409 Park Avenue,
Kelowna, B.C.

Structural Engineering Report
on Existing Building

Prepared for:

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Submitted by:

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Table of Contents

1 Introduction

Datum Consulting Ltd were retained by Brenda Rusnak and Dave Cullen to provide structural engineering services for the remodeling of and additions to, the existing residence at 409 Park Avenue.

The initial task of this assignment was to evaluate the structural condition of the existing building. This document reports on the findings of that evaluation. Note that as it is intended to demolish the later addition on the east side, that area of the building was excluded from the evaluation.

Figure 1.1
Park Avenue Elevation

Figure 1.2
Long Street Elevation

2 Building Inspection

2.1 General Description

Inspections of the building were carried out on the 5th and 19th of June 2019.

Prior to the inspections the building had undergone environmental remediation to remove asbestos and other hazardous materials. That process had involved the removal of all plaster from the interior walls within the original building (i.e. excluding the east wing) so that all timber framing was exposed.

The timber framing appeared to be generally in good condition, albeit that key elements were undersized by today's standards.

2.2 Main Floor Framing and Foundation System

The main floor is constructed as a platform comprised of 1"x6" floorboards spanning between 2"x8" joists spaced at 2'-0" on centre, which in turn are supported by a non-uniform arrangement of 6"x8" fir beams. The fir beams bear on short posts or stacked pieces of 6"x8" which are underlain by an assortment of concrete blocks.

Both the exterior and interior walls are built off the main floor platform and do not have foundations in themselves. A sketch layout of the main floor framing system is shown in Figure 2.1 below. What is notable about this floor framing is that the primary beams (6"x8') are discontinuous and unconnected at the locations where one ends and another starts. There also do not appear to be any mechanical connections between the primary beams and their supporting columns or between the supporting columns and the concrete blocks beneath.

The floor exhibits sloping areas, localized depressions, and raised areas, all of which are indicative of differential settlement of the foundation system supporting the floor.

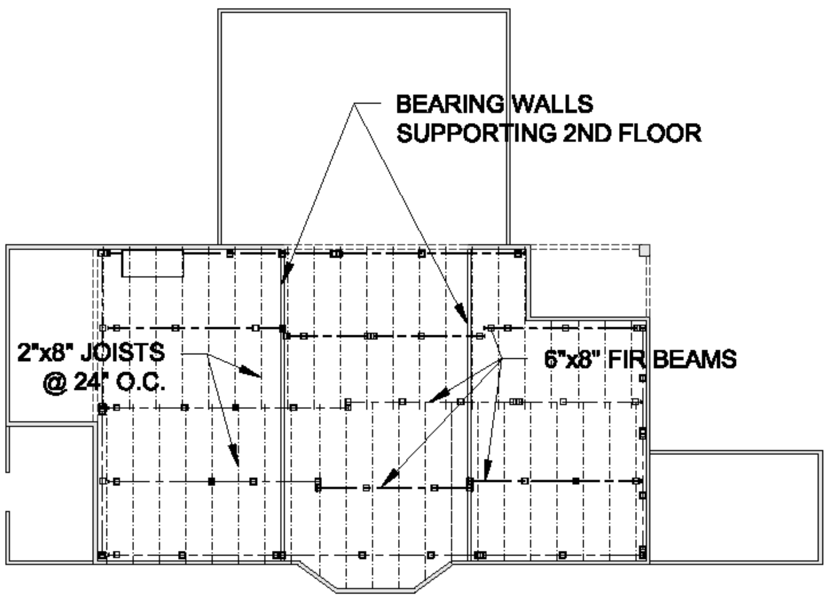

Figure 2.1

Figures 2.2 to 2.7 overleaf are photographs of the main floor framing and foundations taken during the inspection.

Fig. 2.2 is at the base of the west exterior wall showing the absence of a foundation.

Figs. 2.3 & 2.4 showing typical supports of the primary beams around the building perimeter; these are stacked pieces of 6"x8" fir.

Fig. 2.5 shows a typical post support of a primary beam with a concrete block beneath.

Figs. 2.6 & 2.7 show typical discontinuities of the primary beams and post supports. Note the significant out of vertical of the posts in Fig. 2.6

Figure 2.2

Figure 2.3

Figure 2.4

Figure 2.5

Figure 2.6

Figure 2.7

2.3 Wall and Second Floor Framing

The framing of both exterior and interior walls is comprised of 2”x4” studs at 16” on centre. The studs are balloon framed off the main floor platform, i.e. continuous studs from main floor to roof level. However the stud walls on the east and west sides are not connected to the 2nd floor framing. The effective length of the studs is therefore in excess of 12ft and they will need to be reviewed for adequacy under both gravity and wind loads.

There is a bay window on the west side of the house. Based on the review of the framing of this wall, this bay window was not part of the original building but is a later addition.

The second floor is constructed of 5/8”thick x 5”-7” wide shiplap on 2”x8” joists at 16” on centre. The 2nd floor joists run in a north-south direction, bearing on the south exterior wall, the two east-west main floor interior walls, and the beam which was installed when the original north wall was removed. It is noted that the two interior walls supporting the 2nd floor are framed off the main floor but are not directly above either a joist or beam or supporting post. i.e. the load from these walls bears directly on the floorboards of the main floor.

There is no effective 2nd floor diaphragm as the floor sheathing does not extend to the exterior walls in many places.

Part of the original north wall of the house has been removed at some time in the past and replaced with a built-up beam to carry the loads from the floor, exterior wall, and roof above. The fabrication of this built-up beam is flawed and will not have the capacity necessary to satisfy the Building Code.

The 2nd floor and roof framing in the area of the stair has been significantly modified at some point in the building’s history, evidenced by various structural members having been trimmed back, intercepted, or removed altogether. It is thought that these modifications were probably made to accommodate the stair in its current location. Certainly the original building did not have a stair at that location.

2.4 Roof Framing

The house has a hipped roof framed from 2”x4” rough sawn lumber. The rafters are spaced at 16” on centre connected by collar ties at approximately the 1/3rd span point, there is no ridge beam. The rafters are supported by stud walls located just outside the midspan point and then bear on the outside walls. The interior stud walls also support the hip rafters. These stud walls are not aligned directly above beams or built up floor joists but bear solely on the floor sheathing. The original roof sheathing (still in place) is ½” thick x 6” wide rough sawn lumber spaced at about 10” on centre. This original sheathing has been overlaid with OSB in recent years. Figure 2.8 shows a cross section of the building clarifying the above descriptions.

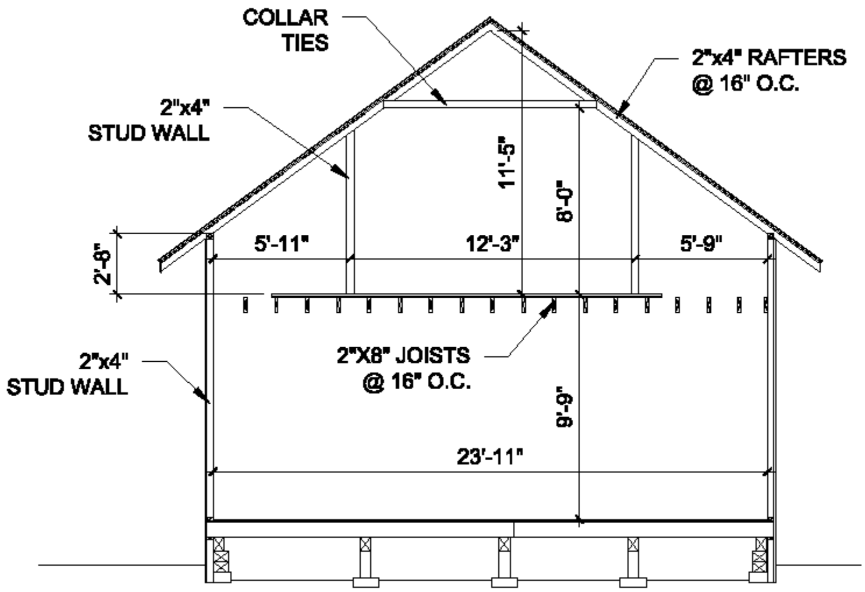

Figure 2.8

The roof contains dormer windows in the north and south ends and a gable on the west side. It is considered likely that the dormer windows are not original but were added later.

The gable on the west side is unquestionably a modification of the original roof construction. The roof framing of this gable is quite crudely done, its structural integrity being entirely reliant on an added interior stud wall on the 2nd floor. However, even if it were to be accepted that this additional stud wall is in itself competent, the modified and added to roof structure supported is unacceptably configured containing serious flaws. On one side the valley rafter is discontinuous and on the other side the valley rafter does not exist at all. The end of the gable ridge beam appears unsupported altogether.

In my opinion this roof structure is unsafe and would be vulnerable to serious deformation, or even collapse, under full snow load.

Figures 2.9 to 2.16 show various views of the second floor and roof framing.

Figure 2.9

Figure 2.10

Figure 2.11

Figure 2.12

Figure 2.13

Figure 2.14

Figure 2.15

Figure 2.16

3 Opinion

3.1 Structural Analysis

The structural frame of the building was analyzed for competency under the design snow load and residential occupancy loads, as mandated by Part 9 of the B.C. Building Code. The analysis excluded the non-compliant roof framing of the west gable addition as from visual inspection alone this is clearly structurally inadequate.

The analysis determined that the exterior stud walls and the roof rafters would be extremely overstressed under full snow load. As the roof framing is such as to also take support from the second floor, the second floor joists are also considerably overstressed under snow load. When occupancy load of the 2nd floor is added into the analysis the situation is exacerbated, such that under full loading conditions collapse is predicted by the analysis.

3.2 Structural Evaluation

The nature of the foundation system beneath this building is not unusual for the period but by today's standards it is considered not only in contravention of the Code but actually dangerous. The various elements of the foundation system are predominantly unconnected mechanically; they rely purely on the weight of the structure supported, and friction, to hold everything in place. The configuration of the foundation system results in point loads being applied to the subsoils, in comparison with today's foundations which distribute the load along strip or pad footings. Consequently this type of foundation system is very prone to differential settlement; this has in fact taken place in this house, as evidenced by the slopes and unevenness of the main floor.

The geotechnical investigation conducted on this property revealed that the house is founded on a combination of fill material, loose sands, and soft silts. These geotechnical conditions contribute further to the inadequacy of the foundation system.

The main floor platform, on which the entire house is founded, is not a single competent grillage but is an assembly of essentially unconnected components. This makes it extremely difficult, if not completely impractical, to construct a new foundation system beneath the house.

Analysis has demonstrated that the stud walls, the second floor joists, and the roof structure are incapable of sustaining the loads required under the Building Code.

The roof structure was so significantly compromised when the west side gable was cut into it that the entire roof in that area of the building would need to be removed and replaced with new framing. The northern end of the roof was also modified when the front of the house was extended. To be added into this equation is the need to develop usable 2nd floor space, which precludes the presence of the interior stud walls which currently provide the primary support to the rafters. Consequently, any approach other than complete removal and replacement of the entire roof framing would be impractical.

The span of the second floor joists exceeds the allowable span as defined in Part 9 of the Building Code. Additionally the 2nd floor diaphragm is incomplete and not physically connected to the exterior walls on the east and west sides. This makes the building laterally unstable.

Although the Building Code does make provision for heritage buildings to access alternative compliance methods it does not make any concessions when it comes to safety measures. Consequently the structural requirements of the code must be met in full.

4 Summary

The existing foundation system is structurally inadequate and in contravention of the Building Code. The foundation system could not be upgraded to satisfy the code and will therefore need to be completely replaced.

The load-bearing walls within the building do not have the capacity to satisfy the Building Code. Similarly the 2nd floor structure is not compliant with the Code.

The roof structure has been heavily compromised during previous modifications to the building to the extent that it would be impractical to consider anything other than complete replacement.

Although it is technically possible to structurally upgrade the load-bearing walls and 2nd floor structure, it is advised that this is considered impractical in the context that both the foundation system and roof structure need to be replaced in their entireties.

I trust you will find this report self-explanatory but please free to contact me if you need any further information.

End of Report

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