roof. We have verified this concept with Agway Metals and pictures are below for a similar recladding project already completed. Of course, other parts of the building are treated with flashing and trim panels.

The picture below shows a re-cladded similar structure completed by Agway Metals.

The picture below shows fasteners from the new cladding to the new Z girts.



Transluscent ceiling panels would likely be covered over and not removed, and recladding would also be coordinated with any desired new doors.

Along the base of the walls on the east and west sides, structural repairs are required due to the level of corrosion and would have to be completed before any recladding. However, the recladding would nicely cover the repairs so the repairs would not be visible from the outside.

We would suggest removal, and possibly the re-use of the interior plywood panels, as we believe there may be debris between the plywood and the steel panels which may hold moisture and accelerate the steel corrosion. Access to the base of the walls is required for repairs.

The final design of the repairs may need further study, but we initially anticipate removal of the grout in areas where the panels are failing. This should be done in a checkerboard pattern of one panel being repaired, and the adjacent panel left as is, then once the first panel is repaired and grouted the adjacent panel can be repaired, so as not to disengage too many structural panels at once. Completing a test section for practicality may be required to see how difficult grout removal will be. An alternate galvanized steel plate anchored to the top of the footing and fastened to the steel panels may be an alternative to fully removing existing grout, but some engineering would be required to determine sizes and anchorage. If existing panels cannot be supplied from a current manufacturer to match the existing in terms of profile, we believe galvanized sheets in the order of 3 mm thick can be bent and spliced with the existing panels.

We have checked with www.Canadianbuildings.ca, a supplier of Quonset Hut-style buildings, to review the option of supplying partial steel panels. As of the time of writing this report, we have not received a response from this supplier. However, we believe galvanized panels to match the existing profile and of a short length to splice over the existing corroded sections are possible. Prefabricated panels from a current supplier may make this a bit more economical. We will advise if and when we get a response from this supplier.

For panels which are not corroding at the base interface with the concrete footing, it may be prudent to add a cold galvanizing coating, or a zinc-rich paint to a strip 200 mm high above the concrete. This would be done after all the repairs are completed.

OBC Part 11 Renovations allows for maintenance and repairs, and structural performance only has to match existing performance and capacity. As noted above, based on 57 years of exposure and use, the existing Quonset Hut-style building has proven to be adequate. It only needs to be reinforced to compensate for the corroded structural panels. The added weight of the sheet steel cladding is very nominal and not significant compared to total loading.

The local staff can best advise regarding the current performance of the doors and if they can be salvaged. We noticed that the cladding is loose over the north overhead doors and there may be missing flashing over door headers, thus, regardless of the door replacement question, some rework at doors is expected.

Certainly, there are alternatives to repairing and modifying the existing Quonset Hut-style structure, which would include trying to fabricate and install another Quonset Hut structure on the existing foundations. However, this may trigger new engineering under the Ontario Building Code as this would be a new building and not just repair / maintenance of an existing building. There are climatic data changes with new Codes, and snow loading and snow distribution under the present code may be more onerous than the original design. Thus, structural sizes may not be the same under the new design requirements.

Other types of buildings, such as fabric structures with steel or wood arch frames, have heavier loading at each frame location, compared to the present Quonset Hut uniform wall loading. Thus, a different building style would require new foundations. Fabric structures also have a limited lifespan as the fabric must be replaced periodically. Regardless, the existing structure requires some structural repairs fairly soon due to the corrosion, and a “do nothing” option will result eventually in walls that will kick out under heavy loads and the roof will fail, in sections, or ultimately the whole building.

Other options would also have to factor in the demolition costs, the removal of material, and the relocation of all the stored items during the construction process. One such option would be to construct a simple, wood-framed shed consisting of pre-engineered wood trusses supported on simple stud walls and a new reinforced concrete foundation. This option constructed over the same footprint of the existing Quonset hut would provide more functional storage space with better vertical clearances along the side walls and options for racking or other storage solutions. It is also possible to design the trusses to carry some light allowances for hanging loads. A design review may reveal that the expected loading on the existing footings would be in the same range as the existing semi-circular Quonset hut, and if this was the case, some re-use of the existing footings at grade and leaving the slab on grade intact may be possible. However, should this not be the case and new footings are required, then the concrete slab on grade would be impacted; the best case being a new slab poured over the existing, or alternately demolishing the existing slab and pouring a new one. Leaving the footings near grade has some risk due to frost, therefore any interior finish material selection would have to keep that in mind. This type of building could be insulated and finished on the interior at the time of initial construction or at some point in the future, as the budget allows.

The construction cost for a small, simple, uninsulated, wood-framed shed with steel cladding on the walls and roof and no interior finishes is estimated at \$80-\$100/sq.ft., depending on options chosen during design, such as additional lighting, etc. The same building insulated, heated, and constructed with simple interior finishes is estimated to cost approximately \$130-\$140/sq.ft., to construct, depending on options chosen during design. Drawings would have to be submitted for a permit. The existing Quonset hut is noncombustible, whereas a wood structure would be combustible, demonstrating an advantage with the non-combustible construction. These estimates are very high level and subject to change with design considerations and market conditions. These estimates do not include soft costs (design and administration), demolition or removal of the existing building, any geotechnical investigations, or any service upgrades that may be required.

If desired, Burnside can assist with further engineering and building design. We trust this meets your expectations and if there are any questions or concerns, please let us know.

Yours truly,

R.J. Burnside & Associates Limited

LICENSED PROFESSIONAL ENGINEER
R. A. DE FARIA
05/16/2024
PROVINCE OF ONTARIO

Richard de Faria, P.Eng.
Senior Structural Engineer
RdF:smm

Enclosures: Photo Pages
Quonset Hut Drawing, by Totten Sims Hubicki and Associates Ltd.

Photo 1: South elevation.

Photo 2: East elevation showing light corrosion on some panels.

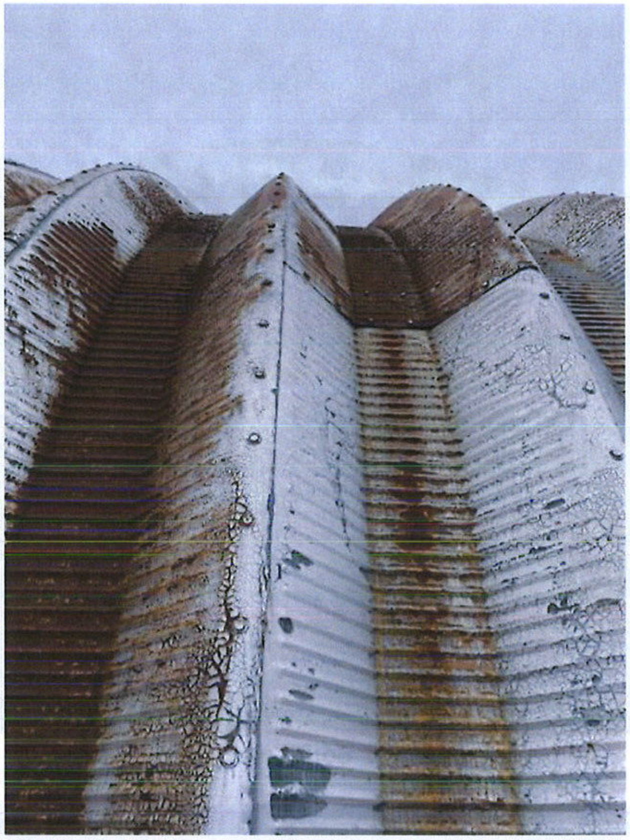


Photo 3: Closer view of corrosion at the roof level.

Photo 4: Corrosion near wall base, possibly clean and touch up repairs.

Photo 5: North elevation.

Photo 6: Cladding loose above the north door.

Photo 7: West elevation.

Photo 8: Northwest corner corrosion. Structural repair required.

Photo 9: West side structural repair at base of panel required.

Photo 10: General interior view. Most insulation is missing.

Photo 11: Translucent roof panels, wood furring strips and plywood panels.

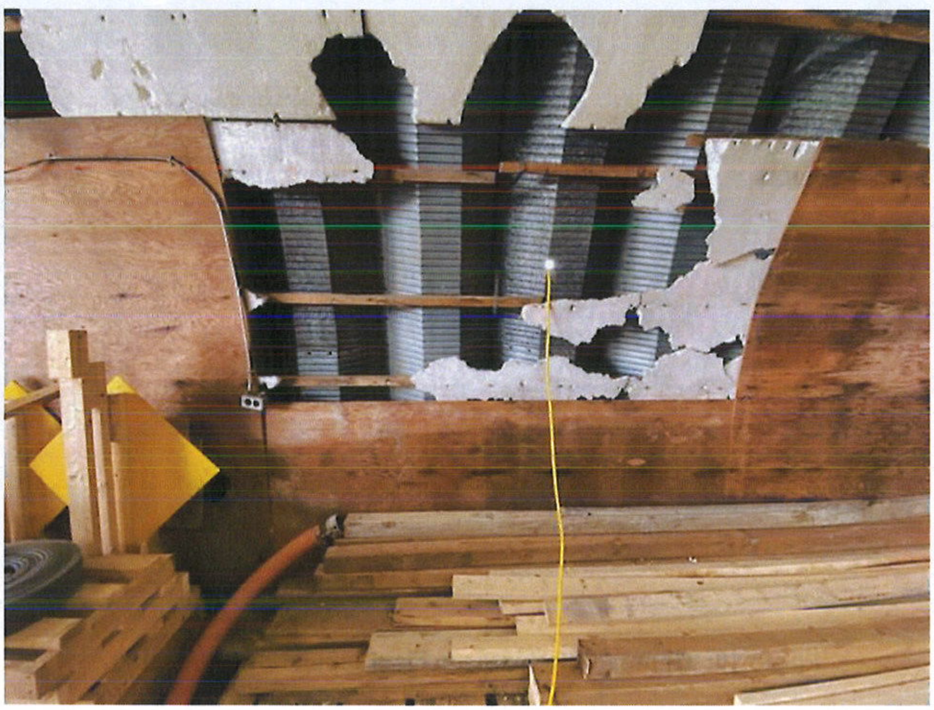
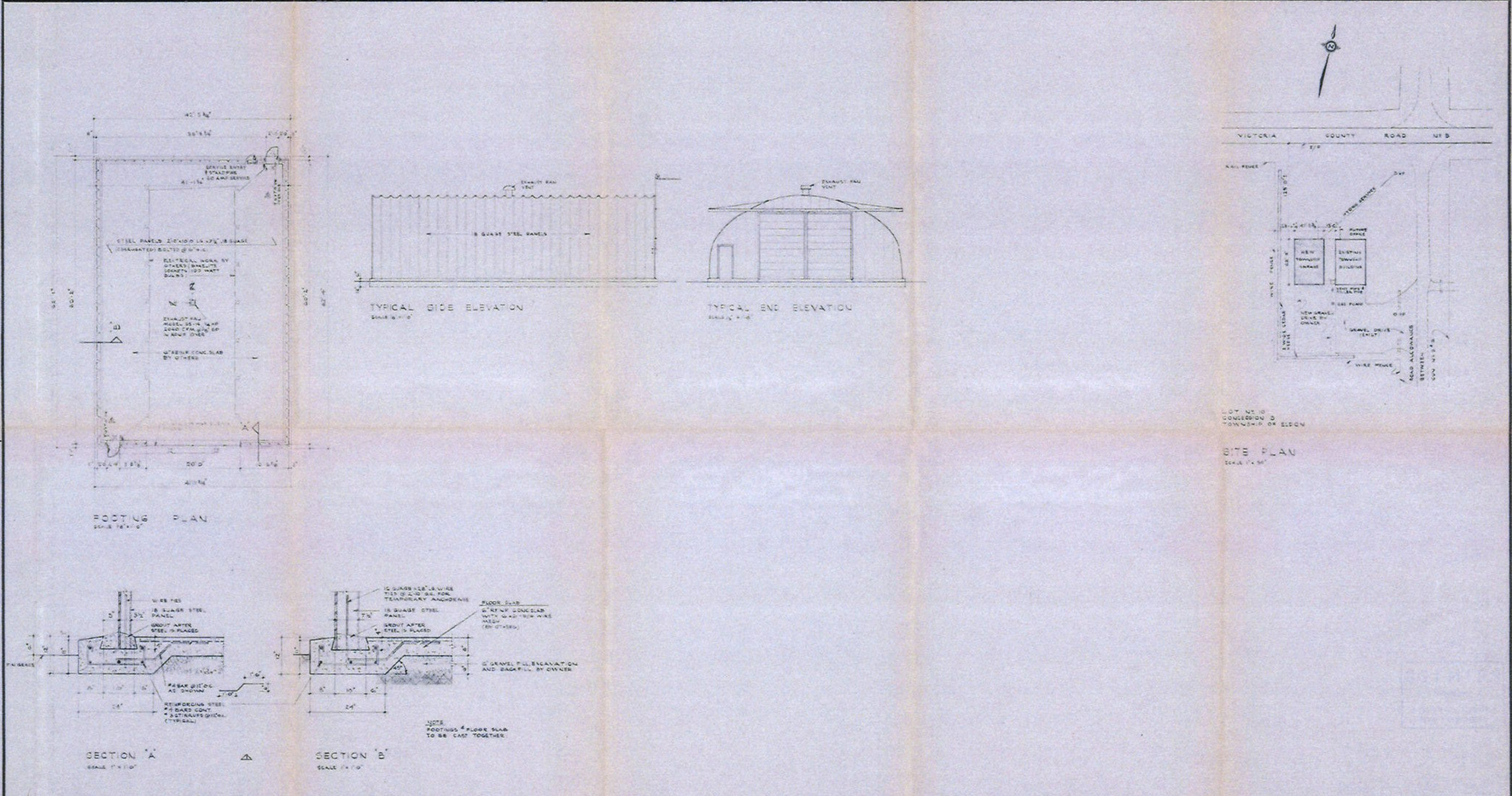


Photo 12: Similar to Photo 11. Note that plywood covers insulation.



TOTTEN SIMS HUBICKI AND ASSOCIATES LTD.

CONSULTING ENGINEERS COBOURG WHITBY

A. K. BEACH — REGISTERED PROFESSIONAL ENGINEER — PROVINCE OF ONTARIO

No.	DATE	BY	REVISIONS
2	JULY 1967	R.W.	REVISE EAST DRG. TO OPEN TO EXTERIOR
1	JUNE 1967	R.W.	SEPARATE FTGS. REVISED TO COMBINED FTG & SLAB

DESIGN
DRAWN R. W.
CHECKED
APPROVED

ROADS GARAGE
FOR
TOWNSHIP OF ELDON

SITE, FOOTING PLAN & ELEVATIONS

DATE MAY 10 67
PROJECT 298
DRAWING A1