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## Reference: North Cowichan Fire Department Crofton Hall – 2nd Floor Load Rating Study

### BACKGROUND

The municipality of North Cowichan (North Cowichan) engaged Stantec Consulting Ltd. (Stantec) to conduct an updated second-floor load rating for the Crofton Firehall. The original Crofton Firehall, located at 1681 Robert Street, Crofton BC, was designed in 1964. A second-floor addition was added to the building approximately 20-30 years ago. There are limited record drawings available for the original structure; however, there are no records available for the second-floor structure.

Stantec provided North Cowichan with a detailed seismic assessment of the Crofton Firehall in August 2019. As part of that assessment, Stantec conducted a load rating study to determine the live load capacity of the second floor. During the site visit, it was found that there was a built-up floor structure above the original roof framing. The built-up floor structure was not visible from the underside and Stantec was unable to confirm how the structure was constructed or connected to the original framing.

Conservatively, Stantec assumed that the built-up floor imposes an additional dead load on the structure but does not provide additional strength capacity. As noted in the previous assessment, it was found that the live load strength capacity of the second-floor was 1.25 kPa (25 psf), limited by the original 38x286 roof joists. Stantec recommended that further investigation be done to verify the construction of the built-up floor structure.

### SITE REVIEW

Kenneth Jamieson (Stantec), Adrienne Leech (Stantec) and Dan Milne (North Cowichan) were onsite on November 13, 2019 to complete an assessment of the second-floor framing at the Crofton Firehall. A carpenter was onsite to expose select areas of the structure to be assessed.

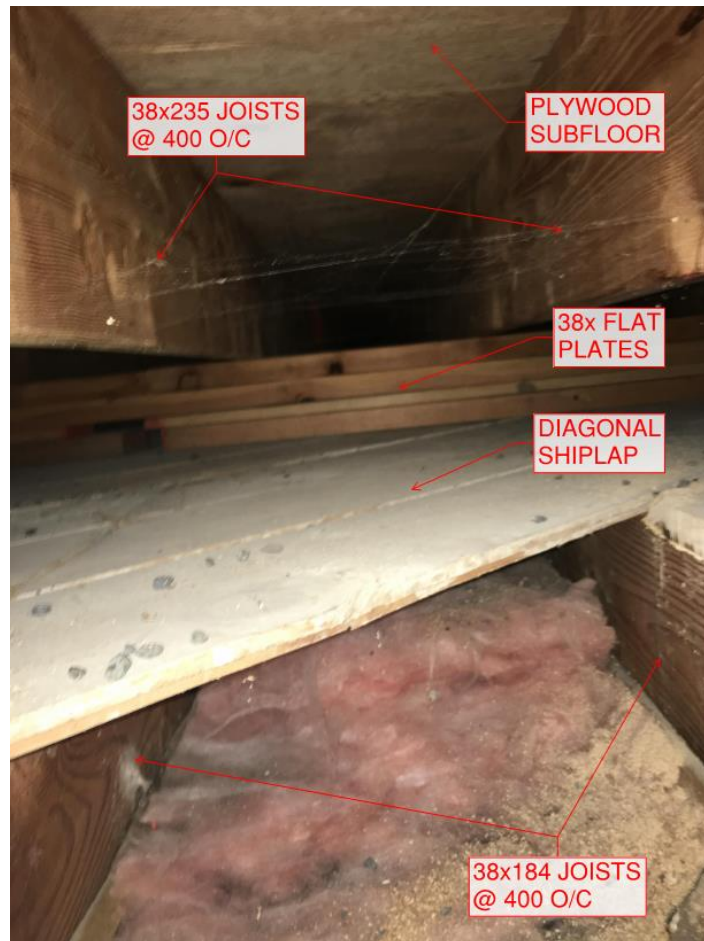
During the previous assessment, the built-up structure above the shiplap was not visible. As part of this assessment, Stantec selected limited locations for holes to be cut in the main floor finished ceiling and shiplap above the original roof joists to expose the built-up floor framing above.

### UPDATED SECOND-FLOOR LOAD RATING

During the previous assessment it was confirmed that the existing structure above the garage bays consists of diagonal shiplap supported by 38x184 joists at 400mm on center, spanning 3.66m. The joists are supported by 130x494 glulam beams spanning 8.4m, supported midspan by steel columns. During the site review conducted on November 13, 2019, it was found that there are additional floor joists above the garage bays consisting of 38x235 joists at 400mm on center. The joists span 3.66m and are supported approximately

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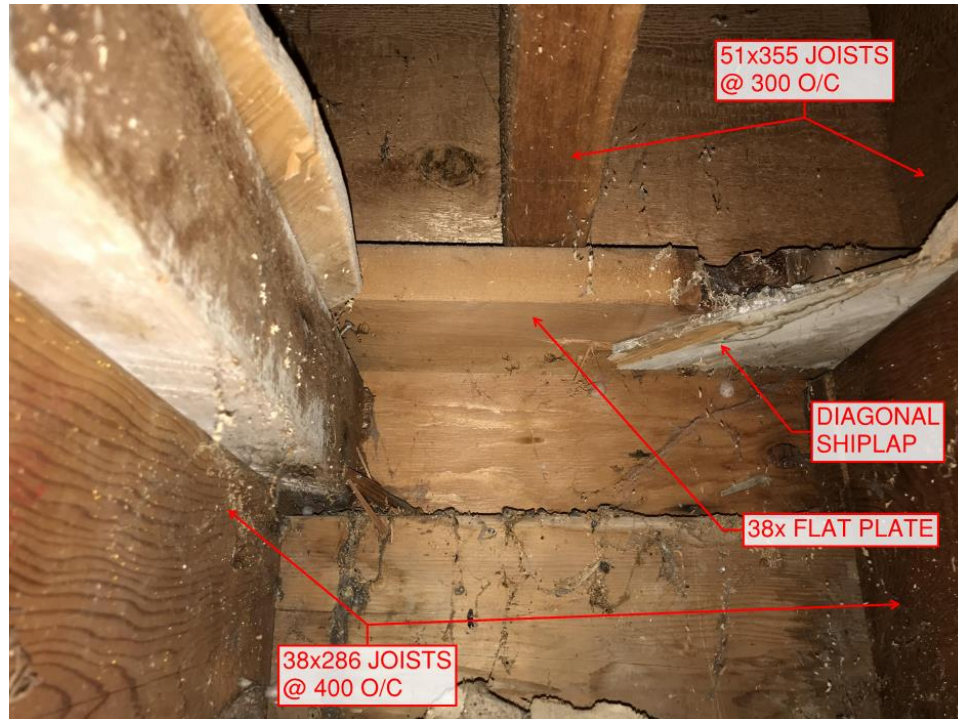
every 2.0m by stacked 38mm thick flat plates. The additional joists generally bear directly above the original joists, as seen in **Figure 1**.



**Figure 1 – General View of Second-Floor Framing Above the Garage Bays**

The existing structure above the office area was confirmed to be diagonal shiplap supported by 38x286 joists at 400mm on center spanning 6.75m. The joists are supported by load-bearing CMU and wood stud walls. There are also additional floor joists above the office area consisting of rough sawn 51x355 joists at 300mm on center. The joists span 6.75m supported approximately every 2.0m by 38mm thick flat plates. The additional floor joists are at a different spacing than the original roof joists; therefore, they do not bear directly on top of each other, as seen in **Figure 2**.

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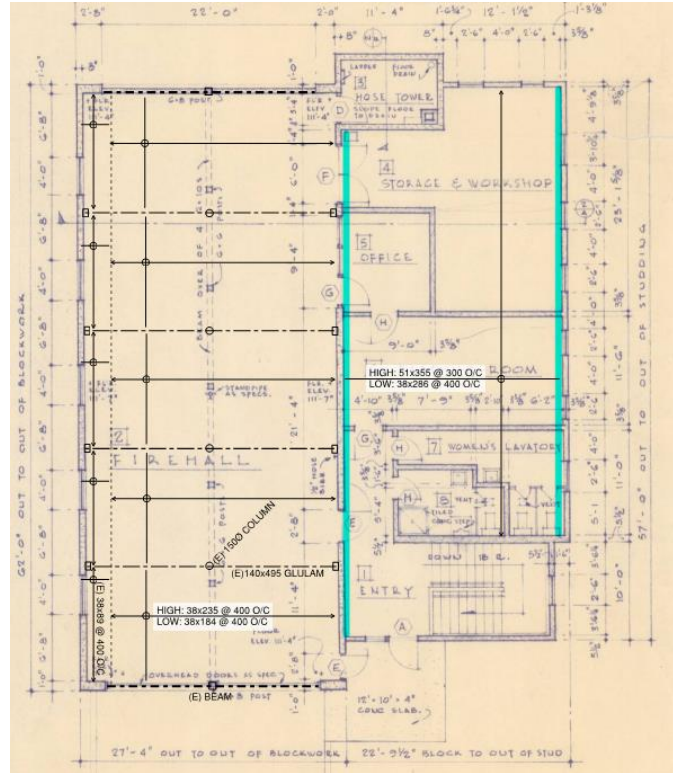
**Figure 2- General View of Second Floor Framing Above Office Area at Exterior Wall**

As seen in the **Figure 2**, the 51x355 joist bears midspan on a single 38x140 flat plate, spanning 400mm between the original 38x286 roof joists. Due to the spacing of the joists, it is likely that this condition occurs along both bearing walls above the office area.

In the current condition, the live load capacity of the floor is limited to 1.25 kPa (25 psf) due to the inadequate capacity of the single 38x140 flat plate. Stantec has found that if the bearing condition is corrected the live load capacity of the floor can be increased to 2.4 kPa (50 psf).

As shown in **Figure 3**, solid blocking would need to be installed for the extent of the bearing walls highlighted. Stantec recommends that 38mm thick double, solid blocking be installed between the original 38x286 joists. The blocking would need to be installed full height so that it fits tight between the stud wall sill plate and the 38x140 flat plate.

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**Figure 3 - Second Floor Framing Layout (1964 record drawings)**

As shown in **Table 1**, completing structural upgrades would increase the live load capacity of the second floor to a maximum of 2.4 kPa for office occupancy use. Subjected to an office occupancy loading of 2.4 kPa, the existing joists will be at a maximum of 94% of the strength capacity. It is Stantec’s opinion that, without replacing the floor joists, the second-floor cannot be upgraded to achieve a live load capacity of 4.8 kPa for assembly occupancy use. The load rating is based on the bending and shear strength of the structural members. The live load strength capacity of the member does not consider deflection criteria that new structures are required to be designed to, in conformance with the British Columbia Building Code 2018.

**Table 1 - Updated Second Floor Live Load Strength Capacity (assuming upgrades are completed)**

Framing Location	Framing	Live Load Demand/ Capacity Ratio (D/C)	
		2.4 kPa (50 psf)	4.8 kPa (100 psf)
Garage Bay Area	High Joists: 38x235 @ 400 O/C Low Joists: 38x184 @ 400 O/C	86%	152%
Office Area	High Joists: 51x355 @ 300 O/C Low Joists: 38x286 @ 400 O/C	94%	161%

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## RECOMMENDATIONS

- In the current condition, Stantec recommends that the live load on the second floor be limited to 1.25 kPa (25 psf). The live load capacity is limited due to the inadequate strength of the single 38x140 flat plate that supports the 51x355 joists.
- If North Cowichan seeks to increase the live load capacity of the second floor, Stantec recommends completing structural upgrades to correct the bearing condition at the load-bearing walls above the office area. This will increase the live load capacity of the second-floor to a maximum of 2.4 kPa (50 psf), allowing the space to be used for office occupancy loads. However, this will not allow the space to be used for assembly occupancy loads or storage loads. Repairing the bearing condition does not address the seismic deficiency of the structure or increase the seismic capacity. Stantec would still advise that the Crofton Firehall undergo a seismic upgrade or replacement.
- Design details for structural upgrades were outside the scope of this assessment. If North Cowichan chooses to complete structural upgrades to increase the capacity of the second floor, Stantec recommends that an engineer is engaged to provide design upgrades.

**Stantec Consulting Ltd.**



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