

ILLUSTRATED GUIDE

For Seismic
Design of
Houses



Lateral Bracing Requirements Part 9 BC Building Code 2012

This guide has been developed to assist house designers and builders in understanding and complying with the new BC Building Code requirements applicable to Part 9 houses in high seismic regions in British Columbia.



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Disclaimer

This illustrated guide is only intended to provide readers with general information about aspects of Part 9 of the British Columbia Building Code (the "Code"). Readers are urged not to rely simply on this guide but to carefully review the Code and consult with appropriate and reputable professionals and construction specialists to assist in interpreting and applying the Code. It is the responsibility of all persons undertaking the design and construction of a home to fully comply with the requirements of the Code. The authors, contributors, funders and publishers assume no liability for the accuracy of the statements made or for any damage, loss, injury or expense that may be incurred or suffered as a result of the use of or reliance on the contents of this guide. The views expressed do not necessarily represent those of individual contributors or the Homeowner Protection Office, a branch of BC Housing.

References

This guide contains most requirements for locating required lateral braced wall panels and the construction details for those panels and is based on Part 9 of the BC Building Code. Version 1.0 Copyright © 2012 all rights reserved. No portion of this guide may be reproduced, stored in a retrieval system or transmitted in any form, or by any means mechanical, electronic, photocopying, recording or otherwise without the prior written permission of the Homeowner Protection Office, a branch of BC Housing. Portions of the building code have been reproduced from the 2010 National Building Code of Canada / BC Building Code with the permission of the National Research Council of Canada and the Queen's Printer of British Columbia, copyright holders.

Introduction

Lateral Bracing - A Step-By-Step Process

Part 9 construction embraces the design and construction of houses with prescriptive requirements that result in safe, comfortable houses. The building code is constantly revised in response to the continually improving understanding about the complex environmental loads that impact the performance of houses.

This guide has been produced in an effort to clearly describe the new building code requirements for lateral bracing of small wood-frame structures in the high seismic regions of British Columbia. Designers will need to consider these requirements when creating the

form of the exterior walls, as well as the dimensions and locations of interior walls. Builders will need to understand the material requirements, as well as the construction methods necessary to fabricate braced wall panels at required locations throughout the structure.

The simple basis of improving the seismic response of a house to an earthquake is to ensure that there is adequate full height walls sheathed or finished with panels well fastened to the frame. The basic, sheathed wall is very strong at resisting the typical lateral movement (back and forth) of the ground experienced during an earthquake.

“The basic, sheathed wall is very strong at resisting the typical lateral movement (back and forth) of the ground experienced during an earthquake”

Several of these braced wall panels installed at key locations from the foundation to the roof structure, and located on all exterior walls of the house, result in a very strong structure. Interruptions in the braced wall panels from openings (such as windows) or significant misalignment (such as walls on subsequent floors that are significantly set back from lower floors), result in a reduction of structural capacity to resist lateral loads.

The new lateral bracing requirements for high seismic regions are determined by following a step-by-step process. The first step is to confirm that the entire perimeter from foundation to roof is enclosed by imaginary braced wall bands, and to identify if additional imaginary braced wall bands are needed at intermediate points within the house. The next step is to locate a minimum number of braced wall panels at key locations within these bands, and then to construct the braced wall panels.

The Braced Wall Panel

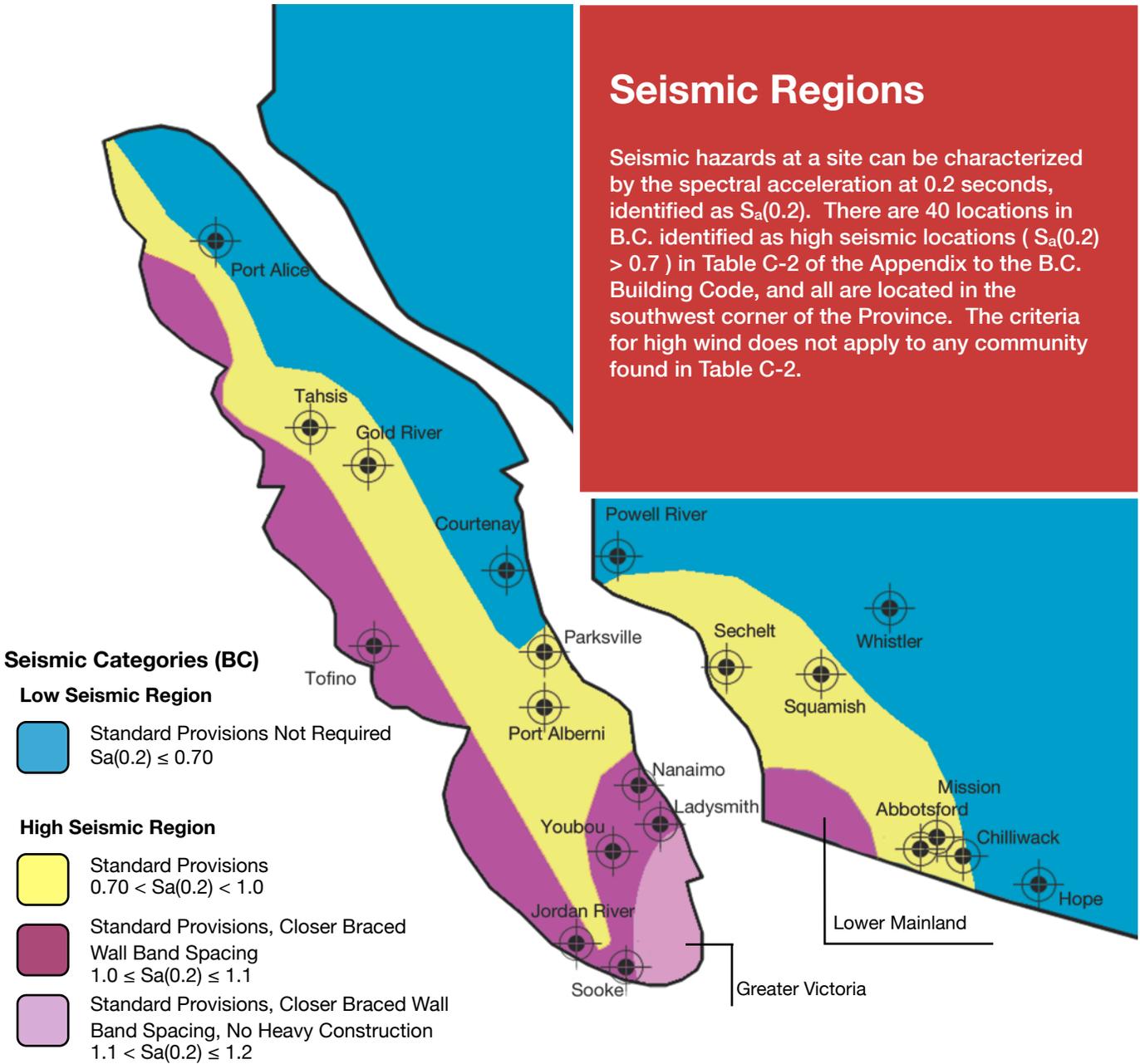
The lateral forces on a building cannot be resisted with unbraced studs and plates. The motion will tend to deflect the studs and result in significant damage or even failure.

By adding sheathing (such as plywood or OSB) to the exterior, and drywall or panelling to the interior, the resistance to lateral loads can be achieved.

Braced wall panels are portions of walls where exterior sheathing or interior finish is designed and installed to provide the required resistance to lateral loads due to earthquakes.



Seismic Regions



Seismic Regions

Seismic hazards at a site can be characterized by the spectral acceleration at 0.2 seconds, identified as $S_a(0.2)$. There are 40 locations in B.C. identified as high seismic locations ($S_a(0.2) > 0.7$) in Table C-2 of the Appendix to the B.C. Building Code, and all are located in the southwest corner of the Province. The criteria for high wind does not apply to any community found in Table C-2.

In an earthquake, the acceleration of the ground creates lateral forces on a structure. The magnitude of the lateral forces on a house is influenced by its height and weight. The exterior and interior walls are the key components for resisting the lateral forces collected from the floors and roof over the height of the house.

Part 9 houses can be quite resistant to lateral loads because of the redundant nature of wood-frame construction. House designs can also include features that result in a reduction of the resistance to lateral seismic loading, such as large openings through exterior walls; open interior floor plans (which eliminate many of the interior walls); and the use of heavy construction

methods like concrete floor toppings and/or tile roofing. Failure can occur in shear at the roof-to-wall, wall-to-wall, and wall-to-foundation connections, as well as racking failure of the walls.

This illustrated guide provides guidelines for building houses in regions where the spectral acceleration, $S_a(0.2)$ is greater than 0.7, and less than or equal to 1.2 (1.1 for a particular case of heavy construction). The guidelines are also for regions where the 1-in-50 hourly wind pressure is greater than 0.80 kPa but less than 1.2 kPa; however, no location in BC has design wind pressure high enough to be in this range.

Main Requirements

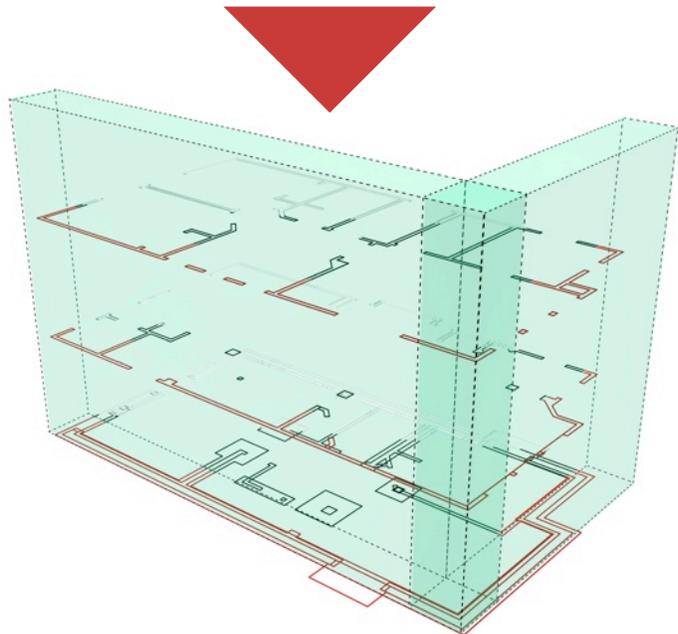
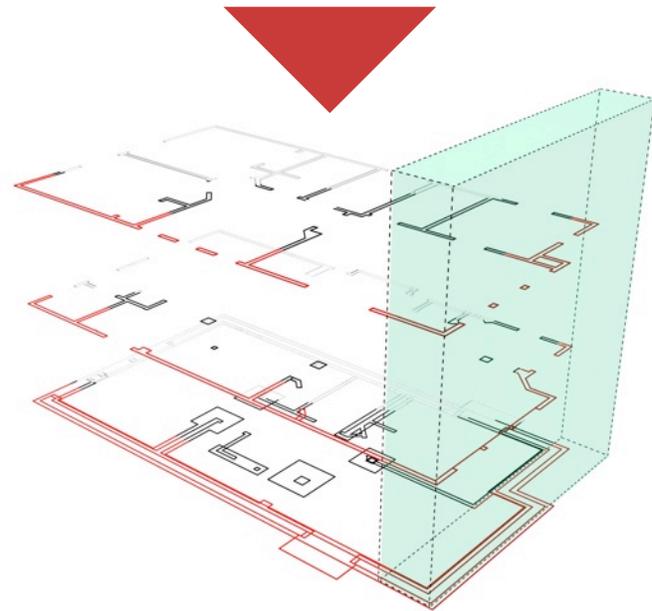
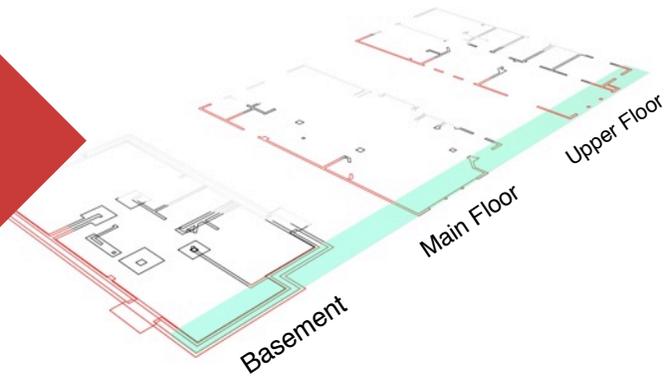
The Braced Wall Band

The braced wall band is an imaginary continuous straight band extending vertically and horizontally through a building (or part of a building) in which braced wall panels are constructed.

The first figure (top right) shows the three floor plans aligned on a drawing and the up to 1.2 m wide braced wall band shown enclosing all of the walls of the front elevation of the house.

The second figure (middle right) shows the band applied to the floor plans as they would stack in construction. Note that the walls on the front elevation are located within the 1.2 m wide band.

The third figure (bottom right) shows the band applied to the second elevation. Bands need to be identified on the remaining elevations and any required interior regions.



Step 1

Braced Wall Band

The braced wall band is an imaginary continuous straight band extending vertically and horizontally through a building (or part of a building) in which braced wall panels are constructed. The first step is to ensure that each perimeter wall and certain interior walls align within an imaginary braced wall band, which extends from the foundation to the roof. These walls must be located within the up to 1.2 m wide braced wall band from the foundation to the roof. ⁱ

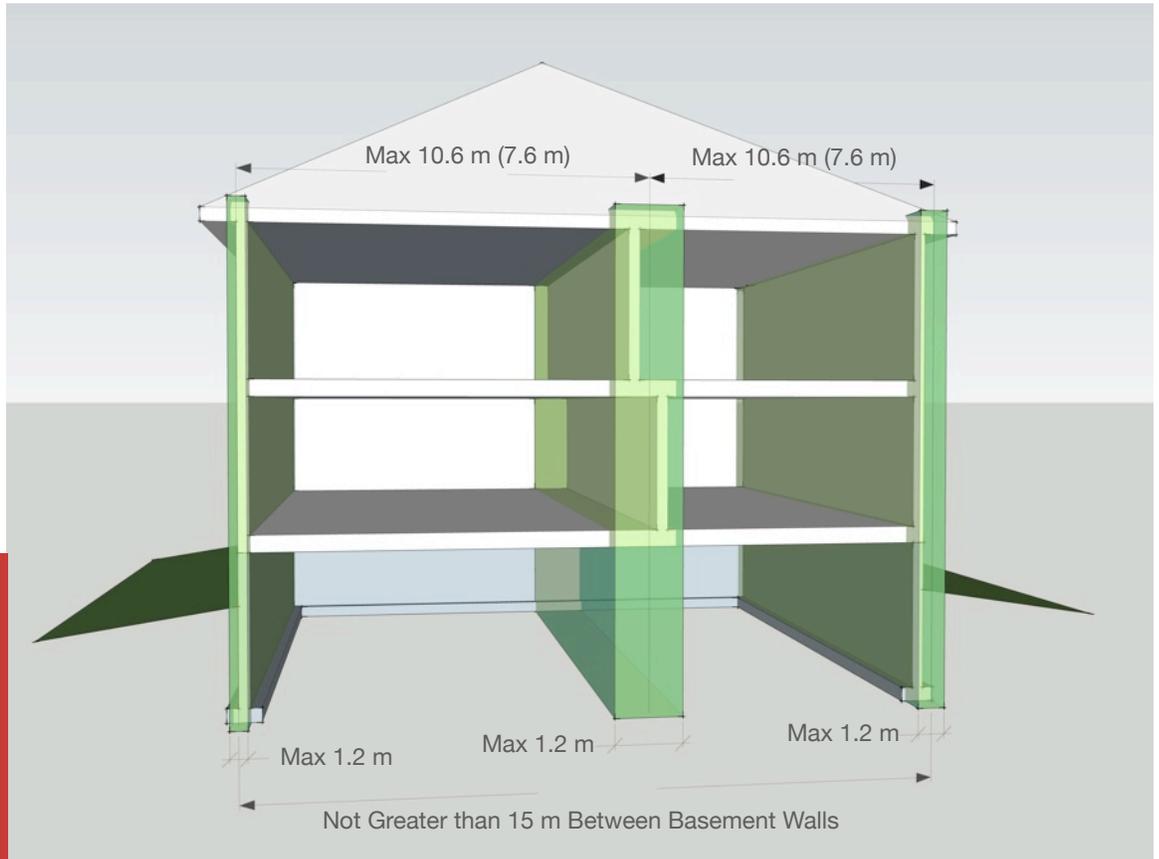
Braced wall bands must be located around the perimeter of the building, and additional braced wall bands may be required at interior wall locations.

ⁱ 9.23.13.4.(1)(a), (b) and (e), 9.23.13.4.(2) (see Appendix)

Braced Wall Bands

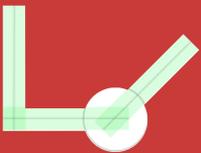
Example Building Sections

Braced wall bands can be up to 1.2 m wide. They must be full storey height and be aligned with braced wall bands on the storeys above and below. The maximum space between bands depends on whether they are in the basement or crawl space (where it can be up to 15 m)ⁱⁱ or above (where it can be 10.6 m or 7.6 m depending on the specific $S_a(0.2)$).ⁱⁱⁱ Exceptions and trade offs are examined in Sections 2 and 3 of this guide.

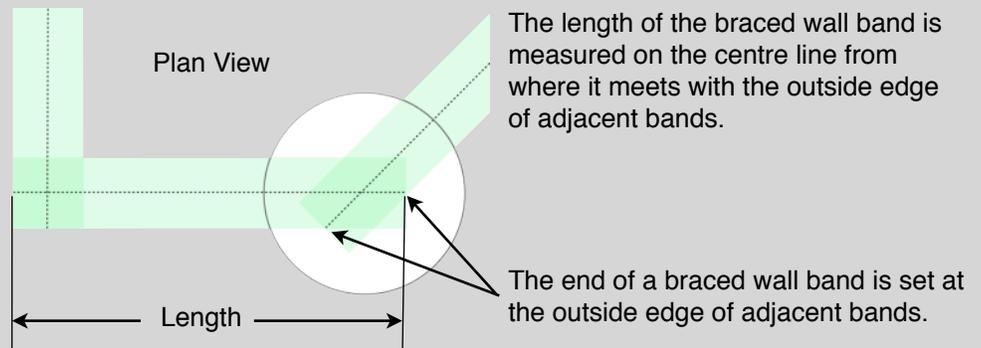


Braced Wall Band

The braced wall band must lap with adjacent braced wall bands at both ends. The centre line of each braced wall band extends to the outer edge of the connected braced wall bands.

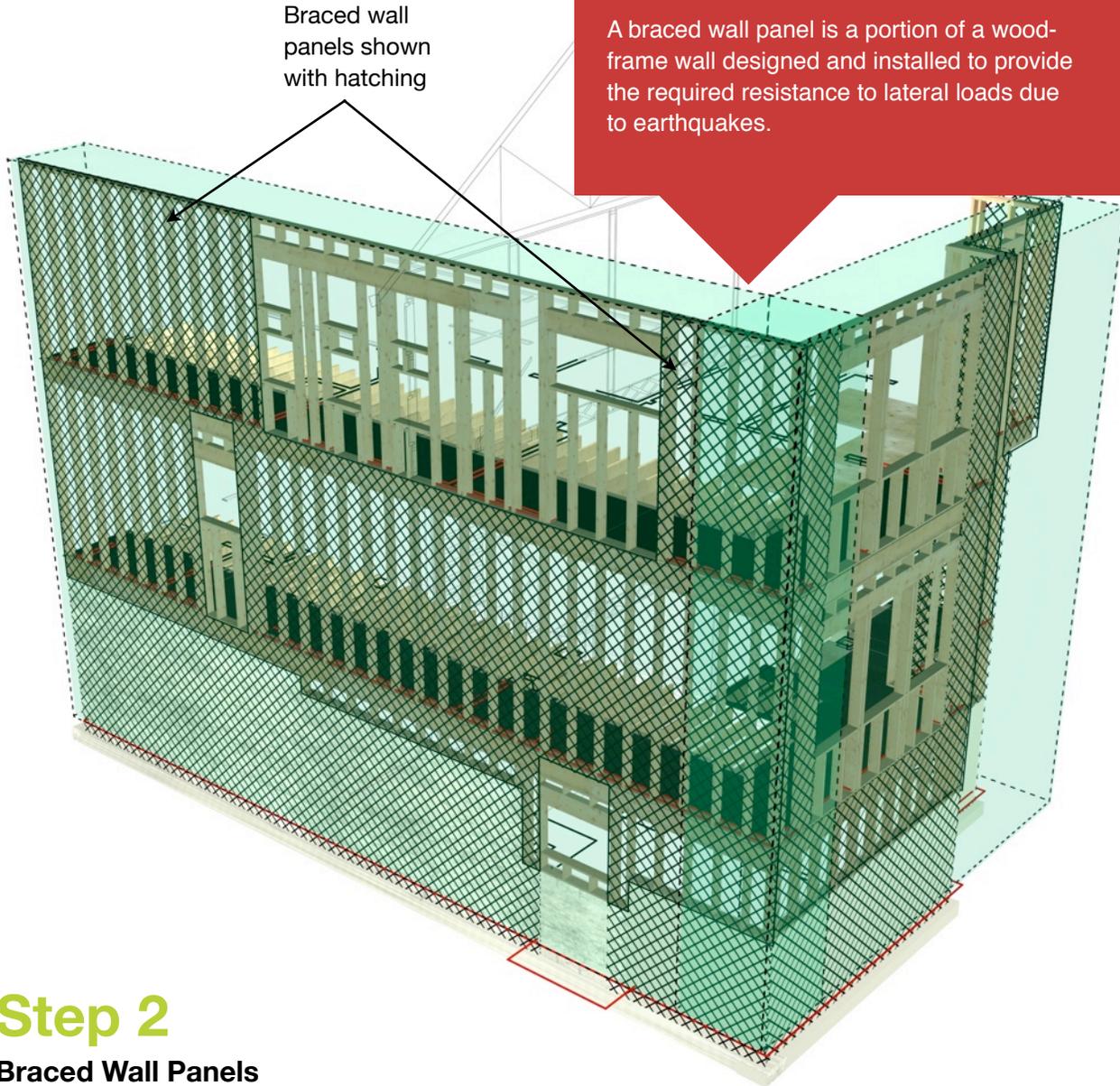


Designer Note



Braced Wall Panels

A braced wall panel is a portion of a wood-frame wall designed and installed to provide the required resistance to lateral loads due to earthquakes.



Step 2

Braced Wall Panels

A braced wall panel is a portion of a wood-frame wall designed and installed to provide the required resistance to lateral loads due to earthquakes. Unlike the imaginary braced wall band, a braced wall panel is an actual physical element that meets certain dimension and construction requirements. Braced wall panels must be located within a braced wall band to be considered effective.^{iv}

Braced wall panel materials for exterior walls include plywood, oriented strand board (OSB) or diagonal lumber sheathing on one side of the wall. Panel-type cladding

may also be used.^v For interior braced wall panel walls, both sides shall be finished with gypsum or wood based products.^{vi} They can be sheathed on one side only provided that the wood-based panels are used and the maximum spacing of the panel fasteners is reduced by half.^{vii} For braced wall panels in braced wall bands required at 15 m intervals, only plywood, OSB or diagonal lumber sheathing shall be used to construct the braced wall panels.^{viii}

^{iv} 9.23.13.5.(1)(a); ^v 9.23.13.6.(1)(a), (b) and (c); ^{vi} 9.23.13.6.(2); ^{vii} 9.23.13.6.(3); ^{viii} 9.23.13.6.(6) (see Appendix)

Spacing and Dimensions

Offset Wall Profiles

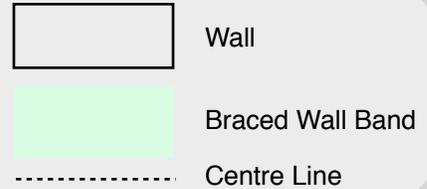
The widths of braced wall bands identified by the designer can have an impact on the design of the house and the layout of its walls.

Designer Note

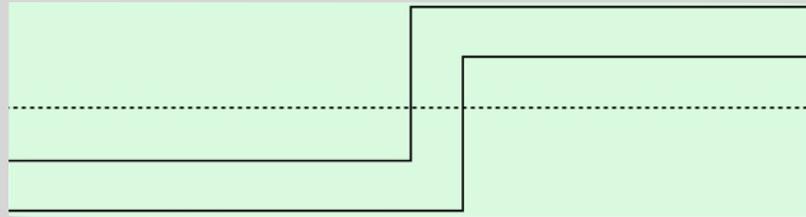
Plan View of Wall



The perimeter of building, and certain interior walls, shall be located within braced wall bands. For simple straight walls, the band need only be the width of the wall.

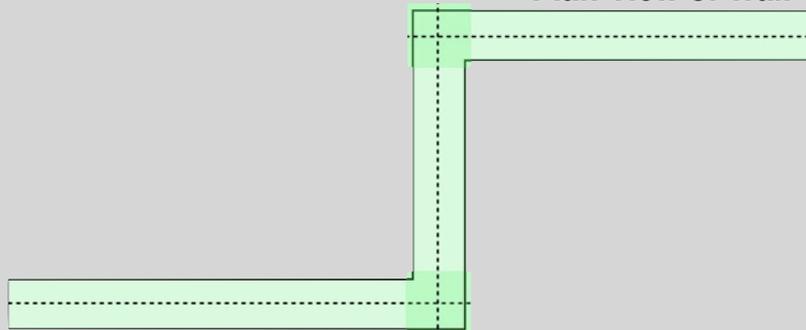


Plan View of Wall



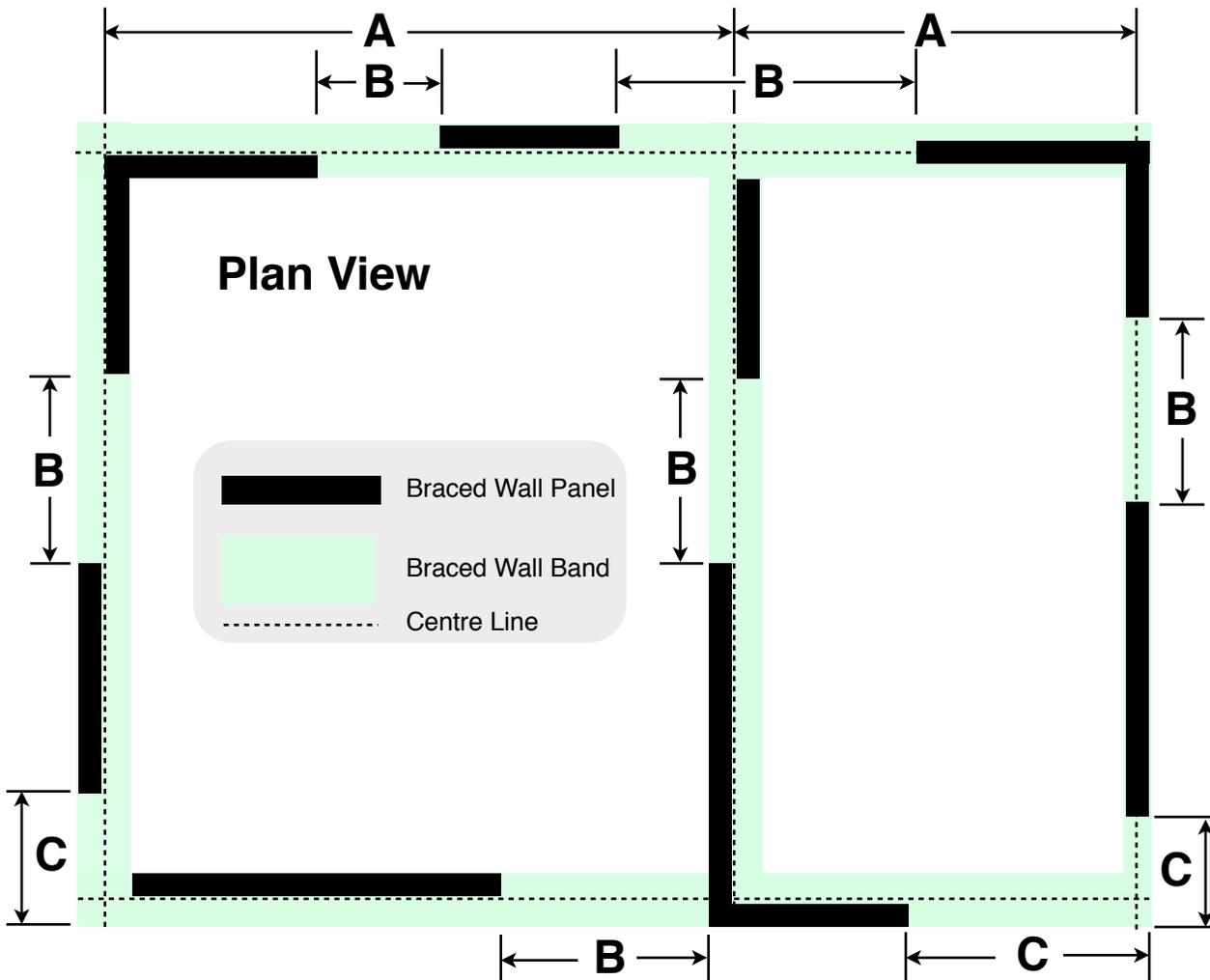
Walls that contain small offsets can be included within the braced wall band as long as the band does not exceed 1.2 m in width and all of the wall elements are located within the band. The jog in this wall is not included as part of the length of the braced wall panel (even if it is sheathed in accordance with the requirements for a braced wall panel).

Plan View of Wall



Walls that contain significant offsets will require separate braced wall bands. Each band shall contain the required minimum braced wall panels.

Spacing and Dimensions

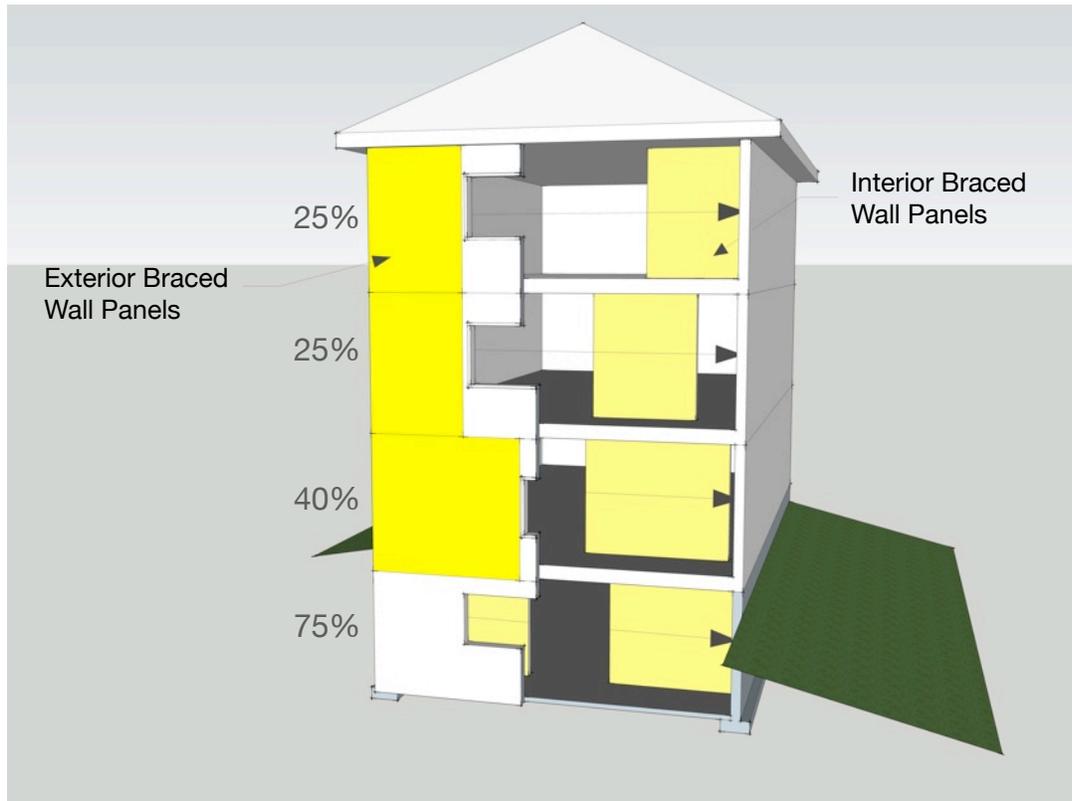


- A** Distance between centre lines of braced wall bands
- B** Distance between braced wall panel edges
- C** Distance from end of braced wall band to end of first braced wall panel

	$0.70 < S_a(0.2) < 1.0$	$1.0 \leq S_a(0.2) \leq 1.2$
A Maximum	10.6 m	7.6 m
B Maximum	6.4 m	6.4 m
C Maximum	2.4 m	2.4 m

From Table 9.23.13.5. (see Appendix)

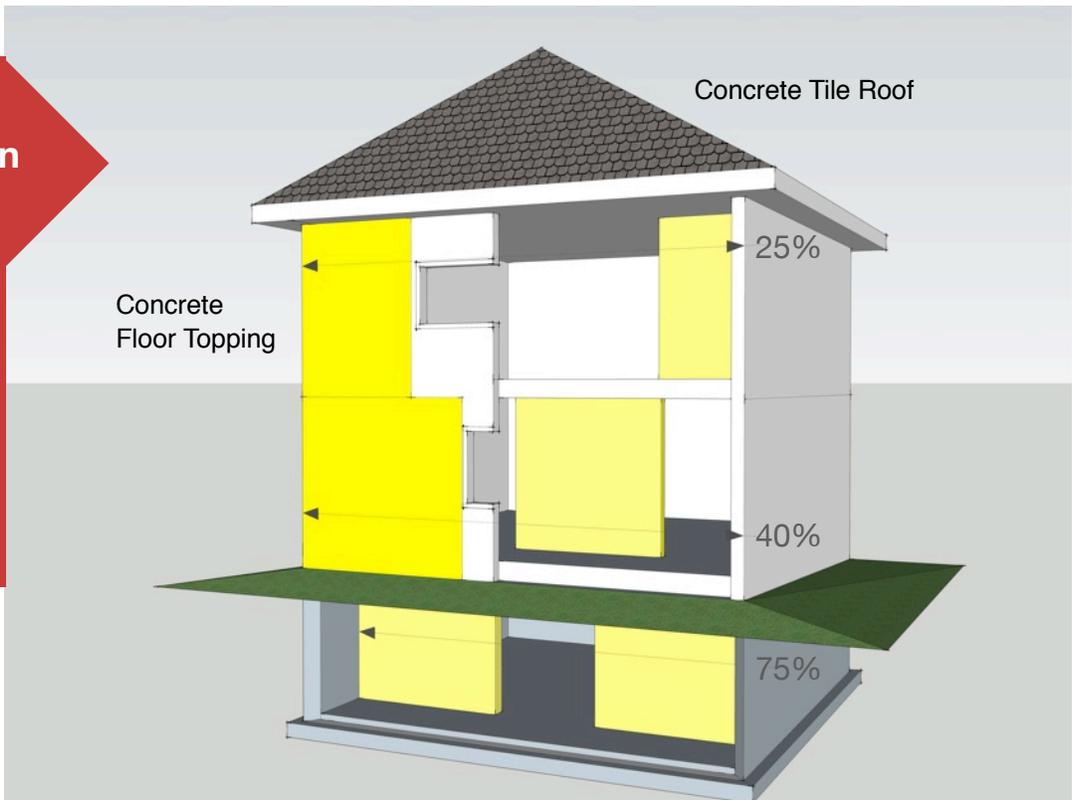
Spacing and Dimensions



Light Construction - Minimum Length of Braced Wall Panels. ^{ix}

Heavy Construction

Heavy construction is any house that includes either concrete roof tiles, concrete floor topping, or both.

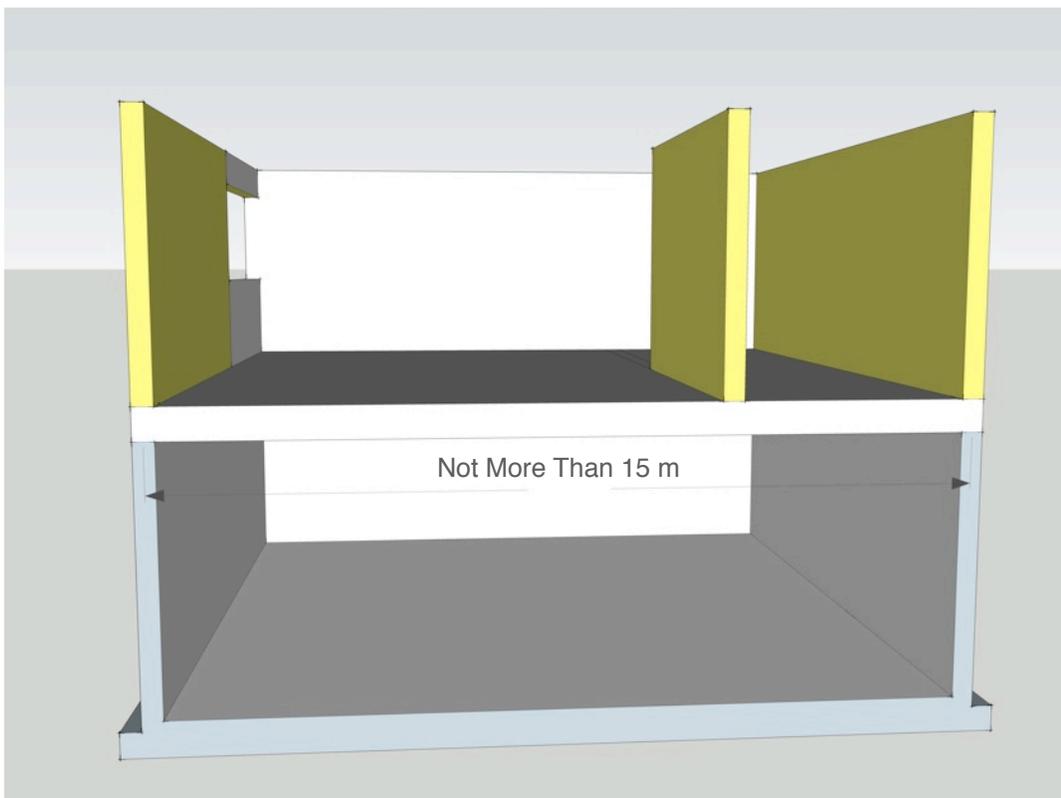


Heavy Construction - Minimum Length of Braced Wall Panels. ^{ix}

Spacing and Dimensions



Minimum length of braced wall panels when connecting to intersecting braced wall panels, and minimum panel length in the field of the wall. ^x



Braced wall panels do not need to be continuous through the basement where the span between basement walls does not exceed 15 m.

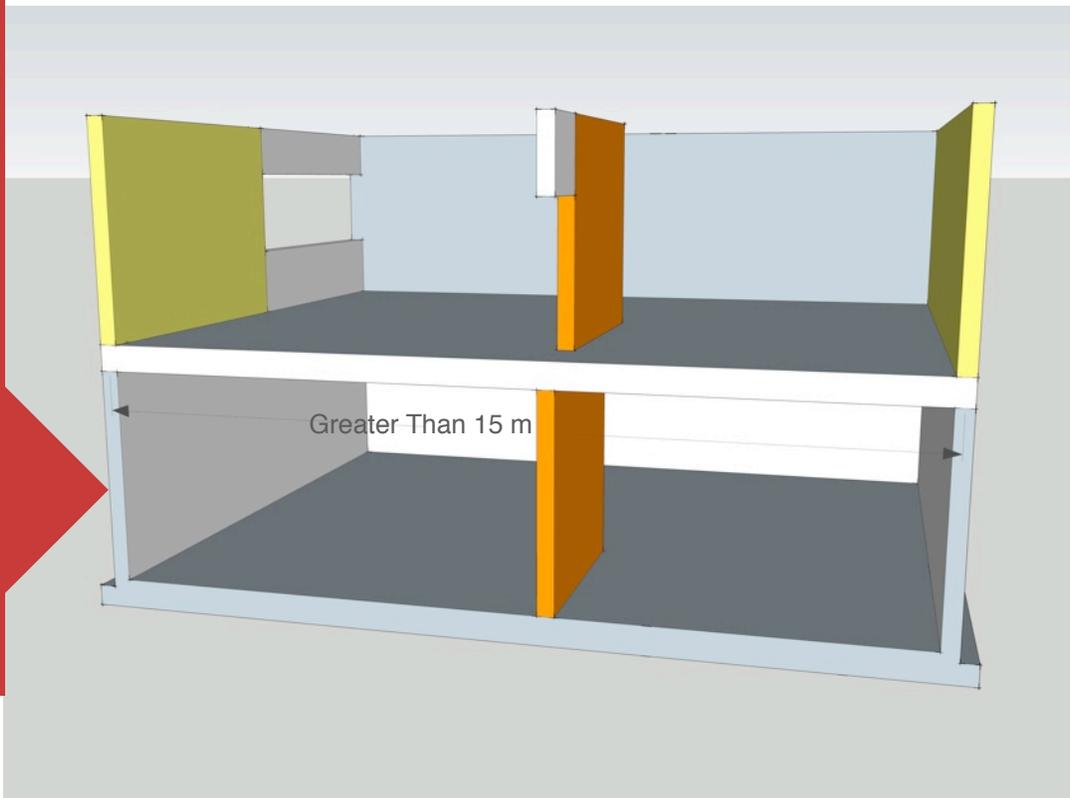
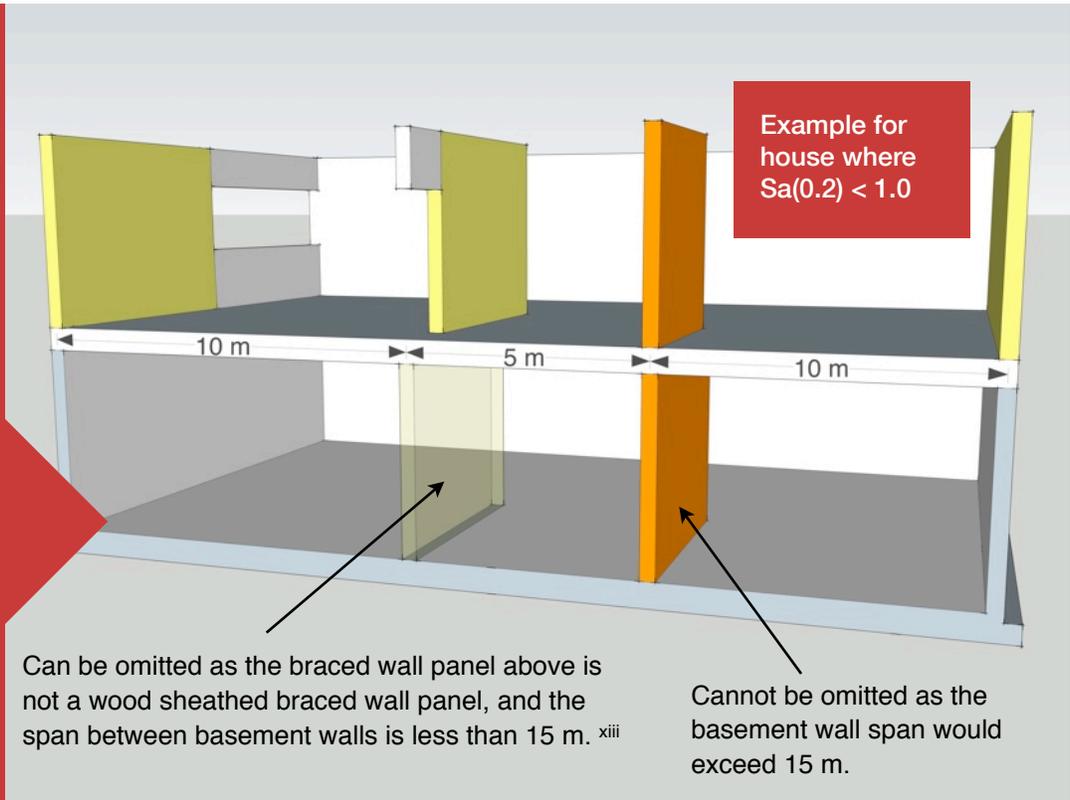
^x Table 9.23.13.5. (see Appendix)

Spacing and Dimensions

Wood Sheathed Braced Wall Panel

A wood sheathed braced wall panel is a braced wall panel that uses plywood, OSB, waferboard or diagonal lumber sheathing on both sides of the wall.

A wood sheathed braced wall panel can be sheathed on one side only provided that the sheathing material is plywood, OSB or waferboard, and the maximum spacing of fasteners along the edge is half of the maximum allowable. ^{xi}

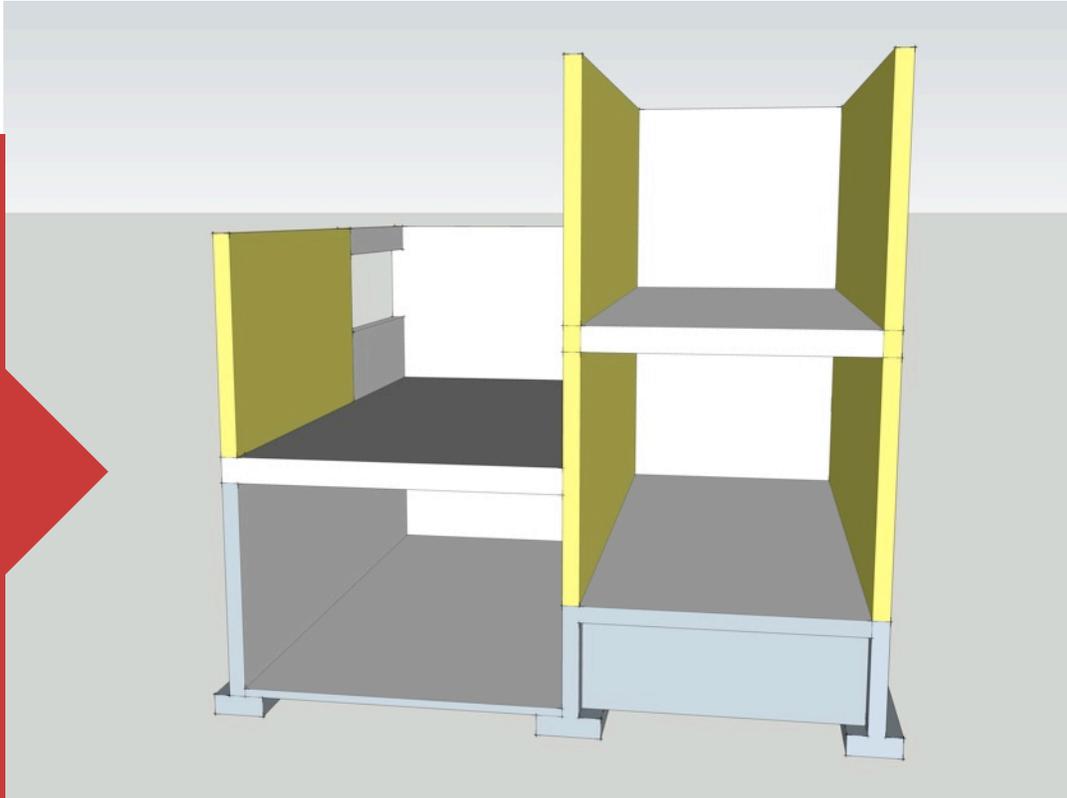


If a wood sheathed braced wall panel is constructed on any floor (including the basement), then wood sheathed braced wall panels are required throughout that braced wall band. ^{xii}

Spacing and Dimensions

Split Level

A split-level house would require a braced wall band at the location of the split when the change in the floor level is greater than the depth of one floor joist. ^{xiv}



^{xiv} 9.23.13.4.(3) (see Appendix)

Design Requirements

This flow chart is a useful checklist for confirming layout requirements and minimum panel areas when designing for seismic lateral loads.

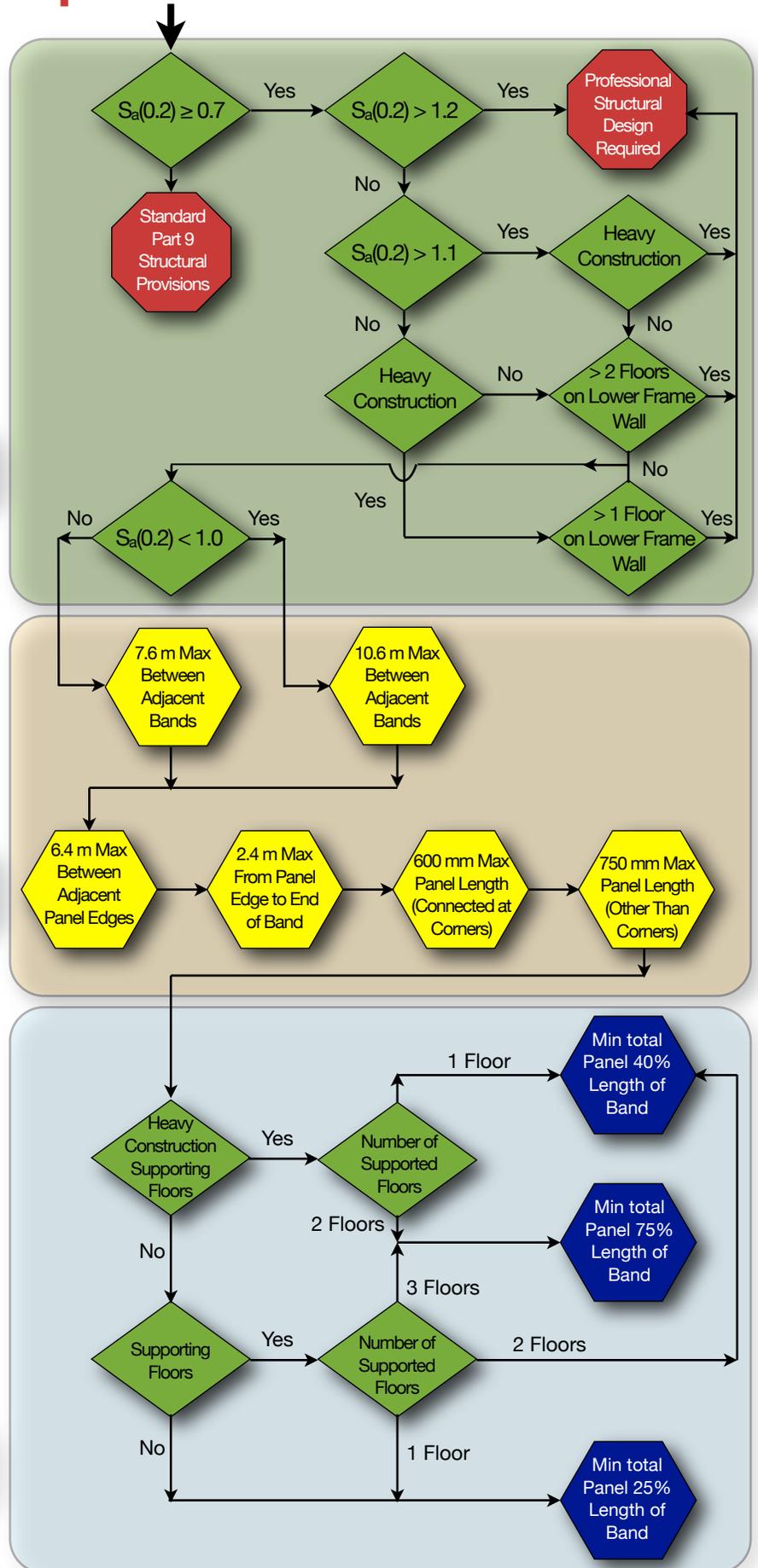
Using this Flow Chart

Identify the $S_a(0.2)$ for the community from Table C-2 in the Appendix to the BC Building Code. Begin from the top of the flow chart and establish which requirements apply.

Lateral Load Qualifier

Layout Requirements

Minimum Panel Length

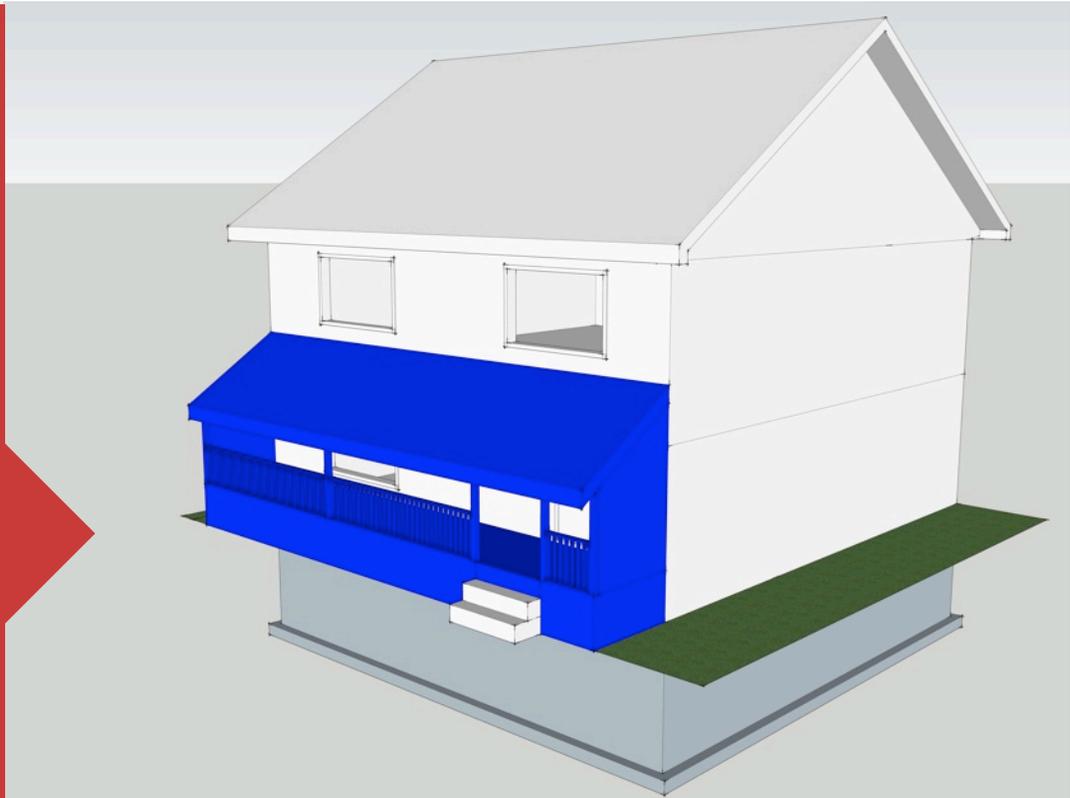


Exceptions

There are some elements where the requirements for braced wall bands and braced wall panels are not required.

Porches

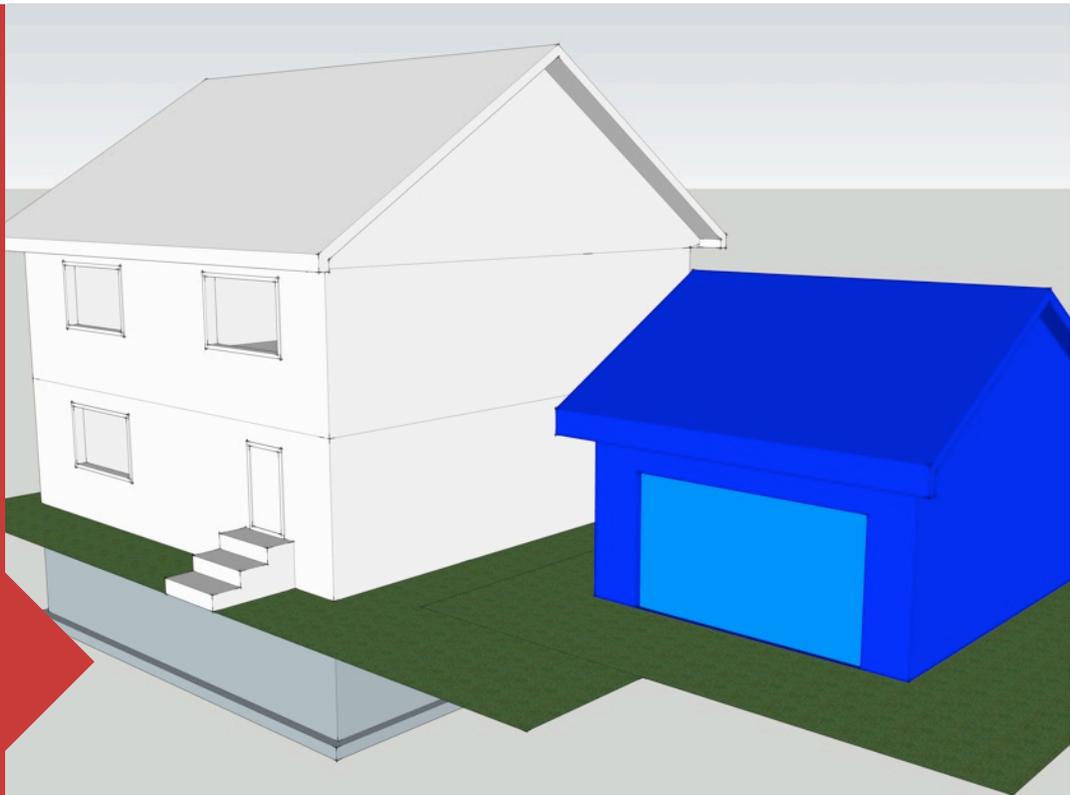
The three walls of any porch extending not more than 3.5 m from the building, and supporting no floors of construction above are exempted from bracing requirements. The extension of the porch from the house shall not exceed half of the length of the porch.^{xv}



The roof of the porch must be integral with the roof of the house, or framed and fastened to the wall framing.

Detached Garages

All detached garages supporting no floors of construction are exempted from bracing requirements.^{xvi}

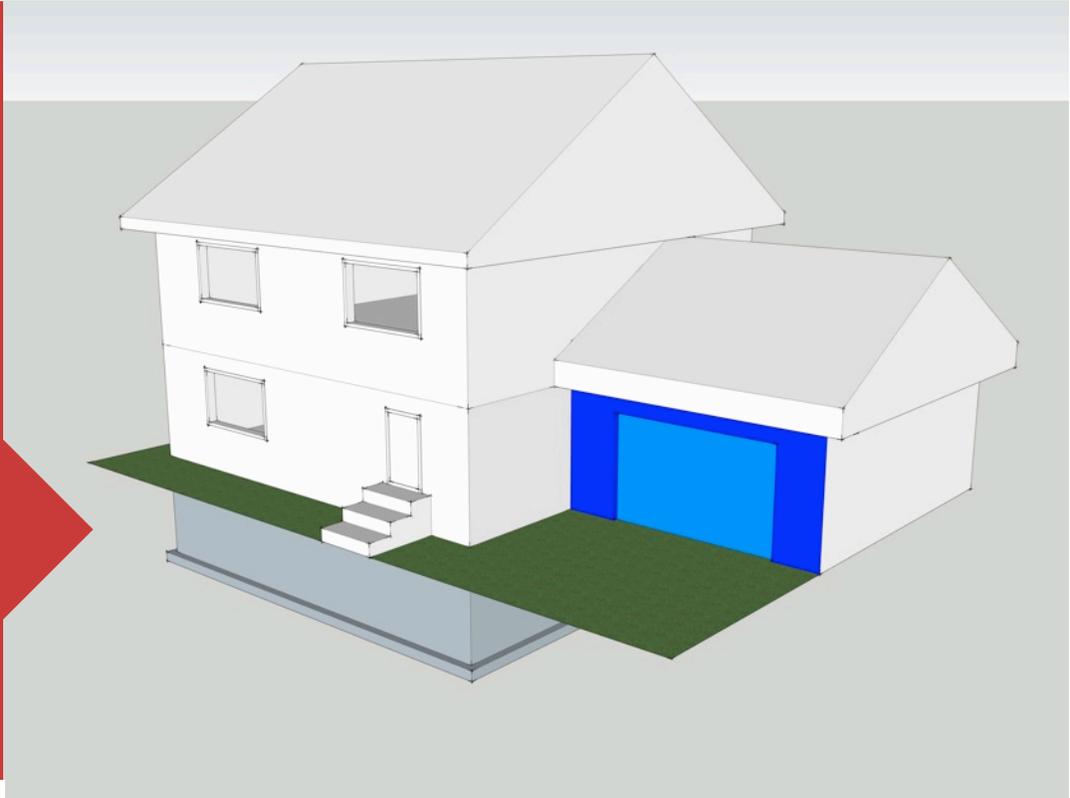


^{xv} 9.23.13.5.(3)(a), (b), and (c); ^{xvi} 9.23.13.5.(4) (see Appendix)

Exceptions

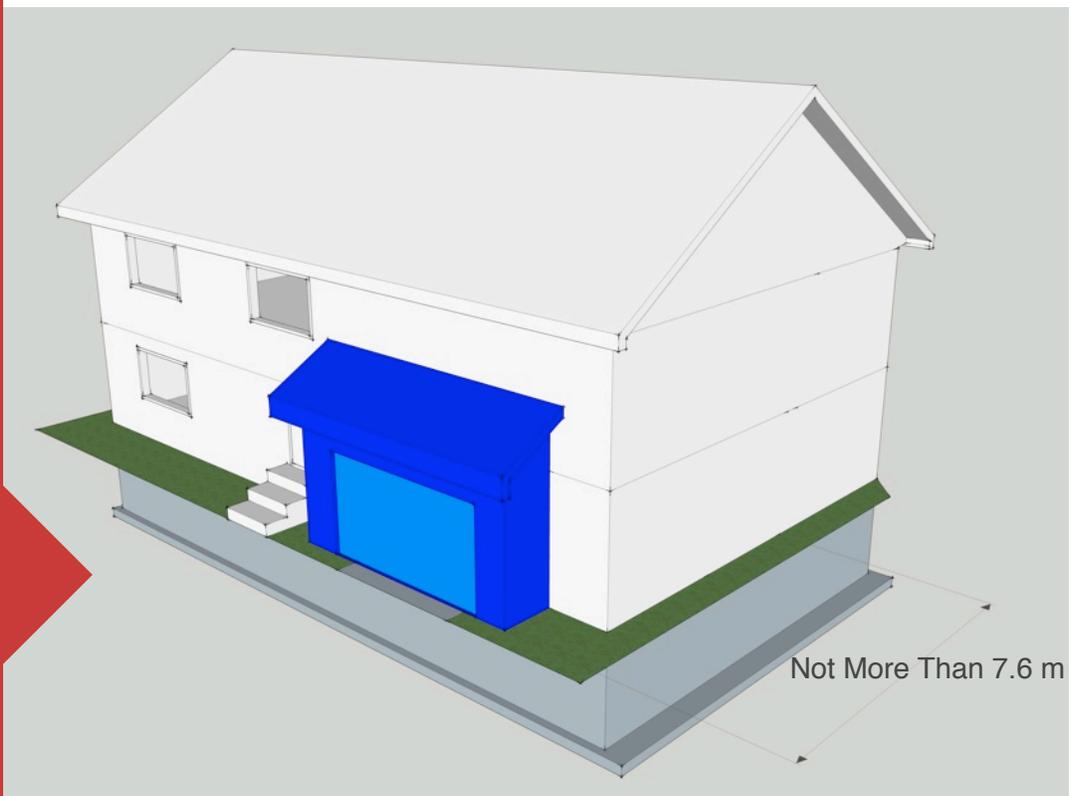
Attached Garages

The front wall of attached garages serving a single dwelling unit and supporting no floors of construction is exempt from bracing requirements.^{xvii}



Attached Garages

If the attached garage supports not more than one floor of construction, the garage door is a permitted large opening, provided that there is adequate bracing of the other three walls of the garage and that the back wall of the garage is not more than 7.6 m from the garage door.^{xviii}



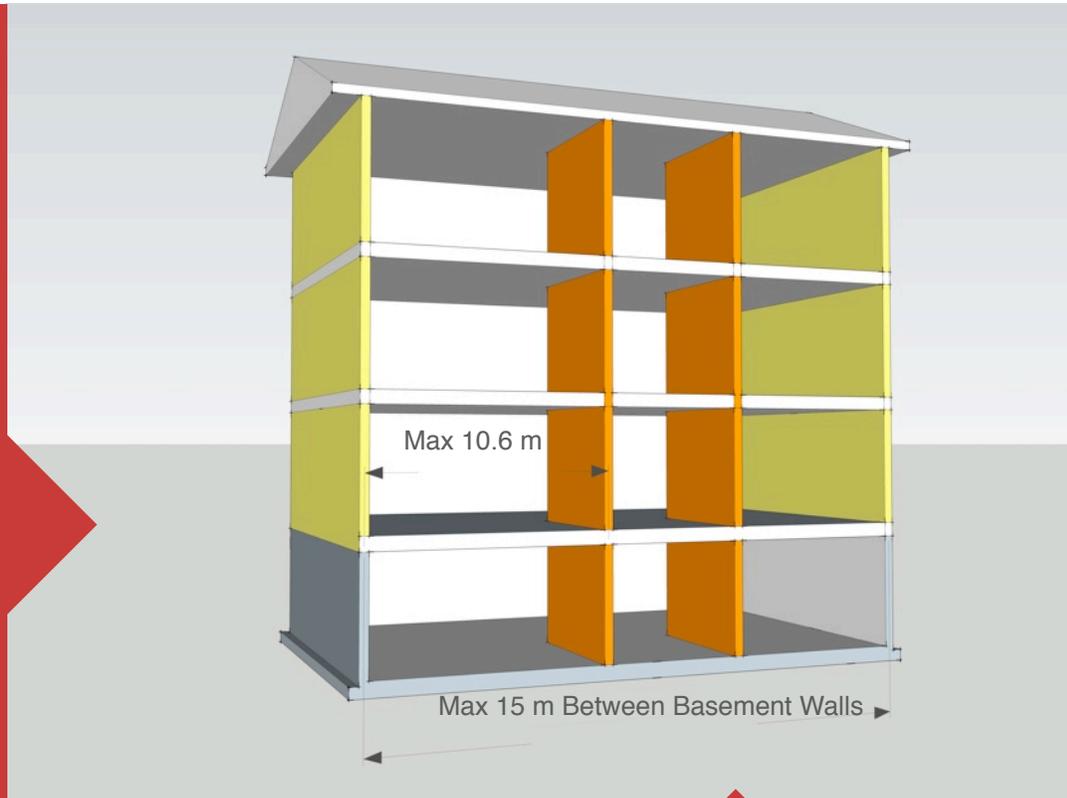
Trade Offs

The following trade offs have been developed to address the need for greater design flexibility when applying the lateral load provisions to Part 9 structures.

1. Open Concept

Wood Sheathed Braced Wall Panel

The 7.6 m separation between braced wall bands in locations where $S_a(0.2)$ is from 1.0 to 1.2, can be increased to a maximum of 10.6 m, provided that the interior braced wall band contains wood sheathed braced wall panels.^{xix}



Adjacent Wood Sheathed Braced Wall Panel Bands

Any wood sheathed braced wall panel band used to increase the maximum spacing of braced wall bands cannot also be considered as a wood sheathed braced wall panel band required for basement walls separated by more than 15 m.^{xx}

^{xix} 9.23.13.7.(5)(a) and (b); ^{xx} 9.23.13.7.(5)(c) (see Appendix)

Trade Offs

2. Set Back Walls

Set Back Wall

One exterior wall (in each orthogonal direction) of the top storey can be set back. ^{xxi}

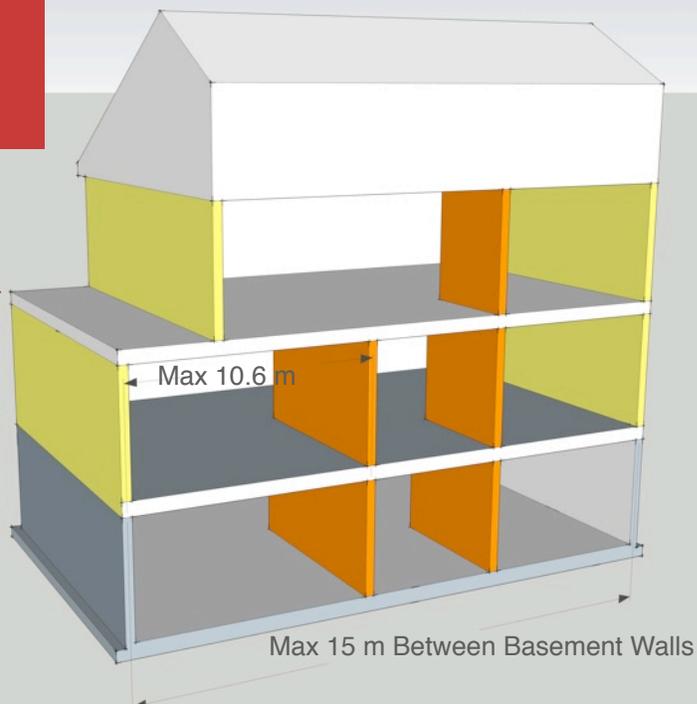
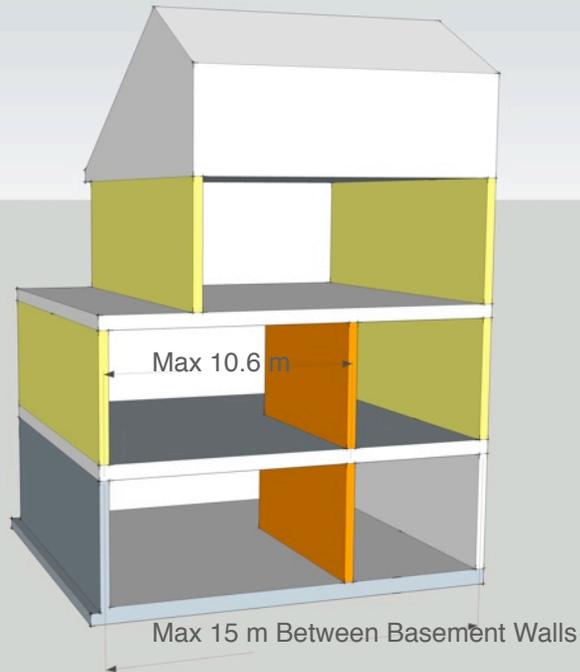
Additional Wood Sheathed Braced Wall Panel Band

To accommodate the set back, there must be an additional wood sheathed braced wall panel band adjacent to and not more than 10.6 m back from the adjacent exterior wall supporting the set back. This wood sheathed braced wall panel band is additional to those required for basements spanning greater than 15 m.

The exterior walls perpendicular to the set back wall shall have their top plates connected with nails at half the normally required spacing, and be fastened with twice the required number of nails.

Roof and Floor Sheathing

The roof and floor supporting the set back wall must be sheathed in wood-based material from the outside wall of the floor below through to the adjacent interior braced wall bands.



Trade Offs

3. Reduced Length of Braced Wall Panels

Increased Openings in the First Storey

One exterior wall (in each orthogonal direction) can have the required length of braced wall panels reduced from 40% to 25%.^{xxii}



Braced Wall Panel Ratio

The walls above any wall with increased openings must not have braced wall panel lengths greater than two times that of the wall with increased openings.

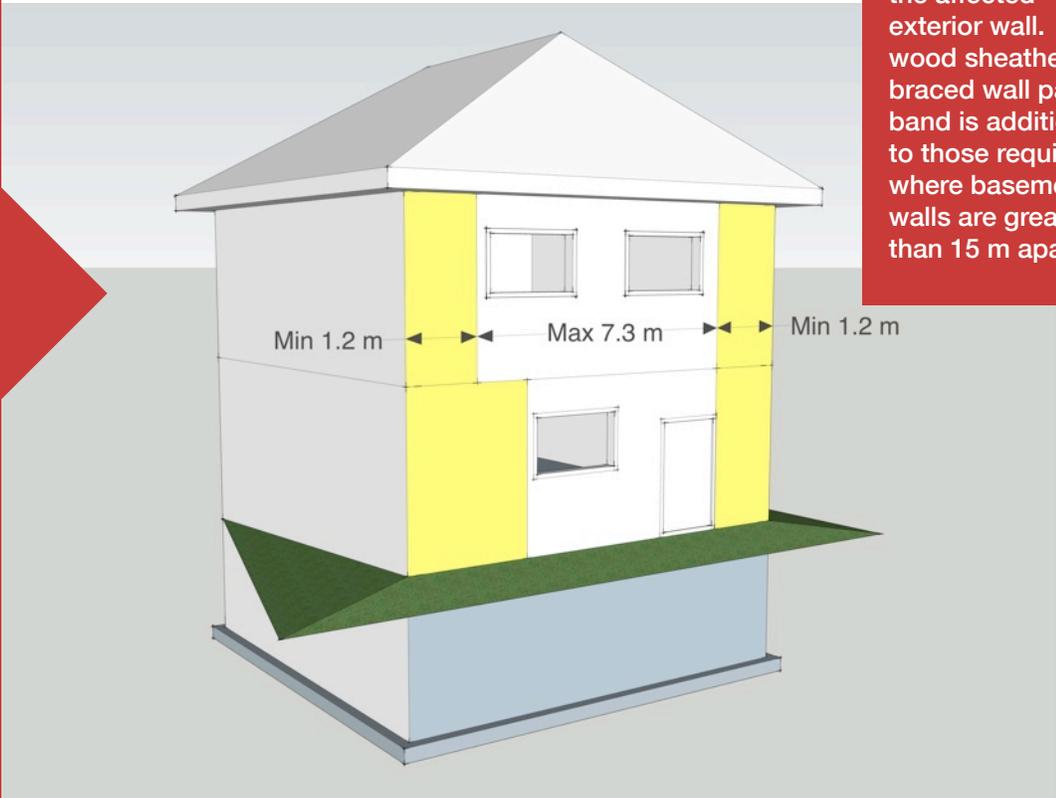
Additional Wood Sheathed Braced Wall Panel Band

To accommodate the reduction, an additional wood sheathed braced wall panel band must be added within 10.6 m of the affected exterior wall. This wood sheathed braced wall panel band is additional to those required where basement walls are greater than 15 m apart.

Increased Spacing Between Braced Wall Panel Edges

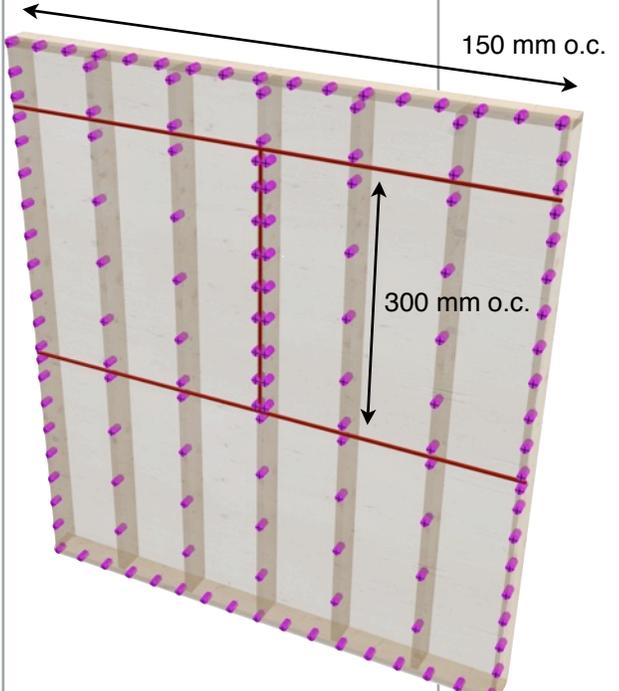
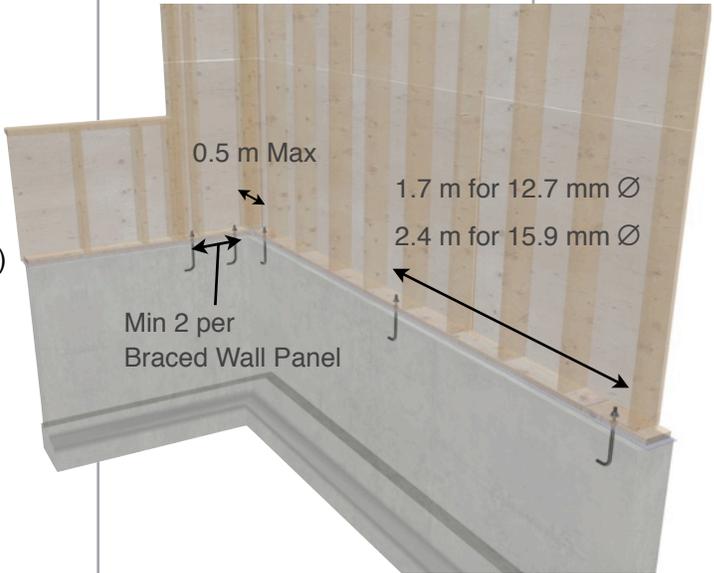
The maximum distance between adjacent braced wall panels (measured from the edge of the panels) may be increased to 7.3 m, provided that all braced wall panels within that particular braced wall band with the increased spacing are at least 1.2 m in length.^{xxiii}

4. Increased Spacing Between Braced Wall Panel Edges



^{xxii} 9.23.13.7.(6), and (7); ^{xxiii} 9.23.13.7.(5) (see Appendix)

Construction Requirements

Construction Requirement	Code Reference (see Appendix)	Description
Nailing of Framing	9.23.3.4.(1)	82 mm Nails at 150 mm o.c.
Fasteners for Sheathing	9.23.3.5.(2) Table 9.23.3.5.B.	
Anchorage of Building Frames	9.23.6.1.(3)	

Construction Requirements

Construction Requirement	Code Reference (see Appendix)	Description
Support of Walls	9.23.9.8.(6)	All walls supported (blocking or joists) for required fastening
Bracing and Lateral Support	9.23.10.2.(1)	Prevention of buckling with blocking or strapping
Required Roof Sheathing	9.23.16.1.(1) 9.23.16.5.(2)	All roofs in the high seismic region must have roof sheathing or continuous, diagonal lumber
Spacing of Nails	9.29.5.8.(4)	Nails for gypsum board spaced not more than 200 mm o.c.
Spacing of Screws	9.29.5.9.(4)	Screws for gypsum board spaced not more than 300 mm o.c.
Nails and Staples	9.29.6.3.(2) Table 9.23.3.5.B.	Nail and staple spacing for plywood sheathing
Nails	9.29.9.3.(2) Table 9.23.3.5.B.	Nail spacing for OSB or waferboard sheathing

Appendix

Definitions:

1. Braced wall band means an imaginary continuous straight band extending vertically and horizontally through the building or part of the building, within which braced wall panels are constructed.
2. Braced wall panel means a portion of a wood-frame wall where bracing, sheathing, cladding or interior finish is designed and installed to provide the required resistance to lateral loads due to wind or earthquake.
3. The words and terms in *italics* in the following Code references have defined meanings found in the National Building Code of Canada under 1.4.1.2. Defined Terms.

Code References - Design Requirements:

9.23.13.4. Braced Wall Bands

- 1) *Braced wall bands* shall
 - a) be full storey height,
 - b) be not more than 1.2 m wide,
 - c) lap at both ends with another *braced wall band*,
 - d) be aligned with *braced wall bands* on storeys above and below, and
 - e) conform to the spacing and dimensions given in Table 9.23.13.5.
- 2) The perimeter of the *building* shall be located within *braced wall bands*.
- 3) For split-level *buildings*, a *braced wall band* shall be located where there is a change in floor level greater than the depth of one floor joist.

9.23.13.5. Braced Wall Panels in Braced Wall Bands

- 4) Except as provided in Sentences (2) to (5) and Article 9.23.13.7., *braced wall panels* shall
 - a) be located within *braced wall bands*,
 - b) extend, as applicable, from the top of the supporting footing, slab, or subfloor to the underside of the floor, ceiling or roof framing above, and,
 - c) conform to the spacing and dimensions given in Table 9.23.13.5.

Table 9.23.13.5.
Spacing and Dimensions of Braced Wall Bands and Braced Wall Panels
 Forming Part of Sentences 9.23.13.4.(1) and 9.23.13.5.(1)

Description	Spacing and Dimensions of <i>Braced Wall Bands</i> and <i>Braced Wall Panels</i>	
	Seismic and Wind Loads	
	$0.70 < S_a(0.2) < 1.0$	$1.0 \leq S_a(0.2) \leq 1.2$ or $0.80 \leq HWP \leq 1.2$ kPa
Maximum distance between centre lines of adjacent <i>braced wall bands</i> measured from the furthest points between centres of the bands	10.6 m	7.6 m
Maximum distance between required <i>braced wall panels</i> measured from the edges of the panels	6.4 m	6.4 m

Appendix (cont.)

Table 9.23.13.5. (Continued)
Spacing and Dimensions of Braced Wall Bands and Braced Wall Panels
 Forming Part of Sentences 9.23.13.4.(1) and 9.23.13.5.(1)

Description	Spacing and Dimensions of <i>Braced Wall Bands and Braced Wall Panels</i>	
	Seismic and Wind Loads	
	$0.70 < S_a(0.2) < 1.0$	$1.0 \leq S_a(0.2) \leq 1.2$ or $0.80 \leq HWP \leq 1.2$ kPa
Maximum distance from the end of a <i>braced wall band</i> to the edge of the closest required <i>braced wall panel</i>	2.4 m	2.4 m
Minimum length of individual <i>braced wall panels</i> : <ul style="list-style-type: none"> panel located at the end of a <i>braced wall band</i> where the <i>braced wall panel</i> connects to an intersecting <i>braced wall panel</i> panel not located at the end of a <i>braced wall band</i> or <i>braced wall panel</i> located at the end of a <i>braced wall band</i> where the <i>braced wall panel</i> does not connect to an intersecting <i>braced wall panel</i> 	600 mm	750 mm
Minimum total length of all <i>braced wall panels</i> in a <i>braced wall band</i>		
<ul style="list-style-type: none"> supporting 3 floors, light construction 	75% of length of <i>braced wall band</i>	
<ul style="list-style-type: none"> supporting 2 floors, heavy construction 	75% of length of <i>braced wall band</i>	
<ul style="list-style-type: none"> supporting 2 floors, light construction 	40% of length of <i>braced wall band</i>	
<ul style="list-style-type: none"> supporting 1 floor, heavy construction 	40% of length of <i>braced wall band</i>	
<ul style="list-style-type: none"> supporting 1 floor, light construction 	25% of length of <i>braced wall band</i>	
<ul style="list-style-type: none"> not supporting a floor 	25% of length of <i>braced wall band</i>	

- 2) In *basements* or crawl spaces where the perimeter *foundation* walls extend from the footings to the underside of the supported floor, *braced wall bands* constructed with *braced wall panels* shall be spaced not more than
 - a) 15 m from the perimeter *foundation* walls,
 - b) 15 m from the interior *foundation* walls, and
 - c) 15 m from adjacent *braced wall bands* constructed with *braced wall panels*.
- 3) Portions of the perimeter of a single open or enclosed space need not comply with Sentence (1), where
 - a) the roof of the space projects not more than
 - i) 3.5 m from the face of the framing of the nearest parallel *braced wall band*, and
 - ii) half the perpendicular plan dimension.

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- b) that portion of the perimeter structure does not support a floor, and
- c) the roof of the space is
 - i) integral with the roof of the rest of the *building* with framing members not more than 400 mm o.c., or
 - ii) constructed with roof framing not more than 400 mm o.c. fastened to the wall framing (see Table 9.23.3.4. and Article 9.23.9.1. for balloon framing).
- 4) Walls in detached garages and in accessory *buildings* serving a single *dwelling unit*, and the front wall of attached garages serving a single *dwelling unit* need not comply with Sentence (1) where these walls do not support a floor.
- 5) *Braced wall panels* in the *braced wall band* at the front of an attached garage serving a single *dwelling unit* need not comply with Sentence (1), provided
 - a) the maximum spacing between the front of the garage and the back wall of the garage does not exceed 7.6 m,
 - b) there is not more than one floor above the garage,
 - c) not less than 50% of the length of the back wall of the garage is constructed of *braced wall panels*, and
 - d) not less than 25% of the length of the side walls is constructed of *braced wall panels*.

9.23.13.6. Materials in Braced Wall Panels

- 1) Required *braced wall panels* shall be
 - a) clad with panel-type cladding complying with Section 9.27. and Table 9.23.3.4.,
 - b) sheathed with plywood, OSB, waferboard or diagonal lumber sheathing complying with Subsection 9.23.16. and Table 9.23.13.6., and fastened in accordance with Article 9.23.3.5., or
 - c) finished on the interior with a panel-type material in accordance with the requirements of Section 9.29. and Table 9.23.13.6.

Table 9.23.13.6.
Minimum Thickness of Cladding, Sheathing or Interior Finish for Braced Wall Panels
 Forming Part of Sentences 9.23.13.6.(1)

Panel Type Cladding, Sheathing or Interior Finish	Minimum Thickness	
	With supports 400 mm o.c.	With supports 600 mm o.c.
Gypsum board interior finish	12.7 mm	15.9 mm
Sheathing complying with CAN/CSA-0325	W16	W24
OSB O-1 and O-2 grades and waferboard R-1 grade	9.5 mm	12.25 mm
Plywood	9.5 mm	12.5 mm
Diagonal lumber	17 mm	17 mm

- 2) Except as provided in Sentence (3), required interior *braced wall panels* shall be
 - a) sheathed or finished on both sides with a wood-based material, or
 - b) finished on both sides with gypsum board.
- 3) Required interior *braced wall panels* of wood-based materials may be sheathed on one side only, provided
 - a) the sheathing material is plywood, OSB or waferboard, and
 - b) the maximum spacing of fasteners along the edge is half the maximum spacing shown in Table 9.23.3.5.B.
- 4) For stacked *braced wall bands*, where the construction of any one *braced wall panel* is required to be of a wood-based material, a wood-based material shall be installed in all the required *braced wall panels* in that *braced wall band*.
- 5) Gypsum board interior finish shall not be considered as an acceptable sheathing material to provide the required bracing in exterior walls.
- 6) At *braced wall band* spacing intervals of not less than 15 m, *braced wall panels* shall be constructed with OSB, plywood, or diagonal lumber.

9.23.13.7. Additional System Requirements

- 1) Except as provided in Sentences (2) and (3), one exterior wall of the uppermost *storey* in each orthogonal direction may be set back from the exterior wall of the *storey* below, provided the adjacent interior *braced wall band* of the *storey* below the setback
 - a) is spaced not more than 10.6 m from the exterior wall of the *storey* below the setback wall,
 - b) consists of *braced wall panels* that are constructed of a wood-based material in conformance with Sentence 9.23.13.6.(2),
 - c) extends to the *foundation*, and
 - d) is not taken into consideration when providing *braced wall panels* constructed of a wood-based material at spacing intervals of not more than 15 m as per Sentence 9.23.13.6.(6).
- 2) Where the exterior wall of the uppermost *storey* is set back from the exterior wall of the *storey* below, the roof and floor space supporting the setback wall shall be sheathed with a wood-based material between the exterior wall of the *storey* below the setback and the adjacent interior *braced wall bands* of the *storey* below the setback.
- 3) Where the exterior wall of the uppermost *storey* is set back from the exterior wall of the *storey* below, the exterior walls perpendicular to the setback wall shall
 - a) have their top plate connected with nails that are spaced at no greater than half the spacing required in Table 9.23.3.4., and
 - b) be fastened with twice the number of nails specified in Sentences 9.23.11.3.(4) and 9.23.11.4.(4).
- 4) The maximum distance between adjacent required *braced wall panels* in a *braced wall band*, measured from the edge of the panels, may be increased to 7.3 m provided that, throughout the height of the *building*, the length of any *braced wall panel* within the *braced wall band* is not less than 1.2 m.
- 5) The maximum spacing between the centre lines of required *braced wall bands* given in Table 9.23.13.5. may be increased from 7.6 m to no more than 10.6 m, provided that the interior *braced wall band* whose spacing is being increased is replaced with an interior *braced wall band* that
 - a) consists of *braced wall panels* that are constructed of a wood-based material in conformance with Sentence 9.23.13.6.(2),
 - b) extends to the *foundation*, and

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- c) is not taken into consideration when providing *braced wall panels* constructed of a wood-based material at spacing intervals no greater than 15 m as per Sentence 9.23.13.6.(6).
- 6) For each orthogonal direction of the *building*, the length of required *braced wall panels* of one exterior wall given in Table 9.23.13.5. may be reduced from 40% to no less than 25% of the length of the *braced wall band*, provided an additional parallel and adjacent interior *braced wall band* is constructed that
 - a) is spaced not more than 10.6 m from the exterior wall,
 - b) consists of *braced wall panels* that are constructed of a wood-based material in conformance with Sentence 9.23.13.6.(2) and whose lengths sum to no less than 25% of the length of the *braced wall band*,
 - c) extends to the *foundation*, and
 - d) is not taken into consideration when providing *braced wall panels* constructed of a wood-based material at spacing intervals no greater than 15 m as per Sentence 9.23.13.6.(6).
- 7) Where the length of required *braced wall panels* of an exterior wall is reduced as described in Sentence (6), the ratio of the length of *braced wall panels* in the respective upper *braced wall bands* to the length of *braced wall panels* in the reduced *braced wall band* and in the reduced exterior *braced wall band* shall not exceed 2.

Code References - Construction Requirements:

9.23.3.4. Nailing of Framing

- 1) Except as provided in Sentence (2), nailing of framing shall conform to Table 9.23.3.4.

Table 9.23.3.4. (Partial)
Nailing for Framing
 Forming Part of Sentence 9.23.3.4.(1)

Construction Detail	Minimum Length of Nails, mm	Minimum Number or Maximum Spacing of Nails
<i>Rim joist</i> , trimmer joist or blocking – supporting walls with required <i>braced wall panels</i> – to sill plate or top wall plate – toe nail	82	150 mm (o.c.)
Bottom wall plate or sole plate – in required <i>braced wall panels</i> – to floor joists, <i>rim joists</i> or blocking (exterior walls)	82	150 mm (o.c.)
Required <i>braced wall panels</i> – in interior walls – to framing above and below	82	150 mm (o.c.)

9.23.3.5. Fasteners for Sheathing or Subflooring

- 2) Fastening of roof sheathing and sheathing in required *braced wall panels* shall conform to Table 9.23.3.5.B., where
 - b) the seismic spectral response acceleration, $S_a(0.2)$, is greater than 0.70 and not more than 1.2.

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Table 9.23.3.5.B.
Fasteners for Sheathing where HWP is Equal to or Greater Than 0.8 kPa and Less Than 1.2 kPa or where $S_a(0.2)$ is Greater Than 0.70 and Not More Than 1.2
 Forming Part of Sentence 9.23.3.5.(2)

Element	Minimum Length of Fasteners, mm			Minimum Number or Maximum Spacing of Fasteners
	Common Spiral or Ring Thread Nails	Screws	14-Gage Staples	
Board lumber 184 mm or less wide	63	51	63	2 per support
Board lumber more than 184 mm wide	63	51	63	3 per support
Plywood, OSB or waferboard up to 20 mm thick	63	51	63	150 mm (o.c.) along edges and 300 mm (o.c.) along intermediate supports; and for roof sheathing where HWP is equal to or greater than 0.8 kPa and less than 1.2 kPa, 50 mm (o.c.) within 1 m of the edges of the roof
Plywood, OSB or waferboard over 20 mm and up to 25 mm thick	63	57	n/a	

9.23.6.1. Anchorage of Building Frames

- 3) For *buildings* with 2 or more floors supported by frame walls that are in areas where the seismic spectral response acceleration, $S_a(0.2)$, is equal to or greater than 0.70 but not greater than 1.2 and the 1-in-50 hourly wind pressure is equal to or greater than 0.80 kPa but not greater than 1.20 kPa, anchorage shall be provided by fastening the sill plate to the *foundation* with not less than two anchor bolts per *braced wall panel*, where all anchor bolts used are
- not less than 15.9 mm in diameter, located within 0.5 m of the end of the *foundation*, and spaced not more than 2.4 m o.c. or
 - not less than 12.7 mm in diameter, located within 0.5 m of the end of the *foundation*, and spaced not more than 1.7 m o.c.

9.23.9.8. Support of Walls

- 6) *Loadbearing* and non-*loadbearing* walls constructed with required *braced wall panels* shall be continuously supported by floor joists, blocking or *rim joists* to allow for the required fastening (see Table 9.23.3.4.).

9.23.10.2. Bracing and Lateral Support

- 1) Where *loadbearing* interior walls are not finished in accordance with Section 9.29., blocking or strapping shall be fastened to the studs at mid-height to prevent sideways buckling.

9.23.16.1. Required Roof Sheathing

- 1) Except where the 1-in-50 hourly wind pressure is less than 0.8 kPa and the seismic spectral response acceleration, $S_a(0.2)$, is less than or equal to 0.70, continuous lumber or panel-type roof sheathing shall be installed to support the roofing.

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9.23.16.5. Lumber Roof Sheathing

- 2) Lumber roof sheathing shall be installed diagonally, where
 - a) the seismic spectral response acceleration, $S_a(0.2)$, is greater than 0.70 but not greater than 1.2, and
 - b) the 1-in-50 hourly wind pressure is equal to or greater than 0.80 kPa but less than 1.20 kPa.

9.29.5.8. Spacing of Nails

- 4) For single-layer application on walls, where gypsum board provides required bracing in *braced wall panels*, lateral support for studs, or fire protection, nails shall be spaced not more than 200 mm o.c. on
 - a) vertical wall supports, and
 - b) top and bottom plates.(See Article 9.23.10.2. and Section 9.10.)

9.29.5.9. Spacing of Screws

- 4) Except as provided in Sentence (5), for single-layer application on walls, where gypsum board provides required bracing in *braced wall panels*, lateral support for studs, or fire protection, screws shall be spaced not more than 300 mm o.c. on
 - a) vertical wall supports, and
 - b) top and bottom plates.(See Article 9.23.10.2. and Section 9.10.)

9.29.6.3. Nails and Staples

- 2) Where plywood finish provides required bracing in *braced wall panels*, the plywood shall be fastened in accordance with the fastening requirements for sheathing stated in Sentence 9.23.3.5.(2).

9.29.9.3. Nails

- 2) Where OSB or waferboard provides required bracing in *braced wall panels*, the OSB or waferboard shall be fastened in accordance with the fastening requirements for sheathing stated in Sentence 9.23.3.5.(2).