rjc
Engineers

July 29, 2019

Dave Chard
Chard Development
102, 608 Broughton Street
Victoria, BC V8W 1C7

Dear Dave,

RE: Ducks Building – 1316 Broad Street, Victoria **RJC No. VIC.116144.0005**

Further to our recent meeting, you have requested that Read Jones Christoffersen Ltd. (RJC) summarize recent discussions regarding designing the above-referenced building for seismic resistance.

Code Seismic Force Levels – Background

Building Codes prescribe the seismic forces that structural engineers must design buildings to resist. The current Code applicable for design of buildings is the BC Building Code 2018 (BCBC2018, or the Code), which is based on the 2015 National Building Code of Canada (typically National Codes are adopted into Provincial Codes 2-3 years after their issuance.) The next National Code is due in 2020, with a revised BC Building Code expected to be enacted within 4 years from now.

Victoria is in a region of high seismic risk. With the recent enactment of BCBC2018, Victoria design seismic force levels for a building similar to the existing Duck's Building increased approximately 45% compared to the previous Code. The increase reflects recent research on the frequency and probability of a very large subduction earthquake off the coast of BC. For comparison, Victoria's current prescribed seismic force levels are now approximately 55% higher than prescribed in Vancouver. Victoria region seismic force levels are projected to increase another 35% when the next edition of the BCBC is enacted (likely within 4 years), while Vancouver's increase will be approximately 10%, resulting in Victoria design seismic force levels for buildings similar to the existing Duck's Building being approximately 90% higher than Vancouver's. The seismic force increases are applicable to all types of structures, with the magnitude of the increase varying by type of structure and soil conditions.

Seismic Upgrading of Heritage Buildings – Victoria Challenges

With the implementation of BCBC2018, it has become much more challenging to upgrade Victoria heritage buildings to resist a reasonable percentage of full Code seismic design force levels. Not only has seismic loading been increased, but the allowable loading for some existing building materials providing seismic resistance, such as timber floor and roof diaphragms, has recently been significantly reduced to reflect

ongoing research. It has been accepted by Victoria Building Officials (the 'Authority Having Jurisdiction') for many years that seismically upgrading older buildings to resist 60-70% of Code levels is acceptable to meet 'Life Safety' requirements (that most people get out of the building alive). The 70% threshold is referenced in the Commentary to the BCBC 2018 as representative of the current Life Safety threshold.

Designing for these significantly higher seismic loads and reduced material resistances results in more 'structural intrusions' being required in older building seismic upgrading (eg more/ larger bracing, new structural walls, etc.), and much higher costs.

Duck's Building – Seismic Upgrading Study

One option considered for the Duck's building was retaining the entire existing building and seismically upgrading it on its own. Geotechnical investigations estimate that there is approximately 15 to 20 feet of clay/till between the base of foundations and bedrock. Softer soils amplify seismic forces emanating from the bedrock, increasing the seismic load experienced by the building. The option considered for upgrading the existing Duck's building took into account the softer soils below the building, which resulted in a seismic induced horizontal force on the building (base shear) of 60% of the building's mass (this is a very high; in the next Code this will increase even more, to 80% of the building's mass). The structural cost to retain the existing building is much higher than the cost of a new building of similar size. For the 'life safety' level of upgrading, 70% of the Code seismic force level is approximately (0.7x60% =) 42% of the structure's mass. When the next Code is enacted, the upgraded building would have a seismic resistance of only approximately 53% of Code, well below the 70% 'life safety' level, with considerable damage and at least partial collapse expected in a significant earthquake. For comparison, most of the buildings in Christchurch, NZ which were mandated to be upgraded to 33% prior to their major earthquake in 2011 either collapsed or were damaged beyond repair; subsequent to their major earthquake the minimum level of seismic upgrading was increased to 66% of Code.

Another consideration was to restrain the existing building by attaching it to new buildings on the north and/or south side. However, the existing timber framing is in relatively poor condition and not oriented to easily facilitate seismic support from new buildings. Additionally, significant additional new interior bracing or walls would be required within the existing building footprint.

Duck's Building - Proposed Solution

The solution deemed most practical in terms of construction, financial viability, and long-term retention of the significant heritage aspects of the Duck's Building consists of retaining the existing building facades on the east and west sides, with new concrete and/or structural steel construction throughout the rest of the site. There will be parking below grade, which results in foundations low enough to bear on rock, significantly lowering the seismic demand on the building (to approximately 13% of building mass). The new structure will be designed to fully restrain the existing heritage facades, with seismic resistance of 100% of the current Code. When the next Code is enacted, the seismic resistance of the structure (including restraint of the heritage facades) will still be approximately 80% of that Code (well above 'life safety'), with the expectation

that the heritage components would experience relatively minor (and repairable) damage in a moderate earthquake. The existing brick walls along the north and south sides of the existing building are proposed to be removed, as retention of these would add 15 to 20% to the overall seismic loading and complicate the new seismic resisting system.

The solution proposed results in a much more resilient retention of the most significant heritage components of the Duck's building (the front and rear facades) compared with retaining and upgrading the entire existing building to 'life safety' standards on its own, with increased expectation of the facades surviving a significant earthquake (80% seismic resistance versus 53% when the next Code is enacted).

We trust that this meets your requirements at this time. Please let us know if you have any questions or comments.

Yours truly,

READ JONES CHRISTOFFERSEN LTD.

PROVINCE OF BRITISH COLUMBIA
B. L. JOHNSON
PROFESSIONAL ENGINEER
16344
DESIGNATED STRUCTURAL ENGINEER

July 29/19.

Bruce Johnson, P.Eng, Struct.Eng, MIStructE
Managing Director

BJ/hr