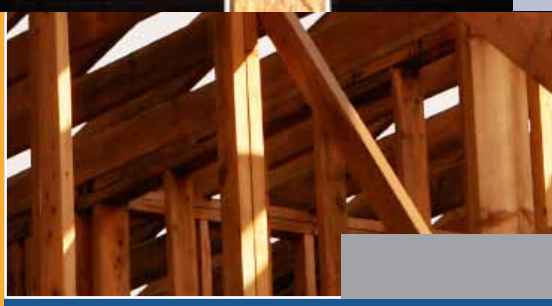
The Association of Professional Engineers and Geoscientists of BC



Structural Design Issues for Housing and Small Buildings in British Columbia:

Information for Local Authorities, Homeowners and Developers

Professional Engineers and Geoscientists of BC

Guidelines for Structural Design Issues for Housing and Small Buildings in British Columbia

Published by the Association of Professional Engineers and Geoscientists of British Columbia

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PREFACE

The Association of Professional Engineers and Geoscientists of British Columbia administers the *Engineers and Geoscientists Act (Act)* for the protection of the health, safety and welfare of the public as it relates to the practice of professional engineering and geoscience in British Columbia. One of the many practice disciplines covered under the *Act* is structural engineering, including the provision of structural engineering services for *housing and small buildings*.

DEFINITIONS

Authority Having Jurisdiction

The government body (usually municipal) with authority to administer and enforce the *BC Building Code (BCBC)* or local building bylaw.

Housing and Small Building

For the purposes of this guide, these types of buildings are defined under Clause 1.3.3.3 1) a), b), c) and d) of the *BCBC 2006*, Clause 2.1.3.3 1) a), b), c) and d) of the VBBL 1999 or Division A Clause 1.3.3.3 1) a), b), c) and d) of the NBC for Canada 2005.

For example this would include buildings of 3 storeys or less in building height with a building area of less then 600 m^2 that are used for residential, business, mercantile, or medium and low hazard occupancies as defined in the relevant building code.

Building Frame

The combination of elements which support the building's self weight and the applicable live load based on occupancy, use of the spaces in the buildings and environmental loads such as wind, snow and seismic forces from earthquakes.

Structural Engineer of Record (SER)

The professional engineer with responsibility for the structural integrity of the *primary structural systems* that includes taking overall responsibility for structural design of the building.

Letters of Assurance (LOA)

Administrative forms that may be requested by *Authorities Having Jurisdiction* per Division C, Part 2 of the applicable building code before permits are issued.

Part 9

The section of the *BCBC, VBB* or the *NBC* which identifies for the category of buildings which fall within the definition of *housing and small buildings* how they are to be designed including structural design requirements.

Primary Structural System

The combination of elements which support the building's self weight and the applicable live load based on occupancy, use of the space and environmental loads such as wind, snow and seismic forces.


1.0 INTRODUCTION

This guide was prepared by the Association of Professional Engineers and Geoscientists of British Columbia (APEGBC) for the benefit of those who are involved in the design and construction of *Housing and Small Buildings*, as classified under *Part 9* of the relevant building code. Note that this guide is not specifically addressed to engineers. For those who are interested in further reading, a more detailed coverage of the technical and professional practice issues is covered in APEGBC's 2008 *Guidelines for Professional Structural Engineering Services for Part 9 Buildings in British Columbia*.

2.0 WHY IS THIS GUIDE NEEDED?

APEGBC wants to assist the public and *Authorities Having Jurisdiction* so that the services of a professional engineer engaged on the structural design of a *house or small building* can be utilized effectively to produce a consistent level of structural performance for *houses or small buildings* (especially in terms of the ability of the building to resist a windstorm or earthquake without collapse).

Following are the three specific issues that may apply to the construction of, renovation to, or addition to a *house or small building*:

(1) **Potential inability of some modern buildings to adequately resist sway forces due to earthquakes or windstorms.** The prescriptive provisions of *Part 9* provide for the pre-engineered design of components for gravity loads (e.g., floor joist span or wall stud spacing) with little regard for wind or earthquake design. The use of these provisions is still an option in the *BC Building Code* (*BCBC*) *2006* but it is important to note that they were developed for traditional homes which have historically resisted sway forces adequately due to the combined integrity of several interconnected parts such as exterior walls, interior walls, continuous floors and roof members. However, *Part 9* buildings with modern features such as open layouts (few interior walls), or significantly interrupted exterior wall framing (many windows or very large doors) do require lateral load design (*BCBC 2006* Appendix A). Checks to determine if the sway resistance is likely to be adequate are relatively straightforward—but these checks are ***not*** contained in the prescriptive provisions and can sometimes be overlooked. Such checks may indicate that additional design details are required depending on the extent of the non-traditional features and the severity of the local wind or seismic hazard.

(2) **Potential lack of coordination of the design of various individual structural components.** Most *Part 9* buildings require one or more specialty structural components which are not covered by the prescriptive provisions of *Part 9.* As per the building code, these non-prescriptive components must be designed by a professional engineer. Proper coordination of the design of such structural components is important to ensure that they are designed consistently and interconnected properly. Without such coordination, the structural integrity of the *building frame* could be compromised.

(3) **Potential weakening of the *building frame* due to a renovation or addition.** The *BC Building Code* requires that an existing structure should not be weakened by renovations or additions. However, the lateral sway resistance of a building may be compromised by increasing the size of the openings in the floors, walls or roof elements. The net effect may be particularly difficult to evaluate for a *Part 9* building since there may not have been any non-prescriptive engineering design in the first instance (see item 1).

3.0 RECOMMENDATIONS

3.1 Recommendation (1)

This addresses Item 2.0 (1) (**Earthquake and Wind Resistance**) as follows:

The basis for the design of lateral sway resistance of *Part 9* buildings should be as follows, and a professional engineer should be engaged as noted.

a) If the building is of wood frame construction then:

(i) As a minimum, the proposed *building frame* should be evaluated using the Canadian Wood Council's *Engineering Guide for Wood Frame Construction* (CWC). This evaluation requires some technical knowledge but the process is relatively straightforward. Local authorities and/or the owner or developer may request a professional engineer or architect to certify the evaluation.

(ii) The minimum basis for the design of the sway resistance should be that determined by the CWC risk evaluation (there are three increasingly stringent design methods according to the risk). Note that after the evaluation, a professional engineer should be engaged to carry out an explicit wind or earthquake design ***unless*** the CWC evaluation has indicated that the risk is in the lowest of the three categories (in which case the prescriptive provisions of *Part 9* are deemed to be adequate).

Note that, the CWC evaluation technique is expressly recommended in Appendix A to *Part 9* of the building code. Thus, it is appropriate for the potential new homeowner to ask the owner or developer (a) whether the CWC evaluation technique was part of the design process, and, (b) whether the design process used was at least consistent with the minimum recommendations of such an evaluation.

b) If the building is not of wood frame construction:

(i) A professional engineer should always be engaged to design for the sway resistance according to Part 4 of the applicable building code (*National Building Code (NBC)*, *BCBC* or the *Vancouver Building Bylaw (VBB)*).

3.2 Recommendation (2)

This addresses Item 2.0 (2) (**Coordination of Designs**) as follows:

Once a professional engineer is required by the building code to provide any structural engineering services on a *house or small building*, the same professional engineer or another professional engineer should be engaged to ensure that the designs of all structural components are consistent with the overall structural design of the *building frame*. These components shall include footings and foundations, beams and trusses, each of which may be designed by a different professional engineer.

In such instances, the engineer providing the coordinating role should be engaged to act as the *Structural Engineer of Record* (*SER)* so they can take professional responsibility for the structural integrity of the *building frame.* This also includes confirmation that a complete load path to the foundation has been provided for both gravity and lateral sway loads for all structural components designed by others (e.g., wood trusses, beams, supporting concentration loads, open web steel joists, steel beams and steel columns). It should be noted that when *letters of assurance* (*LOA)* are requested by the *Authority Having Jurisdiction* it is generally the engineer acting as the *SER* who signs such letters (APEGBC's 2008 *Guidelines for Professional Structural Engineering Services for Part 9 Buildings in British Columbia*).

3.3 Recommendation (3)

This addresses Item 2.0 (3) (**Renovations**) as follows:

A professional engineer should be engaged to confirm that an addition or renovation that is ***not*** structurally independent from an existing structure (*house or small building*) should be designed and constructed such that the structural integrity of the existing building not be made worse (see APEGBC's 2008 *Guidelines for Professional Structural Engineering Services for Part 9 Buildings in British Columbia* for further technical discussion).

The addition or renovation itself should be specifically designed for lateral sway resistance loads as per Recommendation (1) contained in 3.1 of this guide.

4.0 CONCLUDING REMARKS

This guideline has focused on the design of new *Part 9* buildings and on renovations to existing buildings. The increased risk of structural problems for *Part 9* buildings not designed to the standard of good engineering practice has been outlined.

It is APEGBC's position that a member or licensee who has suitable training and experience in this field of practice is appropriately qualified for the services covered in this guideline. A member or licensee with the Designated Structural Engineer (Struct.Eng.) designation is not required for the services covered in this guide.

Most existing wood frame structures have performed extremely well during earthquakes. However, it has been noted that there is an elevated risk of poor performance for a *Part 9* building that has a significantly non-traditional layout and yet has still been designed using the traditional prescriptive option provided in the building codes (and not the option of good engineering practice as recommended in Appendix A of the building code).

When considering this issue, it should be noted that the most cost-effective time for mitigating the risk is during the initial construction phase or during a very extensive renovation. It should also be noted that not all existing buildings in the elevated risk category would automatically perform poorly in an earthquake. In some cases, non-structural components may help the performance in unintended ways.

5.0 REFERENCE DOCUMENTS

- British Columbia Building Code
- National Building Code
- Engineering Guide for Wood Frame Construction Published by the Canadian Wood Council (CWC 2004)
- Vancouver Building Bylaw
- City of Vancouver Bulletin 2001-011-BU, Seismic Design of One and Two Family Dwellings, Revised April 19, 2007
- City of Vancouver Bulletin 2003-001-AD/BU, Guidelines for Seismic Evaluations of One and Two Family Dwellings, Revised April 19 2007
- APEGBC Guidelines for Structural Engineering Services for Building Projects
- APEGBC (2008) Guidelines for Professional Structural Engineering Services for Part 9 Buildings in British Columbia
- APEGBC Bulletin K: Letters of Assurance and Due Diligence including Appendix A – Specialty Engineer – Assurance of Professional Design and Field Review (Schedule S)
- APEGBC Guidelines for Geotechnical Engineering Services for Building Projects
- APEGBC Advice on Hiring a Professional Engineer or Professional Geoscientist in British Columbia

Note: APEGBC guidelines and bulletins are available from the APEGBC website at www.apeg.bc.ca

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