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# METCHOSIN FIRE HALL

## STRUCTURAL ENGINEERING SERVICES

Stephanie Dunlop – Fire Chief

**Metchosin Fire Department**

Project: 12044.01

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## INTRODUCTION

At the request of Mike Hornick, Skyline Engineering Ltd. recently visited the truck bay building of the Metchosin Fire Hall located at 4440 Happy Valley Road, to review the existing structure and available historical documents in order to provide a preliminary structural review of the building.

We performed a visual inspection only, and did not remove any finishes to observe the structure. The inspection was performed on a random basis; we did not review or inspect every element or portion of the building. The intent of the inspection was to determine the general structural composition of the building and provide comment on the existing seismic capacity of the structure. We understand that the other portions of the fire hall are planned to be replaced with new structure in the near future, and that the possibility of retaining (and potentially seismically upgrading) the newer truck bay portion of the facility is under consideration.

At the time of our site visit, we reviewed the available historical documents for the Fire Hall facility. There was little information related to the truck bay portion of the facility - a partial set of Architectural drawings by Keystone Architecture & Planning Ltd. dated Sept. 27, 1990 were available, however these drawings did not have any description of the reason for issue, and the floor plans did not correspond to the layout of the building on site.

There was a letter from C.N. Ryzuk & Associates Ltd. dated November 4, 1993, that documented a field review performed to comment on foundation bearing support conditions for the proposed new building. This letter referenced structural engineering drawings completed by Siefken Engineering, dated September 10, 1993 describing the proposed footings which would consist of "conventional rectangular strip footings" with a "maximum allowable bearing capacity of 3000 psf" noted on those drawings. Copies of the Siefken Engineering structural drawings were not available for our review.

## STRUCTURE DESCRIPTION

The truck bay building is a single storey building approximately 64' wide by 60' deep, with a training "hose tower" located in the southeast corner. The roof consists of engineered wood trusses that span the depth of the building, spaced at 24" on centre and is sheathed with ½" plywood with H-clips at unsupported panel edges. The trusses appear to have OSB sheathing along the bottom chords (the ceiling of the truck

bay) and are toe-nailed to a top plate that is bolted to the walls of the building with ¾" anchor bolts at approximately 24" on centre.

The walls are of concrete "tilt-up" construction, with 8" wall panels approximately 17' high. The side walls do not have any openings through the walls, but the front and back walls of the truck bay have multiple overhead doors and convenience doors, with minimal wall sections.

There is a wood frame mezzanine structure along the east side of the building with ancillary rooms supporting the truck bay operations.

## DISCUSSION

Seismic design requirements were first introduced in the National Building Code of Canada in 1965, and those requirements have evolved considerably over time as Codes developed, through research and observation of structure performance of buildings around the world that were exposed to earthquakes. The truck bay building was originally constructed in 1993 and would have been designed to meet the requirements of the Building Code in effect at that time (the 1992 BC Building Code, which was based on the 1990 National Building Code of Canada). As noted, seismic design requirements have increased since the time of original construction, and the current design forces for this building are higher than at the time of original design (and are anticipated to increase again with the next iteration of the BC Building Code, expected to be released sometime in the next year). As such the building does not currently have the capacity to resist current Code level design forces.

As part of the fire hall building complex, the truck bay should be designed for a seismic importance factor of 1.5 (post-disaster level). In addition to the design seismic loads on the main structure, there are other minimum requirements for components of the structure that must be met for post-disaster design.

The Metchosin Fire Hall has engaged Ryzuk Geotechnical to provide a geotechnical report for the replacement Fire Hall project, and our seismic analysis has been based on the parameters outlined in their report dated April 19, 2022, which recommended a site class "C" along with the site specific seismic hazard values / accelerations to be used for seismic design of the new building.

Without having access to the original design drawings, we can not confirm the level of ductility included in the design of the tilt-up concrete wall panels. A new concrete tilt-up structure requires a minimum level of ductility to meet post-disaster requirements. Presuming the original construction had a similar level of detailing, we compared the design forces at the time of construction to the current code (2018 BCBC) which has increased by approximately 70%. While the two side walls of the building may have adequate capacity to resist current Code level forces (we note that the interconnection of tilt-up panels may be a limiting factor) there are other components of the building that have much less capacity and affect the overall seismic resistance of the building.

The roof diaphragm and connections to the concrete walls of the building are particularly deficient. The level of connection between the OSB sheathing and the underside of the roof trusses is unknown. Assuming a minimal level of connection (no blocking at panel edges, nominal nailing to the trusses) its capacity is estimated to be in the order of 14% of current Code requirements. Diaphragm design forces are sufficiently high that fully blocking and nailing the ceiling diaphragm would still not meet current requirements, and horizontal steel cross bracing is likely required to meet those forces. Similarly, the toe-nailed connections of the roof trusses to the top plates are insufficient, and the anchor bolts to the concrete walls have approximately 65% of the required capacity to transfer seismic forces to the concrete elements. Structural upgrades are also likely required along the tops of the walls to ensure connections to the trusses are able to accommodate out-of-plane seismic forces on the concrete walls.

The north and south walls of the building have minimal walls available to resist seismic forces due to the overhead doors and other access doors that are required for the truck bay to operate. In order to meet current Code level seismic forces, new structural elements would need to be added to supplement the existing building. It appears feasible to add external cast-in-place concrete walls at the east side of the building to increase the seismic resistance in the east-west direction. Due to the magnitude of seismic design force, it appears that it will require 4 walls to resist these forces without significantly encroaching on the adjacent property, with the foundation design anticipated to be a limiting factor. Depending on the layout and relative location of the new adjacent building, it may be feasible to add walls to the west side of the truck bay as well, or potentially incorporate new reinforcing walls as part of the design of the new adjacent fire hall structure.

The wood frame mezzanine may require seismic upgrades to meet current Code requirements as well. Such upgrades are anticipated to include connections of the mezzanine to the concrete side wall, as well as potential new (or upgraded) plywood shear walls along with connections to the concrete slab/foundation structure at the main level.

## SUMMARY

In general, the original building structure appears in reasonable condition, and it will likely be able to withstand smaller earthquakes and still remain operational. However, in order to meet current Code level seismic design forces at a post-disaster level of operations, the building will require supplemental external structural elements as well as upgrades to existing internal components to meet those requirements.

These upgrades may be able to be incorporated into the overall design of the new adjacent fire hall structure, or they may be considered as a stand-alone upgrade project to the existing building. You may wish to have a more detailed schematic seismic upgrade plan prepared with sufficient detail that a qualified general contractor or a quantity surveyor could provide order-of-magnitude costs, to help better inform a decision on how best to proceed with the truck bay building, in consideration of the overall fire hall replacement project.

We note that extensive seismic upgrades are necessary to increase the resistance level of the existing building to meet current Code design level forces. While some of the proposed upgrades may be able to be completed at the outside of the existing structure, it is anticipated that operations of the existing truck bay building will be disrupted for significant periods of time during a seismic upgrade project. Such disruptions to the normal operation of the truck bay building will need to be considered when determining whether to keep and seismically upgrade the building or incorporate a new truck bay into an overall new Fire Hall complex.

We trust the above information is satisfactory. We remain available to assist with developing a schematic seismic upgrade plan for the truck bay building, if desired. If you have any questions or would like to discuss our findings in more detail, please contact the undersigned.

Yours truly,

**Skyline Engineering Ltd.**

Jonathan Reiter, P.Eng., Struct.Eng., LEED AP
Principal

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