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Proposed Change 1475

Code Reference(s):	NBC20 Div.B 9.4.1.1. (first printing) NBC20 Div.B 9.4.2. (first printing) NBC20 Div.B 9.20.1. (first printing) NBC20 Div.B 9.23.1.1. (first printing) NBC20 Div.B 9.23.3.1. (first printing) NBC20 Div.B 9.23.3.4. (first printing) NBC20 Div.B 9.23.3.5. (first printing) NBC20 Div.B 9.23.6.1. (first printing) NBC20 Div.B 9.23.11.4. (first printing) NBC20 Div.B 9.23.13. (first printing) NBC20 Div.B 9.23.16.1. (first printing) NBC20 Div.B 9.23.16.5. (first printing) NBC20 Div.B 9.31.6.2.(3) (first printing) NBC20 Div.B 9.33.4.7.(2) (first printing)
Subject:	Structural Design (Part 9) — Lateral Loads
Title:	Resistance to Lateral Loads
Description:	The proposed change updates the Part 9 provisions for resistance to lateral loads due to earthquakes and wind. It responds to an increase in seismic hazard values for many locations in Canada by replacing Sa(0.2) with the seismic design parameter, Smax, and by defining new wood-frame wall types.
Related Proposed Change(s):	PCF 1775

This change could potentially affect the following topic areas:

- ☐ Division A
- ☑ Division B
- ☐ Division C
- ☐ Design and Construction
- ☐ Building operations
- ☑ Housing
- ☑ Small Buildings
- ☐ Large Buildings
- ☐ Fire Protection
- ☐ Occupant safety in use
- ☐ Accessibility
- ☐ Structural Requirements
- ☐ Building Envelope
- ☐ Energy Efficiency
- ☐ Heating, Ventilating and Air Conditioning
- ☐ Plumbing
- ☐ Construction and Demolition Sites

Problem

General

With trends in home construction shifting to larger open-concept houses with fewer interior partition walls and larger windows, the redundancy once expected in and characteristic of light-frame construction is decreasing (refer to "Review of Structural Materials and Methods for Home Building in the United States: 1900 to 2000" in the supporting documents). As such, lateral loads, such as those due to earthquakes and wind, could negatively affect houses in low-seismicity zones, which currently are not required to be braced to resist these loads.

Seismic Loads

Changes have been made to seismicity values assigned for locations in Canada listed in Appendix C of the NBC 2020. The impact is that some regions will require more stringent prescriptive solutions per Part 9 due to the higher spectral hazard values, and there will be more regions with a spectral hazard of $S_a(0.2)$ greater than 1.8; these regions will thus fall outside the limits of the prescriptive solutions in Part 9 and require design per Part 4. Since some more remote areas have difficulties accessing professional engineers, it is proposed that prescriptive requirements be developed for areas where $S_a(0.2)$ is greater than 1.8.

Wind Loads

The threshold for the 1-in-50-year hourly wind pressure (HWP), above which wind needs to be considered in Part 9 of the NBC 2020, is 0.8 kPa. In conducting the analysis to establish new prescriptive provisions for higher seismic hazard proposed for the NBC 2020 a comparison was made to determine the wind pressures that would produce an equivalent base shear for each of the archetypes examined. The results suggested that the minimum trigger of 0.8 kPa was too high and that braced wall bands

would be justified for lower triggers of HWP than are currently set in Part 9. It was observed that there were only 7 locations within Canada with a HWP greater than 0.8 kPa listed in Appendix C. It was also observed that the trigger reflected wind speeds similar to wind speeds associated with EF2 level tornadoes.

Justification

Seismic Loads

The proposed change will add a new band of more stringent prescriptive solutions in Part 9 for wood-frame construction. This will provide prescriptive requirements for regions with a spectral hazard of $S_a(0.2)$ greater than 1.8. Proposed modifications to provisions for insulating concrete form (ICF) and masonry construction are limited to ensuring that the seismic triggers in the proposed change are equivalent to those used in the NBC 2020, thereby limiting the impact on the ICF and masonry construction industry.

With changing energy codes where builders are opting to replace wood sheathing with foam sheathing in some locations, and where interior partitions are fewer, windows are larger, and houses are bigger, the experience that Part 9 is based on no longer applies and reconsideration is warranted. In addition, a few provinces are recommending bracing for low-seismicity zones for Part 9 buildings. For example, in the Yukon it is recommended "for low seismic zone … adoption of all wall distances and minimum wall panel lengths with added total length of braced wall panels in a braced wall band to be roughly 80% of tabulated length if unblocked and 50% of tabulated length if blocked." The proposed change is closing a loophole in Part 9 to prevent buildings that could have practically close to zero lateral resistance.

Wind Loads

The proposed change attempts to reduce the large gap between Part 9 and Part 4 provisions and introduces minimum requirements for lateral design to resist wind loads for all regions in Canada.

Considering the current trend for more open concept design of houses, the increase in rare wind events, and the decision to require a minimum consideration for lateral resisting elements for all seismic levels, it was deemed appropriate to provide similar minimum requirements for wind loads.

Also, the NBC 2015 introduced a topographic factor, C_t, which magnifies wind loads for structures located on exposed hills or escarpments. The terrain factor is not taken into account in Part 9 even with the proposed revision.

A design review was conducted to Part 4 requirements for a small house on an exposed coastal hill in Newfoundland where the HWP is listed as 0.78 kPa, indicating it does not require any consideration for wind loads. The design results to Part 4, including the C_t factor, indicated that the design wind pressure was so great that a conventional wood-frame structure could not be constructed to resist the wind loads yet Part 9 requires no consideration for wind in this location. The existing structure on this site shows signs of distress due to wind loads.

Cripple Walls

The proposed change includes new provisions related to cripple walls to add clarification for authorities having jurisdiction that typically consider a cripple wall as an additional storey, which could move a Part 9 structure into Part 4. The proposed change defines when a cripple wall is and is not required to be considered as an additional storey.

PROPOSED CHANGE

[9.4.1.1.] 9.4.1.1. General

(See Note A-9.4.1.1. and Article 2.2.7.6. of Division C.)

[1] 1) Subject to the application limitations defined elsewhere in this Part, structural members and their connections shall

[a] a) conform to requirements provided elsewhere in this Part,

[b] b) be designed according to good engineering practice such as that provided in the CWC ~~2014,~~ "Engineering Guide for Wood Frame Construction," or

[c] c) be designed according to Part 4 using the loads and deflection and vibration limits specified in

[i] i) Part 9, or

[ii] ii) Part 4.

[2] 2) Where floor framing is designed in accordance with Clause (1)(b) or (c), and where supporting wall framing and fastenings, or footings are designed according to Clause (1)(a), the maximum specified *live load* on the floor according to Table 4.1.5.3. shall not exceed 2.4 kPa.

[3] 3) Location-specific information for structural design, including snow and wind loads and ~~seismic spectral accelerations~~seismic design parameters, shall be determined according to Subsection 1.1.3.

Note A-9.4.1.1. Structural Design.

Article 9.4.1.1. establishes the principle that the structural members of Part 9 buildings must

- comply with the prescriptive requirements provided in Part 9,
- be designed in accordance with accepted good practice, or
- be designed in accordance with Part 4 using the loads and limits on deflection and vibration specified in Part 9 or Part 4.

Usually a combination of approaches is used. For example, even if the snow load calculation on a wood roof truss is based on Subsection 9.4.2., the joints must be designed in accordance with Part 4. Wall framing may comply with the prescriptive requirements in Subsections 9.23.3., 9.23.10., 9.23.11. and 9.23.12., while the floor framing may be engineered.

Design according to Part 4 or accepted good engineering practice, such as that described in the CWC ~~2014,~~ "Engineering Guide for Wood Frame Construction," requires engineering expertise. The CWC Guide contains alternative solutions and provides information on the applicability of the Part 9 prescriptive structural requirements to further assist designers and building officials to identify the appropriate design approach. The need for professional involvement in the structural design of a building, whether to Part 4 or Part 9 requirements or accepted good practice, is defined by provincial and territorial legislation.

[9.4.2.] 9.4.2. Specified Loads

[9.4.2.1.] 9.4.2.1. Application

[9.4.2.2.] 9.4.2.2. Specified Snow Loads

[9.4.2.3.] 9.4.2.3. Platforms Subject to Snow and Occupancy Loads

[9.4.2.4.] 9.4.2.4. Attics and Roof Spaces

[9.4.2.5.] --- Seismic Design Parameter
(See Note A-9.4.2.5.)

[1] -- Except as provided in Sentence (2) and unless otherwise indicated, the value of the seismic design parameter, S_{max}, at a location listed in Table C-3 of Appendix C shall be taken as S_{max} for unknown Site Class. (See Note A-9.4.2.5.(1).)

[2] -- Where the Site Class is determined in accordance with Sentence 4.1.8.4.(3), the value of the seismic design parameter, S_{max}, at a location listed in Table C-3 of Appendix C, is permitted to be taken as S_{max} for the determined Site Class. (See Note A-9.4.2.5.(2).)

Note A-9.4.2.5. Seismic Design Parameter.

The seismic design parameter, S_{max}, is used as a trigger for the application of seismic design provisions in Part 9. It was derived by considering the upper limit on the specified lateral earthquake force, V, as defined in Clause 4.1.8.11.(2)(c), and is taken as the larger of (2/3)S(0.2) and S(0.5), with S(0.2) and S(0.5) determined in accordance with Sentence 4.1.8.4.(6).

Note A-9.4.2.5.(1) Seismic Design Parameter for Site Class C.

The seismic design parameter, S_{max}, for Site Class C is used as a trigger for the application of certain seismic design provisions in Part 9, where indicated.

Note A-9.4.2.5.(2) Determination of Site Class.

To benefit from a refined, and possibly less conservative, value of S_{max}, the Site Class can be determined on the basis of the ground profile at the site in accordance with Sentence 4.1.8.4.(3). Determination of the Site Class will require the involvement of a suitably qualified and experienced professional engineer.

[9.20.1.] 9.20.1. Application

[9.20.1.1.] 9.20.1.1. General

[1] 1) Except as provided in Article 9.20.1.2., this Section applies to

[a] a) unreinforced masonry and masonry veneer walls not in contact with the ground, where

[i] i) the height of the walls constructed on the *foundation* walls does not exceed 11 m, and

[ii] ii) the roof or floor assembly above the *first storey* is not of concrete construction, and

[b] b) flat insulating concrete form walls not in contact with the ground that (see Note A-9.15.1.1.(1)(c) and 9.20.1.1.(1)(b))

[i] i) have a maximum floor-to-floor height of 3 m,

[ii] ii) are erected in *buildings* not more than 2 *storeys* in *building height*, and

[iii] iii) are erected in locations where the seismic ~~spectral acceleration, S_a(0.2)~~design parameter, S_{max}, for Site Class C is not greater than ~~0.4~~0.27 (see also Article 9.4.2.5.~~Note A-9.20.1.2.~~).

[2] 2) For walls other than those described in Sentence (1), or where the masonry walls or insulating concrete form walls not in contact with the ground are designed for specified loads on the basis of ultimate and serviceability limit states, Subsection 4.3.2. shall apply.

[9.20.1.2.] 9.20.1.2. Earthquake Reinforcement

(See ~~Note A-9.20.1.2.~~also Article 9.4.2.5.)

[1] 1) In locations where the ~~spectral acceleration, $S_a(0.2)$,~~ seismic design parameter, S_{max}, for Site Class C is greater than ~~0.55~~0.37, *loadbearing* elements of masonry *buildings* more than 1 *storey* in *building height* shall be reinforced with not less than the minimum amount of reinforcement required by Subsection 9.20.15.

[2] 2) In locations where the ~~spectral acceleration, $S_a(0.2)$,~~seismic design parameter, S_{max}, for Site Class C is greater than ~~0.35~~0.23 but ~~less than or equal to~~not greater than ~~0.55~~0.37, *loadbearing* elements of masonry *buildings* 3 *storeys* in *building height* shall be reinforced with not less than the minimum amount of reinforcement required by Subsection 9.20.15.

~~Note A-9.20.1.2. Seismic Information.~~

~~Information on spectral acceleration values for various locations can be found in Appendix C.~~

[9.23.1.1.] 9.23.1.1. Limitations

(See Note A-9.23.1.1.)

[1] 1) Subject to the application limitations defined elsewhere in this Part, ~~T~~this Section applies to constructions where wall, floor and roof planes are generally comprised of lumber frames of small repetitive structural members, or engineered components, and where

[a] a) roof and wall planes are clad, sheathed or braced on at least one side,

[b] b) the small repetitive structural members are spaced not more than 600 mm o.c.,

[c] c) the constructions do not serve as *foundations*,

[d] d) the specified *live load* on supported subfloors and floor framing does not exceed 2.4 kPa, and

[e] e) the span of any structural member does not exceed 12.20 m.

(See Note A-9.23.1.1.(1).)

[2] 2) Where the conditions in Sentence (1) are exceeded for wood constructions, the design of the framing and fastening shall conform to Subsection 4.3.1.

[9.23.3.1.] 9.23.3.1. Standards for Nails and Screws

[1] 1) Except as provided in Sentence (2) and unless otherwise indicated, nails specified in this Section shall be common steel wire nails or common spiral nails conforming to

[a] a) ASTM F1667, "Standard Specification for Driven Fasteners: Nails, Spikes, and Staples", or

[b] b) CSA B111, "Wire Nails, Spikes and Staples".

[2] 2) Nails used to comply with Tables 9.23.3.4. and 9.23.3.5.-A to 9.23.3.5.-C shall have a diameter not less than that stated in Table 9.23.3.1. (See Note A-9.23.3.1.(2).)

Table [9.23.3.1.] 9.23.3.1.
Diameter of Nails
Forming Part of Sentence [9.23.3.1.] 9.23.3.1.([2] 2)

Minimum Length of Nails, mm	Minimum Diameter of Nails, mm
45	2.64
51	2.84
57	2.87
63	3.25
76	3.66
82	3.66
101 or greater	4.88

[3] 3) Wood screws specified in this Section shall conform to ASME B18.6.1, "Wood Screws (Inch Series)". (See Note A-9.23.3.1.(3).)

Note A-9.23.3.1.(2) Alternative Nail Sizes.

Where power nails or nails with a diameter smaller ~~diameters~~ than that required by ~~Table 9.23.3.4.~~ Table 9.23.3.1. or 9.23.3.5.-C are used to connect framing, the following equations can be used to determine the required spacing or required number of nails.

The maximum spacing can be reduced using the following equation:

$$S_{adj} = S_{table}\left(\frac{D_{red}}{D_{table}}\right)^2$$

where

S_{adj} = adjusted nail spacing ≥ 20 × nail diameter,
S_{table} = nail spacing required by Table 9.23.3.4., 9.23.3.5.-A, 9.23.3.5.-B or 9.23.3.5.-C,
D_{red} = nail diameter smaller ~~nail diameter~~ than that required by Table 9.23.3.1. or 9.23.3.5.-C, and
D_{table} = nail diameter required by Table 9.23.3.1. or 9.23.3.5.-C.

The number of nails can be increased using the following equation:

$$N_{adj} = N_{table}\left(\frac{D_{table}}{D_{red}}\right)^2$$

where

N_{adj} = adjusted number of nails,
N_{table} = number of nails required by Table 9.23.3.4., 9.23.3.5.-A, 9.23.3.5.-B or 9.23.3.5.-C,
D_{table} = nail diameter required by Table 9.23.3.1. or 9.23.3.5.-C, and
D_{red} = ~~smaller~~ nail diameter smaller than that required by Table 9.23.3.1. or 9.23.3.5.-C.

Note that nails should be spaced ~~sufficiently far apart—preferably~~ no less than 55 mm apart ~~—~~to avoid splitting of framing lumber.

[9.23.3.4.] 9.23.3.4. Nailing of Framing

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

[2] 2) Where the bottom wall plate or sole plate of an exterior wall is not nailed to floor joists, *rim joists* or blocking in conformance with Table 9.23.3.4., the exterior wall is permitted to be fastened to the floor framing by

[a] a) having plywood, OSB or waferboard sheathing extend down over floor framing and fastened to the floor framing by nails or staples conforming to Article 9.23.3.5., or

[b] b) tying the wall framing to the floor framing by galvanized-metal strips

[i] i) 50 mm wide,

[ii] ii) not less than 0.41 mm thick,

[iii] iii) spaced not more than 1.2 m apart, and

[iv] iv) fastened at each end with at least two 63 mm nails.

Table [9.23.3.4.] 9.23.3.4.
Nailing for Framing
Forming Part of Sentences [9.23.3.4.] 9.23.3.4.([1] 1) and 9.23.14.4.(2)

Construction Detail	Minimum Length of Nails, mm	Minimum Number or Maximum Spacing of Nails (1)
Floor joist or blocking perpendicular to sill plate or top wall plate below – toe nail	82	2 per floor joist or blocking
Rim joist, trimmer joist or blocking – supporting walls with required *braced wall panels* – to sill plate or top wall plate – toe nail	82	150 mm o.c.
Wood or metal strapping to underside of floor joists	57	2
Cross bridging to joists	57	2 at each end
Double header or trimmer joists	76	300 mm o.c.
Floor joist to stud (balloon construction)	76	2

Construction Detail	Minimum Length of Nails, mm	Minimum Number or Maximum Spacing of Nails (1)
Ledger strip to wood beam	82	2 per joist
Joist to joist splice (see also Table 9.23.14.8.)	76	2 at each end
Tail joist to adjacent header joist	82	5
(end nailed) around openings	101	3
Each header joist to adjacent trimmer joist	82	5
(end nailed) around openings	101	3
Blocking to stud or Sstud to wall plate (each end) – toe nail	63	4
or end nail	82	2
Doubled studs at openings, or studs at walls or wall intersections and corners	76	750 mm o.c.
Doubled studs at openings, within walls, or abutting studs at wall intersections and corners – in required *braced wall panels*	76	300 mm o.c.
Doubled top wall plates (2)	76	600 mm o.c.
Bottom wall plate or sole plate to floor joists, *rim joists* or blocking (exterior walls) (3)	82	400 mm o.c.
Bottom wall plate or sole plate – in required *braced wall panels* – to floor joists, *rim joists* or blocking (exterior walls) (3)	82	150 mm o.c.
Interior walls to framing or subflooring	82	600 mm o.c.
Required *braced wall panels* – in interior walls – to framing above and below	82	150 mm o.c.
Horizontal member over openings in non-*loadbearing* walls – each end	82	2
Lintels to studs	82	2 at each end
Ceiling joist to plate – toe nail each end	82	2
Roof rafter, roof truss or roof joist to plate – toe nail (4)	82	3
Rafter plate to each ceiling joist	101	2
Rafter to joist (with ridge supported)	76	3
Rafter to joist (with ridge unsupported)	76	see Table 9.23.14.8.
Gusset plate to each rafter at peak	57	4
Rafter to ridge board – toe nail – end nail	82	3
Collar tie to rafter – each end	76	3
Collar tie lateral support to each collar tie	57	2
Jack rafter to hip or valley rafter	82	2
Roof strut to rafter	76	3
Roof strut to *loadbearing* wall – toe nail	82	2
38 mm × 140 mm or less plank decking to support	82	2
Plank decking wider than 38 mm × 140 mm to support	82	3
38 mm edge laid plank decking to support (toe nail)	76	1
38 mm edge laid plank to each other	76	450 mm o.c.
End-joist or end-rafter to built-up wall stud (5)	76	5 or 8 (6)

Notes to Table [9.23.3.4.] 9.23.3.4.:

(1) See Note A-9.23.3.1.(2).

(2) See Article 9.23.11.4. for requirements on the nailing of top plates splices in *braced wall bands*.

(3) See Sentence 9.23.3.4.(2).

(4) See Sentence 9.23.3.4.(3).

(5) See Sentence 9.23.13.5.(3).

(6) Where heavyweight construction is used in the roof of the space, at least 8 nails are required (see Note A-9.23.13.2.(3)Note A-9.23.13.2.(1)(a)(i)).

[3] 3) Where the 1-in-50 hourly wind pressure is equal to or greater than 0.8 kPa, roof rafters, joists or trusses shall be tied to the wall framing with connectors that will resist a factored uplift load of 3 kN.

[4] 4) Galvanized-steel straps are deemed to comply with Sentence (3), provided they are

[a] a) 50 mm wide,

[b] b) not less than 0.91 mm thick, and

[c] c) fastened at each end with at least four 63 mm nails.

[9.23.3.5.] 9.23.3.5. Fasteners for Sheathing or Subflooring

[1] 1) Except as provided in Sentence (2) to (4), fFastening of sheathing and subflooringthe following shall conform to Table 9.23.3.5.-A:.

[a] --) subflooring,

[b] --) wall sheathing not in a required *braced wall panel*, and

[c] --) roof sheathing where the 1-in-50-year hourly wind pressure (HWP) is not greater than 0.6 kPa and the seismic design parameter, S_{max}, for Site Class C is not greater than 0.47.

Table [9.23.3.5.-A] 9.23.3.5.-A
Fastenersing forof Subflooring, and forWall Sheathing Not in a Required Braced Wall Panel, and Roof Sheathing wWhere the 1-in-50 HWP < 0.8≤ 0.6 kPa and $S_a(0.2) \leq 0.70$$S_{max}$ for Site Class C ≤ 0.47
Forming Part of Sentence [9.23.3.5.] 9.23.3.5.([1] 1)

Element	Minimum Length of Fasteners, mm				Minimum Number or Maximum Spacing of Fasteners (1)
	Common or Spiral Nails	Ring Thread Nails or Screws	Roofing Nails	Staples	
Board lumber 184 mm or less wide	51	45	n/a	51	2 per support
Board lumber more than 184 mm wide	51	45	n/a	51	3 per support
Fibreboard sheathing up to 13 mm thick	n/a	n/a	44	28	150 mm o.c. along edges and 300 mm o.c. along intermediate supports
Gypsum sheathing up to 13 mm thick	n/a	n/a	44	n/a	
Plywood, OSB or waferboard up to 10 mm thick	51	45	n/a	38	
Plywood, OSB or waferboard over 10 mm and up to 20 mm thick	51	45	n/a	51	
Plywood, OSB or waferboard over 20 mm and up to 25 mm thick	57	51	n/a	n/a	

Note to Table [9.23.3.5.-A] 9.23.3.5.-A:

(1) See Note A-9.23.3.1.(2).

[2] 2) Except as provided in Sentence (4), ~~F~~fastening of roof sheathing ~~and sheathing in required *braced wall panels*~~ shall conform to Table 9.23.3.5.-B, where

[a] --) the 1-in-50-year hourly wind pressure (HWP) is ~~equal to or~~ greater than ~~0.8~~0.6 kPa ~~and less~~ but not greater than 1.2 kPa ~~and the seismic spectral acceleration, $S_a(0.2)$, is not more than 0.90~~, or

[b] --) the seismic ~~spectral acceleration~~design parameter, ~~$S_a(0.2)$~~S_{max}, for Site Class C is greater than ~~0.70~~0.47 but S_{max} is not greater~~and not more~~ than ~~0.90~~2.6.

Table [9.23.3.5.-B] 9.23.3.5.-B
Fastening~~ers for~~of Roof Sheathing W~~w~~here ~~0.8 kPa ≤ 1-in-50~~0.6 kPa < HWP ~~<~~≤ 1.2 kPa ~~and~~or Where S_{max} for Site Class C > 0.47 and S_{max} ≤ 2.6 ~~$S_a(0.2) \leq 0.90$ or where $0.70 < S_a(0.2) \leq 0.90$~~
Forming Part of Sentence [9.23.3.5.] 9.23.3.5.([2] 2)

HWP and S_{max} (1) Limits	Element	Minimum Length of Fasteners, mm			Minimum Number or Maximum Spacing of Fasteners (2)
		Common, Spiral or Ring Thread Nails	Screws	14-Ggauge Staples	
0.6 kPa < HWP ≤ 0.8 kPa and S_{max} ≤ 0.6 or S_{max} for Site Class C > 0.47, S_{max} ≤ 0.6 and HWP ≤ 0.8 kPa	Board lumber 184 mm or less wide (3)	63	51	63	2 per support
	Board lumber more than 184 mm wide (3)	63	51	63	3 per support
	Plywood, OSB or waferboard up to 20 mm thick (4)	63	51	63	150 mm o.c. along the edges of sheathing panels 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, and 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	
0.8 kPa < HWP ≤ 1.2 kPa and S_{max} ≤ 2.6 or S_{max} for Site Class C > 0.47, 0.6 < S_{max} ≤ 2.6 and HWP ≤ 1.2 kPa	Plywood, OSB or waferboard up to 20 mm thick	63	51	n/a	75 mm o.c. along the edges of sheathing panels, 300 mm o.c. along intermediate supports, and where 0.8 kPa < HWP ≤ 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	

Notes to Table [9.23.3.5.-B] 9.23.3.5.-B:

(1) See Article 9.4.2.5.

(2) See Note A-9.23.3.1.(2).

(3) See Article 9.23.16.5.

(4) See Note A-Table 9.23.3.5.-B.

[3] 3) Except as provided in Sentence (4), fFastening of roof sheathing and wall sheathing in required *braced wall panels* shall conform to the reference framing types specified in Table 9.23.3.5.-C, where.

[a] --) the 1-in-50 hourly wind pressure (HWP) is equal to or greater than 0.8 kPa and less than 1.2 kPa and the spectral acceleration, $S_a(0.2)$, is not more than 1.8, or

[b] --) the seismic spectral acceleration, $S_a(0.2)$, is greater than 0.90 and not more than 1.8.

Table [9.23.3.5.-C]
Fastening of Wall Sheathing in Required Braced Wall Panels Where HWP ≤ 1.2 kPa and S_{max} ≤ 2.6
Forming Part of Sentence [9.23.3.5.] 9.23.3.5.([3] 3)

Reference Framing Type (1)	Minimum Sheathing Element (2) and Maximum Stud Spacing	Minimum Specifications for Fasteners		Minimum Number or Maximum Spacing of Fasteners (3) (4) along Panel Edges Fastened to Framing
		Common, Spiral or Ring Thread Nails	Screws	
GWB-O (interior side of WSP and DWB framing types)	12.5 mm gypsum board for 600 mm stud spacing	2.48 mm diameter ring thread with 20 mm penetration into support framing (5)	3.45 mm shank diameter, Type W, with 20 mm penetration into support framing (6)	200 mm o.c. for nails or 300 mm o.c. for screws
GWB-A	12.5 mm gypsum board for 600 mm stud spacing			200 mm o.c for nails or 300 mm o.c. for screws
GWB-B	12.5 mm gypsum board for 400 mm stud spacing			200 mm o.c.
GWB-C	12.5 mm gypsum board for 400 mm stud spacing or 12.5 mm gypsum board, blocked, (7) for 600 mm stud spacing			150 mm o.c. or 200 mm o.c. for blocked
GWB-D	12.5 mm gypsum board for 400 mm stud spacing			100 mm o.c.
WSP-A	9.5 mm plywood, OSB or waferboard for 400 mm stud spacing	2.84 mm × 51 mm (8)	NP (9)	150 mm o.c.
WSP-B	11 mm plywood, OSB or waferboard, blocked, (7) for 600 mm stud spacing	3.25 mm × 63 mm (8)		150 mm o.c.
WSP-C	11 mm plywood, OSB or waferboard, blocked, (7) for 600 mm stud spacing	3.25 mm × 63 mm (8)		100 mm o.c.

Reference Framing Type (1)	Minimum Sheathing Element (2) and Maximum Stud Spacing	Minimum Specifications for Fasteners		Minimum Number or Maximum Spacing of Fasteners (3) (4) along Panel Edges Fastened to Framing
		Common, Spiral or Ring Thread Nails	Screws	
WSP-D	11 mm plywood, OSB or waferboard, blocked (7) for 600 mm stud spacing	3.25 mm × 63 mm (8)		75 mm o.c.
WSP-E	15.5 mm plywood, OSB or waferboard, blocked, (7) for 600 mm stud spacing	3.66 mm × 63 mm (8)		75 mm o.c.
DWB	19 mm diagonal lumber board	3.25 mm × 63 mm (8)	3.25 mm × 51 mm	2 per support framing where lumber width ≤ 184 mm or 3 per support framing where lumber width > 184 mm

Notes to Table [9.23.3.5.-C] :

(1) See Note A-Table 9.23.3.5.-C.

(2) Plywood, OSB, waferboard and board lumber shall conform to the material standards specified in Subsection 9.23.17. Wood-based panels may be installed vertically or horizontally. Gypsum sheathing shall conform to the requirements for gypsum board set out in Subsection 9.29.5.

(3) See Note A-9.23.3.1.(2).

(4) For plywood, OSB, or waferboard panel sheathing, the maximum fastener spacing along intermediate supports shall be 300 mm o.c. For gypsum sheathing, the maximum spacing along intermediate supports shall conform to Sentence 9.29.5.8.(4) for nails and to Sentence 9.29.5.9.(4) for screws.

(5) Nails for GWB framing types shall conform to Article 9.29.5.6.

(6) Screws for GWB framing types shall conform to Article 9.29.5.7.

(7) Where blocking is required, horizontal joints of panel sheathing shall occur over blocking consisting of not less than 38 mm × 89 mm lumber oriented either edgewise or flatwise, and the panel sheathing shall be fastened to the blocking.

(8) Nails for WSP and DWB framing types shall conform to Article 9.23.3.1.

(9) NP = not permitted.

Table [9.23.3.5.-D]
Fasteners for Sheathing where 0.8 kPa ≤ 1-in-50 HWP < 1.2 kPa and Sa(0.2) ≤ 1.8 or where 0.90 < Sa(0.2) ≤ 1.8
Forming Part of Sentence [9.23.3.5.] 9.23.3.5.([3] 3)

Element	Minimum Length of Fasteners, mm		Minimum Number or Maximum Spacing of Fasteners
	Common, Spiral or Ring Thread Nails	Screws	
Plywood, OSB or waferboard up to 20 mm thick (1)	63	51	75 mm o.c. along edges and 300 mm o.c. along intermediate supports; and for roof sheathing where 1-in-50 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	

Note to Table [9.23.3.5.-D] :

(1) See Note A-Table 9.23.3.5.-B.

[4] 4) Fastening of wall sheathing in required *braced wall panels* and roof sheathing shall conform to Part 4, where
[a] a) where the 1-in-50-year hourly wind pressure (HWP) is equal to or greater than 1.2 kPa, or
[b] --) for required *braced wall panels*, where the seismic spectral acceleration, Sa(0.2), is greater than 1.8.
[c] b) the seismic design parameter, S_{max}, is greater than 2.6, or
[d] --) the seismic design parameter, S_{max}, for Site Class C is greater than 0.47, for *buildings* of 3 *storeys* in *building height* and
[i] --) of heavyweight construction,
[ii] --) clad at full height with masonry veneer, or
[iii] --) clad at full height with stone veneer
(see Sentence 9.23.13.2.(3)).

[5] 5) Staples shall not be less than 1.6 mm in diameter or thickness, with not less than a 9.5 mm crown driven with the crown parallel to framing.

[6] 6) Roofing nails for the attachment of fibreboard or gypsum sheathing shall not be less than 3.2 mm in diameter with a minimum head diameter of 11.1 mm.

[7] 7) Flooring screws shall not be less than 3.2 mm in diameter.

[8] 8) The edges of sheathing in a *braced wall panel* shall be supported and fastened to wood blocking where
[a] a) the seismic spectral acceleration, $S_a(0.2)$, is greater than 1.2, or
[b] b) the *braced wall panel* supports more than a roof of lightweight construction.

Note A-Table 9.23.3.5.-C Reference Framing Types.

Table 9.23.3.5.-C describes the fastening of sheathing elements for each reference framing type available for use as a braced wall panel. The reference framing types fall into three categories: wood-sheathed panel (WSP), diagonal wood (lumber) board (DWB), and gypsum board (GWB).

Note A-Table 9.23.3.5.-B Alternative Nail Sizes.

Where power nails or nails having a different diameter than the diameters listed in CSA B111, "Wire Nails, Spikes and Staples", are used to connect the edges of the wall sheathing to the wall framing of wood-sheathed braced wall panels, the maximum spacing should be as shown in Table A-Table 9.23.3.5.-B.

~~Table [Table 9.23.3.5.-B] A-Table 9.23.3.5.-B~~
~~Alternative Nail Diameters and Spacing~~

~~Element~~	~~Nail Diameter, mm (1)~~	~~Maximum Spacing of Nails Along Edges of Wall Sheathing, mm o.c.~~
~~Plywood, OSB or waferboard~~	~~2.19–2.52~~	~~75~~
	~~2.53–2.82~~	~~100~~
	~~2.83–3.09~~	~~125~~
	~~> 3.09~~	~~150~~

~~Note to Table [Table 9.23.3.5.-B] A-Table 9.23.3.5.-B:~~

~~(1) For alternative nail lengths of 63 mm or longer.~~

[9.23.6.1.] 9.23.6.1. Anchorage of Building Frames

[1] 1) Except as required by Sentence 9.23.6.3.(1), *building* frames shall be anchored to the *foundation* unless a structural analysis that considers wind and earthquake loads and lateral earth pressures shows that anchorage is not required.

[2] 2) Except as provided in Sentences (3) to (6), anchorage shall be provided by

[a] a) embedding the ends of the first floor joists in concrete, or

[b] b) fastening the sill plate to the *foundation* with not less than 12.7 mm diam anchor bolts spaced not more than 2.4 m o.c.

[3] 3) ~~For buildings with 2 or more floors supported by frame walls that are in areas where the seismic spectral acceleration, Sa(0.2), is not greater than 0.70 or the 1-in-50 hourly wind pressure (HWP) is equal to or greater than 0.80 kPa but not greater than 1.20 kPa~~Except as provided in Sentence (6), where the seismic design parameter, S_{max}, for Site Class C is greater than 0.47, anchorage of *braced wall panels* 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~~, such that

[a] a) there are not less than ~~15.9 mm in diameter, located~~ two anchor bolts per *braced wall panel*, located at opposite ends of the *braced wall panel* within 0.5 m of the *foundation* end ~~of the *foundation*, and spaced not more than 2.4 m o.c.~~ or within 0.3 m of the end of the *braced wall panel*, and

[b] b) ~~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.~~the anchor bolts are spaced in accordance with Table 9.23.6.1.

(See Note A-9.23.6.1.(3).)

~~[4] 4) For *buildings* supported by frame walls that are in areas where the seismic spectral acceleration, $S_a(0.2)$, is greater than 0.70 but not greater than 1.8 and the 1-in-50 hourly wind pressure (HWP) is 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* located within 0.5 m of the end of the *foundation* and spaced in accordance with Table 9.23.6.1.~~

Table [9.23.6.1.-A]
Anchor Bolt Spacing within Braced Wall Panels W~~w~~here ~~the 1-in-50~~ HWP ≤ 1.2~~0~~ kPa~~, and 0.70 < Sa(0.2) ≤ 1.8~~S_{max} for Site Class C > 0.47 and S_{max} ≤ 2.6
Forming Part of Sentence [9.23.6.1.] 9.23.6.1.([3] 3)

Reference Framing Type	Maximum Spacing of Anchor Bolts within *Braced Wall Panels*, m	
	Anchor Bolt Diameter	
	12.7 mm	15.9 mm
GWB-A	2.4	2.4
GWB-B	2.4	2.4
GWB-C	1.8	2.4
GWB-D	1.4	2.1
WSP-A	1.4	2.1

Reference Framing Type	Maximum Spacing of Anchor Bolts within *Braced Wall Panels*, m	
	Anchor Bolt Diameter	
	12.7 mm	15.9 mm
WSP-B	0.8	1.2
WSP-C	0.7	1.0
WSP-D	0.6	0.9
WSP-E	0.5	0.8
DWB	0.8	1.2

~~Anchor Bolt Diameter, mm~~	~~$S_a(0.2)$~~	~~Maximum Spacing of Anchor Bolts Along *Braced Wall Band*, m~~				
		~~Light Construction~~			~~Heavy Construction (1)~~	
		~~Number of Floors Supported (2)~~				
		~~1~~	~~2~~	~~3~~	~~1~~	~~2~~
~~12.7~~	~~$0.70 < S_a(0.2) \le 0.80$~~	~~2.4~~	~~2.3~~	~~1.8~~	~~2.4~~	~~2.0~~
	~~$0.80 < S_a(0.2) \le 0.90$~~	~~2.4~~	~~2.3~~	~~1.8~~	~~2.4~~	~~2.0~~
	~~$0.90 < S_a(0.2) \le 1.0$~~	~~2.4~~	~~2.2~~	~~1.5~~	~~2.4~~	~~1.8~~
	~~$1.0 < S_a(0.2) \le 1.1$~~	~~2.4~~	~~2.1~~	~~1.4~~	~~2.4~~	~~1.6~~
	~~$1.1 < S_a(0.2) \le 1.2$~~	~~2.4~~	~~2.0~~	~~1.3~~	~~2.4~~	~~1.5~~
	~~$1.2 < S_a(0.2) \le 1.3$~~	~~2.4~~	~~1.9~~	~~1.3~~	~~2.4~~	~~1.5~~
	~~$1.3 < S_a(0.2) \le 1.35$~~	~~2.4~~	~~1.8~~	~~1.2~~	~~2.3~~	~~1.4~~
	~~$1.35 < S_a(0.2) \le 1.8$~~	~~2.4~~	~~1.8~~	~~1.1~~	~~2.3~~	~~1.4~~
~~15.9Table9.23.6.1~~	~~$0.70 < S_a(0.2) \le 0.80$~~	~~2.4~~	~~2.4~~	~~2.2~~	~~2.4~~	~~2.4~~
	~~$0.80 < S_a(0.2) \le 0.90$~~	~~2.4~~	~~2.4~~	~~2.2~~	~~2.4~~	~~2.4~~
	~~$0.90 < S_a(0.2) \le 1.0$~~	~~2.4~~	~~2.4~~	~~2.1~~	~~2.4~~	~~2.3~~
	~~$1.0 < S_a(0.2) \le 1.1$~~	~~2.4~~	~~2.4~~	~~1.9~~	~~2.4~~	~~2.3~~
	~~$1.1 < S_a(0.2) \le 1.2$~~	~~2.4~~	~~2.4~~	~~1.9~~	~~2.4~~	~~2.2~~
	~~$1.2 < S_a(0.2) \le 1.3$~~	~~2.4~~	~~2.4~~	~~1.8~~	~~2.4~~	~~2.1~~
	~~$1.3 < S_a(0.2) \le 1.35$~~	~~2.4~~	~~2.3~~	~~1.7~~	~~2.4~~	~~2.0~~
	~~$1.35 < S_a(0.2) \le 1.8$~~	~~2.4~~	~~2.2~~	~~1.6~~	~~2.4~~	~~1.9~~

~~Notes to :~~

~~(1) See Note A-9.23.13.2.(1)(a)(i).~~

~~(2) All constructions include support of a roof load in addition to the indicated number of floors.~~

[5] 5) Anchor bolts referred to in Sentences (2) ~~to~~and (3~~4~~) shall be

[a] a) fastened to the sill plate with nuts and washers,

[b] b) embedded not less than 100 mm in the *foundation*, and

[c] c) so designed that they may be tightened without withdrawing them from the *foundation*.

[6] 6) ~~Where the seismic spectral acceleration, $S_a(0.2)$, is greater than 1.8 or the 1-in-50 hourly wind pressure is equal to or greater than 1.2 kPa, a~~Anchorage shall be designed according to Part 4, where~~.~~

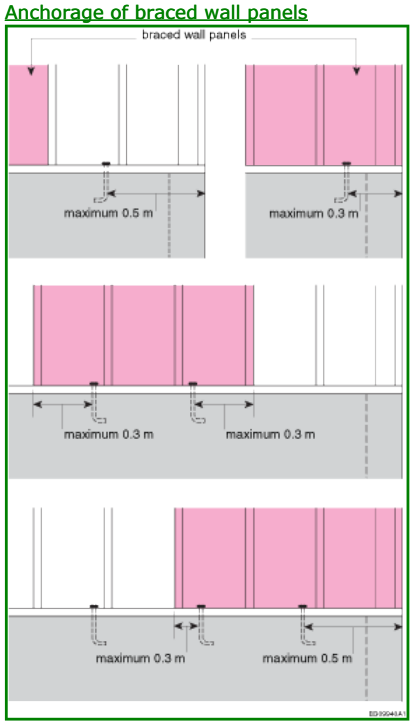
[a] --) the 1-in-50-year hourly wind pressure (HWP) is greater than 1.2 kPa,

[b] --) the seismic design parameter, S_{max}, is greater than 2.6, or

[c] --) the seismic design parameter, S_{max}, for Site Class C is greater than 0.47, for *buildings* of 3 *storeys* in *building height* and
[i] --) of heavyweight construction,
[ii] --) clad at full height with masonry veneer, or
[iii] --) clad at full height with stone veneer
(see Sentence 9.23.13.2.(3)).

Note A-9.23.6.1.(3) Anchorage of Braced Wall Panels.

Figure [A-9.23.6.1.(3)]
Anchorage of braced wall panels



[9.23.11.4.] 9.23.11.4. Joints in Top Plates

[1] 1) Joints in the top plates of *loadbearing* walls shall be staggered not less than ~~one stud spacing.~~
[a] --) one stud spacing where the minimum number of nails required by Sentence (5) is not more than 16,
[b] --) two stud spacings where the minimum number of nails required by Sentence (5) is greater than 16 but not more than 32, and
[c] --) three stud spacings where the minimum number of nails required by Sentence (5) is greater than 32.

[2] 2) The top plates in *loadbearing* walls shall be lapped or otherwise tied at corners and intersecting walls in accordance with Sentence (4).

[3] 3) Joints in single top plates used with *loadbearing* walls shall be tied in accordance with Sentence (4).

[4] 4) Ties referred to in Sentences (2) and (3) shall be the equivalent of not less than 75 mm by 150 mm by 0.91 mm thick galvanized steel nailed to each wall with at least three 63 mm nails.

[5] 5) ~~Where the seismic spectral acceleration, $S_a(0.2)$, is greater than 0.70 but not more than 1.8~~Except as provided in Sentence (7), doubled top plates in *braced wall bands* shall be fastened on each side of a splice with not less than 76 mm long common steel wire nails or spiral nails in accordance with the minimum number of nails required by Table 9.23.11.4. or 9.23.11.4.-C, whichever is greater, where
[a] --) the seismic design parameter, S_{max}, for Site Class C is greater than 0.47 and S_{max} is not greater than 2.6, or
[b] --) the 1-in-50-year hourly wind pressure (HWP) is equal to or greater than 0.6 kPa but not greater than 1.2 kPa.

Table [9.23.11.4.-A] 9.23.11.4.
Fasteners in Doubled Top Plate Splice Connections in Braced Wall Bands Wwhere ~~0.70 < $S_a(0.2)$ ≤ 1.8~~S_{max} for Site Class C > 0.47 and S_{max} ≤ 2.6
Forming Part of Sentence [9.23.11.4.] 9.23.11.4.([5] 5)

S_{max} (1)	Minimum Number of Nails on Each Side of Doubled Top Plate Splice for *Braced Wall Band* Spacing of 10.6 m (2)			
	Weight of Construction or Cladding Type (3)			
	Normal-Weight Construction	Heavyweight Construction (4)	Masonry Veneer (on one or more *building* faces) (4) (5)	Stone Veneer (on one or more *building* faces) (4) (5)
S_{max} ≤ 0.60	4	7	8	10
0.6 < S_{max} ≤ 0.8	6	8	9	12
0.8 < S_{max} ≤ 1.2	9	12	14	19
1.2 < S_{max} ≤ 1.6	12	16	19	25
1.6 < S_{max} ≤ 2.0	14	20	23	31
2.0 < S_{max} ≤ 2.6	19	25	30	40

Notes to Table [9.23.11.4.-A] 9.23.11.4.:

(1) See Article 9.4.2.5.

(2) For a *braced wall band* spacing of 7.6 m or less, the minimum number of nails may be divided by 2.

(3) See Sentence 9.23.13.2.(3).

(4) Limited to 2 *storeys* in *building height*. See Sentence (7).

(5) Where the height of the masonry or stone veneer does not exceed a half *storey* above the *foundation*, the veneer may be disregarded.

~~$S_a(0.2)$~~	~~Minimum Number of Nails on Each Side of Doubled Top Plate Splice~~				
	~~Light Construction~~			~~Heavy Construction (1)~~	
	~~Number of Supported Floors (2)~~				
	~~0~~	~~1~~	~~2~~	~~0~~	~~1~~
~~0.70 < $S_a(0.2)$ ≤ 0.80~~	~~2~~	~~5~~	~~8~~	~~3~~	~~8~~
~~0.80 < $S_a(0.2)$ ≤ 0.90~~	~~2~~	~~5~~	~~8~~	~~4~~	~~8~~
~~0.90 < $S_a(0.2)$ ≤ 1.0~~	~~3~~	~~6~~	~~10~~	~~4~~	~~10~~
~~1.0 < $S_a(0.2)$ ≤ 1.1~~	~~3~~	~~7~~	~~11~~	~~5~~	~~11~~
~~1.1 < $S_a(0.2)$ ≤ 1.2~~	~~3~~	~~7~~	~~11~~	~~5~~	~~12~~
~~1.2 < $S_a(0.2)$ ≤ 1.3~~	~~3~~	~~8~~	~~12~~	~~5~~	~~12~~
~~1.3 < $S_a(0.2)$ ≤ 1.35~~	~~4~~	~~8~~	~~12~~	~~5~~	~~13~~
~~1.35 < $S_a(0.2)$ ≤ 1.8~~	~~4~~	~~8~~	~~13~~	~~5~~	~~13~~

~~Notes to :~~

~~(1) See Note A-9.23.13.2.(1)(a)(i).~~

~~(2) All constructions include support of a roof load in addition to the number of floors indicated.~~

Table [9.23.11.4.-C]
Fasteners in Doubled Top Plate Splice Connections in Braced Wall Bands Where 0.6 kPa < HWP ≤ 1.2 kPa
Forming Part of Sentence [9.23.11.4.] 9.23.11.4.([5] 5)

HWP	Minimum Number of Nails on Each Side of Doubled Top Plate Splice for *Braced Wall Band* Spacing of 10.6 m, (1) Rough Terrain (2), and Roof Eave-to-Ridge Height of 3 m (3)
HWP ≤ 0.3	7
0.3 < HWP ≤ 0.4	9
0.4 < HWP ≤ 0.5	11
0.5 < HWP ≤ 0.6	13
0.6 < HWP≤ 0.9	20
0.9 < HWP ≤ 1.2	26

Notes to Table [9.23.11.4.-C] :

(1) For a *braced wall band* spacing of 7.6 m or less, the minimum number of nails may be divided by 2.

(2) For open terrain, multiply the minimum number of nails by the wind exposure adjustment factor, K_{exp}, as provided in Table 9.23.13.7.-B. See Note A-9.23.13.7.(3) and (4).

(3) For roof-level top plates (i.e., top plates supporting roof framing), multiply the minimum number of nails by the roof eave-to-ridge height adjustment factor, K_{roof}, as provided in Table 9.23.13.7-B.

[6] --) Nails referred to in Sentence (5) shall be spaced not less than 75 mm o.c. along the top plate in rows spaced not less than 35 mm apart.

[7] --) Doubled top plates in *braced wall bands* shall be designed according to Part 4 where

[a] --) the 1-in-50-year hourly wind pressure (HWP) is greater than 1.2 kPa,

[b] --) the seismic design parameter, S_{max}, is greater than 2.6, or

[c] --) the seismic design parameter, S_{max}, for Site Class C is greater than 0.47, for *buildings* of 3 *storeys* in *building height* and

[i] --) of heavyweight construction,

[ii] --) clad with masonry veneer, or

[iii] --) clad with stone veneer

(see Sentence 9.23.13.2.(3)).

[9.23.13.] 9.23.13. Bracing to Resist Lateral Loads Due to Wind and Earthquake

(See Note A-9.23.13.)

[9.23.13.1.] 9.23.13.1. Requirements for Low to Moderate Wind and Seismic Forces

~~(See Note A-9.23.13.1.)~~

[1] 1) This Article applies ~~in locations~~ where ~~the seismic spectral acceleration, $S_a(0.2)$, is not more than 0.70 and the 1-in-50 hourly wind pressure is less than 0.80 kPa.~~

[a] --) the seismic design parameter, S_{max}, for Site Class C is not greater than 0.47,

[b] --) the 1-in-50-year hourly wind pressure (HWP) is not greater than 0.6 kPa,

[c] --) the unsupported height of the *braced wall panels* in the *building* is not greater than 3.1 m, and

[d] --) the lowest exterior frame wall supports a roof and not more than 2 floors.

[2] 2) Bracing to resist lateral loads shall be designed and constructed ~~as follows~~in accordance with~~:~~

[a] a) ~~exterior walls shall be~~the simplified approach outlined in Article 9.23.13.11., where the seismic design parameter, S_{max}, is not greater than 0.47 and the 1-in-50-year hourly wind pressure (HWP) is not greater than 0.6 kPa,

~~[i] i) clad with panel-type cladding in accordance with Section 9.27.,~~

~~[ii] ii) sheathed with plywood, OSB, waferboard, fibreboard, gypsum board or diagonal lumber sheathing complying with Subsection 9.23.17. and fastened in accordance with Table 9.23.3.5.-A, or~~

~~[iii] iii) finished on the interior with a panel-type material in accordance with the requirements of Section 9.29., or~~

[b] b) ~~in accordance with~~Articles 9.23.13.4. to 9.23.13.10.,

[i] i) Articles 9.23.13.4. to 9.23.13.7.,
[ii] ii) Part 4, or
[iii] iii) good engineering practice such as that provided in CWC 2014, "Engineering Guide for Wood Frame Construction".
[c] --) Part 4, or
[d] --) good engineering practice such as that provided in the CWC "Engineering Guide for Wood Frame Construction."

[9.23.13.2.] 9.23.13.2. Requirements for High Wind and Seismic Forces

[1] 1) Except as provided in Article 9.23.13.1., this Article applies in locations where
[a] --) the unsupported height of the *braced wall panels* in the *building* is not greater than 3.1 m,
[b] b) the 1-in-50-year hourly wind pressure (HWP) is lessnot greater than 1.20 kPa,
[c] --) the seismic design parameter, S_{max}, is not greater than 2.6, and
[d] a) the seismic spectral acceleration, $S_a(0.2)$, is greater than 0.70 but not more than 1.8 and the lowest exterior frame wall supports a roof and not more than
[i] i) the lowest exterior frame wall supports not more than 21 floors in a *buildings* of normal-weightof heavy construction (see Note A-9.23.13.2.(1)(a)(i)), or
[ii] ii) the lowest exterior frame wall supports not more than 21 floors in other types ofa *building* of heavyweight construction or clad at full height with masonry veneer or stone veneer., and

[2] 2) Bracing to resist lateral loads shall be designed and constructed in accordance with
[a] a) Articles 9.23.13.4. to 9.23.13.710.,
[b] b) Part 4, or
[c] c) good engineering practice such as that provided in the CWC 2014, "Engineering Guide for Wood Frame Construction."

[3] --) For the purposes of Sentence (1) and this Part,
[a] --) in a *building* of normal-weight construction, the average dead weight per *storey* shall not exceed
[i] --) 0.5 kPa for floors and 0.5 kPa for *partitions* and interior walls,
[ii] --) 0.5 kPa for the roof, and
[iii] --) 0.4 kPa for exterior walls,
[b] --) in a *building* of heavyweight construction, the average dead weight per *storey* shall conform to Clause (a), except that the average dead weight per *storey* shall not exceed
[i] --) 1.5 kPa for floors and 0.5 kPa for *partitions* and interior walls,
[ii] --) 1.0 kPa for the roof, or
[iii] --) 1.2 kPa for exterior walls,
[c] --) in a *building* clad with masonry veneer, the average dead weight of the masonry veneer shall not exceed 1.9 kPa, and
[d] --) in a *building* clad with stone veneer, the average dead weight of the stone veneer shall not exceed 3.2 kPa.
(See Note A-9.23.13.2.(3).)

[9.23.13.3.] 9.23.13.3. Requirements for Extreme Wind and Seismic Forces

[1] 1) Except as provided in Articles 9.23.13.1. and 9.23.13.2., this Article applies in locations where
[a] a) the seismic spectral acceleration, $S_a(0.2)$, is
[i] i) greater than 1.8,
[ii] ii) greater than 0.70 and the lowest exterior frame wall supports more than 2 floors in *buildings* of light construction, or
[iii] iii) greater than 0.70 and the lowest exterior frame wall supports more than 1 floor in *buildings* of heavy construction, or
[b] a) the 1-in-50-year hourly wind pressure (HWP) is equal to or greater than 1.20 kPa.,
[c] b) the seismic design parameter, S_{max}, is greater than 2.6, or
[d] --) the seismic design parameter, S_{max}, for Site Class C is greater than 0.47, and the lowest exterior frame wall supports a roof and more than 1 floor in a *building* of heavyweight construction or clad at full height with masonry veneer or stone veneer.

[2] 2) Bracing to resist lateral loads shall be designed and constructed in accordance with
[a] a) Part 4, or
[b] b) good engineering practice such as that provided in the CWC 2014, "Engineering Guide for Wood Frame Construction."

[9.23.13.4.] 9.23.13.4. Braced Wall Bands
(See Note A-9.23.13.4.)

[1] 1) *Braced wall bands* shall

[a] --) surround the perimeter of the *building*,

[b] a) be full *storey* height,

[c] b) be not more than 1.2 m wide,

[d] c) lap at both ends with another *braced wall band*,

[e] d) be aligned with *braced wall bands* on *storeys* above and below, and

[f] e) conform to the spacing and dimensions given in Table 9.23.13.5. and Article 9.23.13.7.-2025

~~[2] 2) The perimeter of the *building* shall be located within *braced wall bands*.~~

[3] 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.] 9.23.13.5. Braced Wall Panels in Braced Wall Bands

[1] 1) Except as provided in Sentences (2) ~~to (5)~~ and 9.23.13.10.(2) to (4) and Article 9.23.13.7.-2025, *braced wall panels* shall

[a] a) be located within *braced wall bands*,

[b] --) be laterally supported at each floor level and the roof,

[c] 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

[d] c) conform to the spacing and dimensions given in Table 9.23.13.5. and Article 9.23.13.7.-2025

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

Description	Spacing and Dimensions of *Braced Wall Bands* and *Braced Wall Panels* (1) (2) (3)	
	~~Seismic and Wind Loads~~	
	~~$0.70 < S_a(0.2) < 1.0$~~	~~$1.0 \leq S_a(0.2) \leq 1.8$ or $0.80 \leq HWP \leq 1.2$ kPa~~
Maximum distance between centre lines of adjacent *braced wall bands* measured from the furthest points between centres of the bands (4)	10.6 m	~~7.6 m~~
Maximum distance between required *braced wall panels* measured from the edges of the panels	6.4 m	~~6.4 m~~
Maximum distance from the end of a *braced wall band* to the edge of the closest required *braced wall panel*	2.4 m	~~2.4 m~~
Minimum length of individual wood-sheathed *braced wall panels*:		
• panel located at the end of a *braced wall band* where the *braced wall panel* connects to an intersecting *braced wall panel*	600 mm	~~600 mm~~
• panel not located at the end of a *braced wall band* or *braced wall panel* located at the end of a *braced wall band* where the *braced wall panel* does not connect to an intersecting *braced wall panel*	750 mm	~~750 mm~~
Minimum length of individual *braced wall panels* sheathed only with gypsum board	1.2 m	
Minimum length of individual diagonal-lumber-sheathed *braced wall panels*	1.2 m	
Minimum total length of all *braced wall panels* in a *braced wall band*	Per Article 9.23.13.7.-2025	
~~• supporting 3 floors, light construction~~	~~75% of length of *braced wall band*~~	
~~• supporting 2 floors, heavy construction (5)~~	~~75% of length of *braced wall band*~~	
~~• supporting 2 floors, light construction~~	~~40% of length of *braced wall band*~~	

Description	Spacing and Dimensions of *Braced Wall Bands* and *Braced Wall Panels* (1) (2) (3)	
	~~Seismic and Wind Loads~~	
	~~$0.70 < S_a(0.2) < 1.0$~~	~~$1.0 \leq S_a(0.2) \leq 1.8$ or $0.80 \leq HWP \leq 1.2$ kPa~~
~~• supporting 1 floor, heavy construction (5)~~	~~40% of length of *braced wall band*~~	
~~• supporting 1 floor, light construction~~	~~25% of length of *braced wall band*~~	
~~• not supporting a floor~~	~~25% of length of *braced wall band*~~	

Notes to Table [9.23.13.5.] 9.23.13.5.:

(1) See Note A-Table 9.23.13.5.

(2) All constructions include support of a roof load in addition to the indicated number of floors.

(3) See Article 9.23.13.~~7~~10. for ~~alternative~~additional system considerations~~methods of compliance~~.

(4) See Sentence (2) for an exception for *basements* and crawl spaces.

~~(5) See Sentence 9.23.13.3.(1) for overall limit on application to heavy construction.~~

[2] 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] --) have a total length of *braced wall panels* not less than the total length of *braced wall panels* in the *braced wall band* in the *storey* above, and

[b] b) be spaced not more than

[i] --) 15 m from the perimeter *foundation* walls,

[ii] --) 15 m from interior *foundation* walls, and

[iii] --) 15 m from adjacent *braced wall bands* constructed with *braced wall panels*.

~~[c] a) 15 m from the perimeter *foundation* walls,~~

~~[d] b) 15 m from interior *foundation* walls, and~~

~~[e] c) 15 m from adjacent *braced wall bands* constructed with *braced wall panels*.~~

(See Note A-9.23.13.5.(2).)

[3] --) Interior or exterior wood-sheathed *braced wall panels*, other than panels of WSP-A framing type, in the uppermost *storey* shall

[a] --) extend to the roof framing, and

[b] --) have their top plate connected to

[i] --) top chords of perpendicular or offset parallel trusses by using blocking panels or other methods of lateral load transfer designed by the roof truss manufacturer,

[ii] --) perpendicular or offset parallel joists or rafters by using blocking of the same construction as the *braced wall panel* below, or

[iii] --) rafters, joists or trusses by using methods of lateral load transfer designed in accordance with good engineering practice.

(See Note A-9.23.13.5.(3) and (4).)

[4] --) The top plates of *braced wall panels* described in Sentence (3) shall be fastened in accordance with Table 9.23.3.4.

(See Note A-9.23.13.5.(3) and (4).)

~~[5] 3) Portions of the perimeter of a single open or enclosed space need not comply with Sentence (1), where~~

~~[a] a) the roof of the space projects not more than~~

~~[i] i) 3.5 m from the face of the framing of the nearest parallel *braced wall band*, and~~

~~[ii] ii) the perpendicular plan dimension,~~

~~[b] b) that portion of the perimeter structure does not support a floor,~~

~~[c] c) the roof of the space is~~

[i] i) integral with the roof of the rest of the *building* with framing members not more than 400 mm o.c. where roof sheathing edges are not supported on blocking and not more than 600 mm o.c. where roof sheathing edges are supported on blocking securely fastened between framing members, or

[ii] ii) constructed with roof framing not more than 400 mm o.c. where roof sheathing edges are not supported on blocking and not more than 600 mm o.c. where roof sheathing edges are supported on blocking securely fastened between framing members, and fastened to the wall framing (see Table 9.23.3.4. and Article 9.23.9.1. for balloon framing), and

[d] d) the end-joists or end-rafters for the roof of the space are fastened to a 3-ply, 38 mm × 140 mm built-up column or a 5-ply, 38 mm × 89 mm built-up column that is integral with the wall framing.

(See Note A-9.23.13.5.(3).)

[6] 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.

[7] 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] a) the maximum spacing between the front of the garage and the back wall of the garage does not exceed 7.6 m,

[b] b) there is not more than one floor above the garage,

[c] c) not less than 50% of the length of the back wall of the garage is constructed of *braced wall panels*, and

[d] d) not less than 25% of the length of the side walls is constructed of *braced wall panels*.

[9.23.13.6.] 9.23.13.6. Materials in Braced Wall Panels

[1] 1) Required *braced wall panels* shall be

[a] a) clad with panel-type cladding complying with Section 9.27. and Table 9.23.3.4.,

[b] b) sheathed on the exterior side with plywood, OSB, waferboard or diagonal lumber sheathing complying with Subsection 9.23.167. and Table 9.23.13.6., and fastened in accordance with Article9.23.3.5.Sentence 9.23.3.5.(3)Article 9.23.3.5., or, and finished on the interior side with gypsum board complying with Subsection 9.29.5., or

[c] 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.

[d] c) sheathed on the interior side or exterior side with gypsum board complying with Subsection 9.29.5. and fastened in accordance with Sentence 9.23.3.5.(3).

(See Note A-9.23.13.6.(1).)

[2] --) Except as provided in Sentences (4) and (5), *braced wall bands* shall be constructed of *braced wall panels* of the same sheathing material.

[3] 6) At *braced wall band* spacing intervals of not more than 15 m, *bBraced wall panels* in *basements* and crawl spaces shall be sheathedconstructed with OSB, plywood, waferboard or diagonal lumber. (See Note A-9.23.13.6.(5) and (6).)

[a] --) at *braced wall band* spacing intervals of not more than 15 m, and

[b] --) under all interior *braced wall bands* containing wood-sheathed *braced wall panels*.

(See Note A-9.23.13.6.(3).)

[4] --) Mixing of *braced wall panel* framing types is permitted in stacked *braced wall bands*, provided that wood-sheathed *braced wall panels* are not located above *braced wall bands* containing

[a] --) gypsum-sheathed *braced wall panels*, or

[b] --) diagonal-lumber-sheathed *braced wall panels*.

[5] --) Mixing of *braced wall panel* framing types is permitted along a *braced wall band* within the same *storey*, provided that

[a] --) panels of WSP-A or WSP-B framing type are substituted for panels of a GWB framing type, and the total length of all the *braced wall panels* is determined based on the GWB framing type, or

[b] --) the lengths of the *braced wall panels* of mixed framing types are based on accepted engineering principles.

(See Note A-9.23.13.6.(5).)

Table [9.23.13.6.] 9.23.13.6.
Minimum Thicknesses of Cladding, Sheathing or Interior Finish for Braced Wall Panels
Forming Part of Sentence [9.23.13.6.] 9.23.13.6.([1] 1)

Panel-Type Cladding, Sheathing or Interior Finish	Minimum Thickness			
	Where $S_a(0.2) \leq 0.90$		Where $S_a(0.2) > 0.90$	
	With supports 400 mm o.c.	With supports 600 mm o.c.	With supports 400 mm o.c.	With supports 600 mm o.c.
Gypsum board interior finish (1)	12.7 mm	15.9 mm	12.7 mm	15.9 mm
Sheathing complying with CSA O325	W16	W24	W16	W24
OSB O-1 and O-2 grades	11 mm	12.5 mm	11 mm	12.5 mm
Waferboard R-1 grade	9.5 mm	12.5 mm	n/a	n/a
Plywood	11 mm	12.5 mm	11 mm	12.5 mm
Diagonal lumber	17 mm	17 mm	n/a	n/a

Note to Table [9.23.13.6.] 9.23.13.6.:

(1) See Sentences (5) and (6).

[6] 2) Except as provided in Sentence (3), required interior *braced wall panels* shall be
[a] a) sheathed or finished on both sides with a wood-based material, or
[b] b) finished on both sides with gypsum board.

[7] 3) Required interior *braced wall panels* of wood-based material may be sheathed on one side only, provided
[a] a) the sheathing material is plywood, OSB or waferboard, and
[b] b) the maximum spacing of fasteners along the edge is half of the maximum spacing shown in Table 9.23.3.5.-B.

[8] 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*.

[9] 5) Gypsum board interior finish shall not be considered as an acceptable sheathing material to provide the required bracing in exterior walls. (See Note A-9.23.13.6.(5) and (6).)

[9.23.13.7.] --- Braced Wall Panel Length

[1] --) Except as provided in Tables 9.23.13.7.-B and 9.23.13.7.-D, all adjustment factors required for the calculation of the minimum total length of *braced wall panels* in accordance with this Article shall be taken as 1.

[2] --) The minimum total length of *braced wall panels* in a *braced wall band* shall be taken as the greater of L_w, as determined in Sentence (3) for the appropriate 1-in-50-year hourly wind pressure (HWP), and L_s, as determined in Sentence (4) for the appropriate seismic design parameter, S_{max}, where
[a] --) HWP is not greater than 1.2 kPa, and
[b] --) S_{max} for Site Class C is not greater than 2.6.

[3] --) For resistance to wind pressure, the minimum total length of *braced wall panels* in each *braced wall band*, L_w, shall be determined by applying the adjustment factors provided in Table 9.23.13.7.-B to the unadjusted minimum total *braced wall panel* length, L_{uw}, provided in Table 9.23.13.7.-A, using the following equation:

$$L_w = L_{uw}K_{exp}K_{roof}K_{Wspacing}K_{Wnumber}K_{gyp}K_{sheath} \geq BWP_{min}$$

where

K_{exp} = wind exposure adjustment factor, and
= 1 for rough terrain (suburban, urban or wooded terrain extending upwind from the *building* uninterrupted for at least 1 km),

K_{roof} = roof eave-to-ridge height adjustment factor, and
= 1 for a roof eave-to-ridge height of 3 m,

$K_{Wspacing}$ = *braced wall band* spacing adjustment factor for wind (see Sentence (5)-2025), per *building* plan direction, and
= 1 for a *braced wall band* spacing of 7.6 m,

$K_{Wnumber}$ = number of parallel *braced wall bands* adjustment factor for wind, per *building* plan direction, and
= 1 for two exterior walls and no intermediate parallel *braced wall bands*,

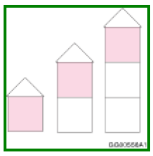
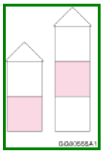
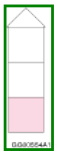
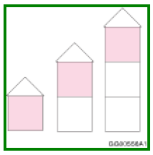
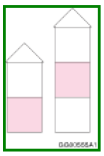
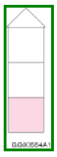
K_{gyp} = interior gypsum board adjustment factor, and
= 1 for *braced wall panels* with gypsum board installed on the interior side,

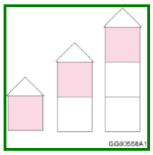
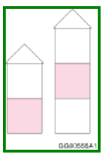
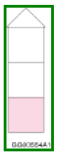
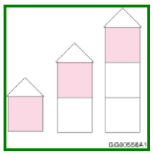
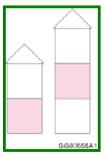
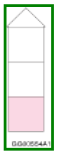
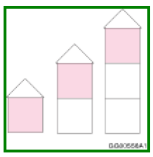
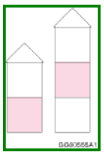
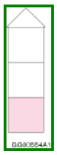
K_{sheath} = intermittent *braced wall panels* adjustment factor, and
= 1 for continuously sheathed *braced wall bands*, and

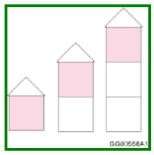
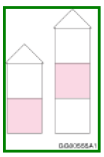
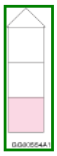
BWP_{min} = minimum length of individual *braced wall panels*, as per Table 9.23.13.5.

(See Note A-9.23.13.7.(3) for an alternative procedure to calculate L_w directly and Note A-9.23.13.7.(3) and (4).)

Table [9.23.13.7.-A]
Unadjusted Minimum Total Braced Wall Panel Lengths for Wind
Forming Part of Sentence [9.23.13.7.] -- ([3] --)

HWP	*Storey*	Unadjusted Minimum Total *Braced Wall Panel* Length for Wind, L_{uw}, m (1)								
		Diagonal-Lumber-Sheathed Framing Type (with gypsum board on opposite side) (2)	Gypsum-Sheathed Framing Type (with gypsum board on only one side) (2) (3)				Wood-Sheathed Framing Type (with gypsum board on opposite side) (2)			
		DWB	GWB-A	GWB-B	GWB-C	GWB-D	WSP-A	WSP-B	WSP-C	WSP-D	WSP-E
HWP ≤ 0.3		0.65	3.29	1.91	1.42	1.14	1.14	0.60	0.52	0.48	0.43
		1.33	6.75	3.92	2.91	2.35	2.35	1.24	1.08	0.98	0.88
		2.02	10.21	5.93	4.40	3.57	3.57	1.87	1.63	1.49	1.34
0.3 < HWP ≤ 0.4		0.86	4.38	2.54	1.89	1.52	1.52	0.80	0.70	0.64	0.57
		1.78	9.00	5.23	3.88	3.14	3.14	1.65	1.43	1.31	1.18
		2.69	13.61	7.91	5.86	4.75	4.75	2.50	2.17	1.98	1.79

0.4 < HWP ≤ 0.5		1.08	5.84	3.18	2.36	1.90	1.90	1.00	0.87	0.79	0.72
		2.22	11.25	6.54	4.85	3.92	3.92	2.06	1.79	1.63	1.47
		3.37	17.01	9.88	7.33	5.94	5.94	3.12	2.72	2.48	2.23
0.5 < HWP ≤ 0.6		1.29	6.57	3.82	2.83	2.29	2.29	1.20	1.05	0.95	0.86
		2.67	13.50	7.84	5.82	4.71	4.71	2.47	2.15	1.96	1.77
		4.04	20.42	11.86	8.79	7.13	7.13	3.75	3.26	2.97	2.68
0.6 < HWP ≤ 0.9		1.94	9.86	5.73	4.25	3.43	3.43	1.80	1.57	1.43	1.29
		4.00	20.25	11.76	8.72	7.06	7.06	3.71	3.23	2.94	2.65
		6.06	30.62	17.79	13.19	10.70	10.70	5.62	4.89	4.46	4.02

0.9 < HWP ≤ 1.2		2.59	13.14	7.63	5.66	4.57	4.57	2.40	2.09	1.91	1.72
		5.33	27.00	15.68	11.63	9.41	9.41	4.95	4.30	3.92	3.54
		8.08	40.83	23.72	17.59	14.26	14.26	7.50	6.52	5.94	5.36

Notes to Table [9.23.13.7.-A] :

(1) Unadjusted minimum total *braced wall panel* lengths are for the applicable conditions corresponding to an adjustment factor of 1 in the equation for L_w.

(2) See Sentence 9.23.3.5.(3) for a description of framing types and fastening requirements.

(3) See Sentence (6)-2025 for *braced wall panels* with gypsum board installed on both sides.

Table [9.23.13.7.-B]
Adjustment Factors for the Determination of Minimum Total Braced Wall Panel Lengths for Wind
Forming Part of Sentence [9.23.13.7.] -- ([3] --)

Symbol	Description	*Storey*	Condition	Adjustment Factor
K_{exp} (1)	Wind exposure: apply factor to all *storeys* in both directions	All *storeys*	Rough terrain	1.00
		All *storeys* in 1-*storey building*	Open terrain	1.29
		All *storeys* in 2-*storey building*		1.40
		All *storeys* in 3-*storey building*		1.48
K_{roof} (2)	Roof eave-to-ridge height: apply factor separately to each *storey*	*Storey* supporting roof only	≤ 1.5 m	0.52
			3.0 m	1.00
			4.5 m	1.58
			6.0 m	1.99
		Storey supporting roof and 1 floor	≤ 1.5 m	0.79
			3.0 m	1.00
			4.5 m	1.26
			6.0 m	1.47

		Storey supporting roof and 2 floors	≤ 1.5 m	0.87
			3.0 m	1.00
			4.5 m	1.16
			6.0 m	1.31
$K_{Wspacing}$ (2) (3) (4)	*Braced wall band* spacing: apply factor to all *braced wall panels* per *building* plan direction	Any *storey*	3.8 m	0.51
			7.6 m	1.00
			10.6 m	1.35
			15 m (5)	1.86
$K_{Wnumber}$	Number of parallel *braced wall bands*: apply factor to all *braced wall panels* per *building* plan direction	Any *storey*	2	1.00
			3	1.28
			4	1.38
			≥ 5	1.43
K_{gyp}	Interior gypsum board: apply factor in accordance with whether gypsum board is installed or omitted on interior side of *braced wall panels*	Any *storey*	Installed	1.00
			Omitted, blocked wall	1.20
			Omitted, unblocked wall	1.40
K_{sheath}	Intermittent *braced wall panels*: apply factor in accordance with continuity of sheathing within *braced wall band*	Any *storey*	Continuously sheathed	1.00
			Intermittently sheathed	1.15

Notes to Table [9.23.13.7.-B] :

(1) K_{exp} is determined based on the terrain. Rough terrain is suburban, urban or wooded terrain extending upwind from the *building* uninterrupted for at least 1 km. Open terrain is level terrain with only scattered trees, *buildings* or other obstructions, open water or shorelines.

(2) For K_{roof}, linear interpolation between roof eave-to-ridge heights is permitted.

(3) For for $K_{Wspacing}$, linear interpolation between *braced wall band* spacings is permitted.

(4) An average *braced wall band* spacing is permitted to be used for the determination of $K_{Wspacing}$. See Sentence (5)-2025.

(5) A *braced wall band* spacing of 15 m is only permitted in basements and crawl spaces.

[4] --) For resistance to seismic forces, the minimum total length of *braced wall panels* in each *braced wall band*, L_s, shall be determined by applying the adjustment factors provided in Table 9.23.13.7.-D to the unadjusted minimum total *braced wall panel* length, L_{us}, provided in Table 9.23.13.7.-C, using the following equation:

$$L_s = L_{us}K_{weight}K_{snow}K_{Sspacing}K_{Snumber}K_{gyp}K_{sheath} \geq BWP_{min}$$

where

K_{weight} = weight of construction and cladding adjustment factor, and
= 1 for normal-weight construction (see Sentence 9.23.13.2.(3)),

K_{snow} = roof snow load adjustment factor, and
= 1 for a specified roof snow load of 2 kPa or less, as calculated in accordance with Article 9.4.2.2.,

$K_{Sspacing}$

= *braced wall band* spacing adjustment factor for seismic forces (see Sentence (5)-2025), per *building* plan direction, and
= 1 for a *braced wall band* spacing of 7.6 m,

$K_{Snumber}$ = number of parallel *braced wall bands* adjustment factor for seismic forces, per *building* plan direction, and
= 1 for two exterior walls and no intermediate parallel *braced wall bands,*

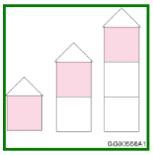
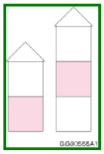
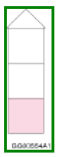
K_{gyp} = interior gypsum board adjustment factor, and
= 1 for *braced wall panels* with gypsum board installed on the interior side,

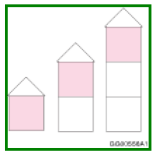
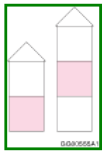
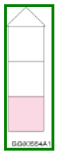
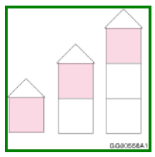
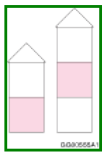
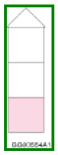
K_{sheath} = intermittent *braced wall panels* adjustment factor, and
= 1 for continuously sheathed *braced wall bands*, and

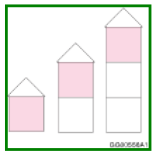
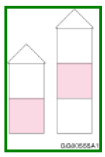
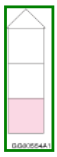
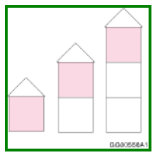
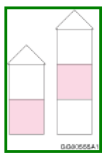
BWP_{min} = minimum length of individual *braced wall panels*, as per Table 9.23.13.5.

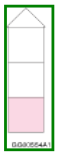
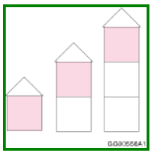
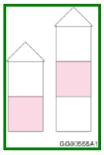
(See Note A-9.23.13.7.(4) for an alternative procedure to calculate L_s directly and Note A-9.23.13.7.(3) and (4).)

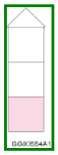
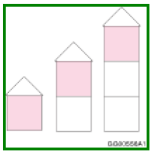
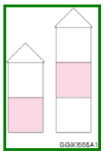
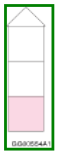
Table [9.23.13.7.-C]
Unadjusted Minimum Total Braced Wall Panel Lengths for Seismic Forces
Forming Part of Sentence [9.23.13.7.] -- ([4] --)

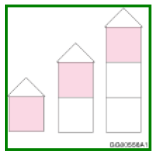
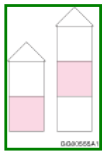
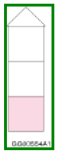
S_{max}	*Storey*	*Building* Plan Dimension Parallel to *Braced Wall Band*, L_{wl}, m	Unadjusted Minimum Total *Braced Wall Panel* Length for Seismic Forces, L_{us}, m (1) (2)									
			Diagonal-Lumber-Sheathed Framing Type (with gypsum board on opposite side) (3)	Gypsum-Sheathed Framing Type (with gypsum board on only one side) (3) (4)				Wood-Sheathed Framing Type (with gypsum board on opposite side) (3)				
			DWB	GWB-A	GWB-B	GWB-C	GWB-D	WSP-A	WSP-B	WSP-C	WSP-D	WSP-E
$S_{max} \leq 0.2$		3.1	0.06	0.47	0.27	0.20	0.17	0.11	0.06	0.05	0.05	0.04
		6.1	0.11	0.81	0.47	0.35	0.28	0.19	0.10	0.09	0.08	0.07
		9.1	0.15	1.15	0.67	0.50	0.40	0.27	0.14	0.12	0.11	0.10
		12.2	0.20	1.5	0.87	0.65	0.53	0.35	0.18	0.16	0.15	0.13
		15.2	0.24	1.81	1.05	0.78	0.64	0.43	0.23	0.20	0.18	0.16
		18.3	0.29	2.20	1.28	0.95	0.77	0.51	0.27	0.23	0.21	0.19
		3.1	0.15	1.10	0.65	0.48	0.39	0.26	0.14	0.12	0.11	0.10
		6.1	0.24	1.84	1.07	0.79	0.65	0.43	0.23	0.20	0.18	0.16
		9.1	0.34	2.57	1.49	1.11	0.90	0.60	0.32	0.27	0.25	0.23
		12.2	0.44	3.32	1.93	1.43	1.17	0.78	0.41	0.36	0.32	0.29
		15.2	0.54	3.99	2.31	1.72	1.40	0.95	0.50	0.43	0.39	0.36
		18.3	0.64	4.80	2.79	2.07	1.68	1.12	0.59	0.51	0.47	0.42
		3.1	0.23	1.76	1.02	0.76	0.62	0.41	0.22	0.19	0.17	0.15
		6.1	0.38	2.87	1.67	1.24	1.01	0.67	0.35	0.31	0.28	0.25
		9.1	0.53	3.99	1.49	1.72	1.40	0.93	0.49	0.43	0.39	0.35
		12.2	0.68	5.14	2.99	2.21	1.80	1.20	0.63	0.55	0.50	0.45
		15.2	0.83	6.16	3.58	2.65	2.16	1.46	0.77	0.67	0.61	0.55
		18.3	0.98	7.41	4.30	3.19	2.60	1.73	0.91	0.79	0.72	0.65

0.2 < S_{max} ≤ 0.4		3.1	0.13	0.94	0.55	0.41	0.33	0.22	0.12	0.10	0.09	0.08
		6.1	0.22	1.63	0.94	0.70	0.57	0.38	0.20	0.17	0.16	0.14
		9.1	0.31	2.31	1.34	0.99	0.81	0.54	0.28	0.25	0.22	0.20
		12.2	0.40	3.01	1.75	1.30	1.05	0.70	0.37	0.32	0.29	0.26
		15.2	0.49	3.63	2.11	1.56	1.27	0.86	0.45	0.39	0.36	0.32
		18.3	0.58	4.39	2.55	1.89	1.54	1.03	0.54	0.47	0.43	0.39
		3.1	0.30	2.23	1.30	0.96	0.78	0.52	0.27	0.24	0.22	0.20
		6.1	0.49	3.69	2.14	1.59	1.29	0.86	0.45	0.39	0.36	0.32
		9.1	0.68	5.14	2.99	2.21	1.80	1.20	0.63	0.55	0.50	0.45
		12.2	0.88	6.65	3.86	2.86	2.33	1.55	0.82	0.71	0.65	0.58
		15.2	1.07	7.97	4.63	3.43	2.79	1.89	1.00	0.87	0.79	0.71
		18.3	1.27	9.61	5.58	4.14	3.37	2.25	1.18	1.03	0.94	0.84
		3.1	0.47	DR (1.12)	2.04	1.51	1.23	0.82	0.43	0.38	0.34	0.31
		6.1	0.76	5.50	3.34	2.48	2.01	1.34	0.71	0.61	0.56	0.50
		9.1	1.06	7.98	4.63	3.44	2.80	1.86	0.98	0.85	0.78	0.70
		12.2	1.36	10.29	5.97	4.43	3.61	2.40	1.26	1.10	1.00	0.90
		15.2	1.66	12.31	7.15	5.30	4.32	2.93	1.54	1.34	1.22	1.10
		18.3	1.96	14.82	8.61	6.38	5.20	3.46	1.82	1.58	1.44	1.30
0.4 < S_{max} ≤ 0.6		3.1	0.19	1.42	0.82	0.61	0.50	0.33	0.17	0.15	0.14	0.12
		6.1	0.32	2.44	1.42	1.05	0.85	0.57	0.30	0.26	0.24	0.21
		9.1	0.46	3.46	2.01	1.49	1.21	0.81	0.42	0.37	0.34	0.30
		12.2	0.60	4.51	2.62	1.94	1.58	1.05	0.55	0.48	0.44	0.40
		15.2	0.73	5.44	3.16	2.34	1.91	1.29	0.68	0.59	0.54	0.49
		18.3	0.87	6.59	3.83	2.84	2.31	1.54	0.81	0.70	0.64	0.58
		3.1	0.44	DR (1.67)	1.94	1.44	1.17	0.78	0.41	0.36	0.33	0.29
		6.1	0.73	5.53	3.21	2.38	1.94	1.29	0.68	0.59	0.54	0.49
		9.1	1.02	7.71	4.48	3.32	2.70	1.80	0.95	0.82	0.75	0.68
		12.2	1.32	9.97	5.79	4.29	3.50	2.33	1.23	1.07	0.97	0.88
		15.2	1.61	11.96	6.94	5.15	4.19	2.84	1.49	1.30	1.18	1.07
		18.3	1.91	14.41	8.37	6.21	5.05	3.37	1.77	1.54	1.40	1.27
		3.1	0.70	DR (2.64)	3.06	2.27	1.85	1.23	0.65	0.56	0.51	0.46
		6.1	1.14	DR (4.31)	5.01	3.71	3.02	2.01	1.06	0.92	0.84	0.76
		9.1	1.59	DR (5.99)	6.95	5.15	4.20	2.80	1.47	1.28	1.17	1.05
		12.2	2.04	DR (7.72)	8.96	6.64	5.41	3.61	1.90	1.65	1.50	1.35
		15.2	2.49	DR (9.24)	10.73	7.96	6.48	4.39	2.31	2.01	1.83	1.65

		18.3	2.95	DR (11.12)	12.91	9.58	7.80	5.20	2.73	2.38	2.17	1.95
0.6 < S_{max} ≤ 0.8		3.1	0.25	1.89	1.10	0.81	0.66	0.44	0.23	0.20	0.18	0.17
		6.1	0.43	3.25	1.89	1.40	1.14	0.76	0.40	0.35	0.32	0.29
		9.1	0.61	4.61	2.68	1.99	1.62	1.08	0.57	0.49	0.45	0.40
		12.2	0.80	6.02	3.49	2.59	2.11	1.41	0.74	0.64	0.59	0.53
		15.2	0.98	7.25	4.21	3.12	2.54	1.72	0.91	0.79	0.72	0.65
		18.3	1.16	8.78	5.10	3.78	3.08	2.05	1.08	0.94	0.86	0.77
		3.1	0.59	DR (2.23)	2.59	1.92	1.56	1.04	0.55	0.48	0.43	0.39
		6.1	0.98	DR (3.69)	4.28	3.18	2.58	1.72	0.91	0.79	0.72	0.65
		9.1	1.36	DR (5.14)	5.97	4.43	3.61	2.40	1.26	1.10	1.00	0.90
		12.2	1.76	DR (6.65)	7.72	5.73	4.66	3.11	1.63	1.42	1.29	1.17
		15.2	2.15	DR (7.97)	9.26	6.87	5.59	3.79	1.99	1.73	1.58	1.42
		18.3	2.55	DR (9.61)	11.16	8.28	6.74	4.49	2.36	2.05	1.87	1.69
		3.1	0.93	DR	DR (2.04)	3.03	2.46	1.64	0.86	0.75	0.68	0.62
		6.1	1.52	DR (5.75)	DR (3.34)	4.95	4.03	2.69	1.41	1.23	1.12	1.01
		9.1	2.11	DR (7.98)	DR (4.64)	6.87	5.59	3.73	1.96	1.71	1.55	1.40
		12.2	2.72	DR (10.29)	11.95	8.86	7.21	4.81	2.53	2.20	2.00	1.81
		15.2	3.32	DR (12.32)	14.30	10.61	8.63	5.85	3.08	2.68	2.44	2.20
		18.3	3.93	DR (14.83)	17.22	12.77	10.39	6.93	3.64	3.17	2.89	2.60
0.8 < S_{max} ≤ 1.2		3.1	0.38	2.83	1.65	1.22	0.99	0.66	0.35	0.30	0.28	0.25
		6.1	0.65	4.88	2.83	2.10	1.71	1.14	0.60	0.52	0.47	0.43
		9.1	0.92	6.92	4.02	2.98	2.42	1.62	0.85	0.74	0.67	0.61
		12.2	1.20	9.03	5.24	3.89	3.16	2.11	1.11	0.96	0.88	0.79
		15.2	1.47	10.88	6.32	4.69	3.81	2.59	1.36	1.18	1.08	0.97
		18.3	1.75	13.18	7.65	5.67	4.62	3.08	1.62	1.41	1.28	1.16
		3.1	0.89	DR	DR (1.95)	2.88	2.35	1.56	0.82	0.71	0.65	0.59
		6.1	1.46	DR (5.53)	DR (3.21)	4.76	3.88	2.58	1.36	1.18	1.08	0.97

		9.1	2.04	DR (7.72)	8.96	6.64	5.41	3.61	1.90	1.65	1.50	1.35
		12.2	2.64	DR (9.97)	11.58	8.59	6.99	4.66	2.45	2.13	1.94	1.75
		15.2	3.22	DR (11.96)	13.89	10.30	8.38	5.68	2.99	2.60	2.37	2.13
		18.3	3.82	DR (14.41)	16.74	12.41	10.11	6.74	3.54	3.08	2.81	2.53
		3.1	1.40	DR	DR (3.06)	DR (2.27)	DR (1.85)	2.46	1.30	1.13	1.03	0.93
		6.1	2.28	DR	DR (5.01)	DR (3.72)	6.04	4.03	2.12	1.84	1.68	1.51
		9.1	3.17	DR	DR (6.95)	DR (5.16)	8.39	5.59	2.94	2.56	2.33	2.10
		12.2	4.09	DR	DR (8.96)	DR (6.65)	10.82	7.21	3.79	3.30	3.01	2.71
		15.2	4.97	DR	DR (10.73)	DR (7.96)	12.95	8.78	4.61	4.01	3.66	3.30
		18.3	5.89	DR	DR (12.92)	DR (9.58)	15.59	10.39	5.46	4.75	4.33	3.90
1.2 < S_{max} ≤ 1.6		3.1	0.50	DR (1.89)	2.19	1.63	1.32	0.88	0.46	0.40	0.37	0.33
		6.1	0.86	DR (3.25)	3.78	2.80	2.28	1.52	0.80	0.69	0.63	0.57
		9.1	1.22	DR (4.61)	5.36	3.67	3.23	2.16	1.13	0.99	0.90	0.81
		12.2	1.59	12.03	6.99	5.18	4.22	2.81	1.48	1.29	1.17	1.06
		15.2	1.95	14.51	8.43	6.25	5.09	3.45	1.81	1.58	1.44	1.30
		18.3	2.33	17.57	10.20	7.57	6.16	4.11	2.16	1.88	1.71	1.54
		3.1	1.18	DR	DR (2.59)	DR (1.92)	3.13	2.08	1.10	0.95	0.87	0.78
		6.1	1.95	DR	DR (4.28)	DR (3.18)	5.17	3.45	1.81	1.58	1.44	1.29
		9.1	2.72	DR	DR (5.98)	8.86	7.21	4.81	2.53	2.20	2.00	1.81
		12.2	3.52	DR	DR (7.72)	11.45	9.32	6.21	3.27	2.84	2.59	2.33
		15.2	4.29	DR	DR (9.26)	13.73	11.18	7.58	3.98	3.46	3.16	2.85
		18.3	5.09	DR	DR (11.16)	16.55	13.47	8.98	4.72	4.11	3.74	3.37

		3.1	1.86	DR	DR	DR (3.03)	DR (2.47)	DR	1.73	1.50	1.37	1.23
		6.1	3.05	DR	DR	DR (4.95)	DR (4.03)	5.37	2.82	2.46	2.24	2.02
		9.1	4.23	DR	DR	DR (6.87)	DR (5.60)	7.46	3.92	3.41	3.11	2.80
		12.2	5.45	DR	DR (11.95)	DR (8.86)	DR (7.21)	9.62	5.06	4.40	4.01	3.61
		15.2	6.63	DR	DR (14.31)	DR (10.61)	DR (8.64)	11.70	6.15	5.35	4.88	4.40
		18.3	7.85	DR	DR (17.22)	DR (12.77)	DR (10.40)	13.86	7.29	6.34	5.78	5.21
1.6 < S_{max} ≤ 2.0		3.1	0.63	DR (2.36)	2.74	2.03	1.66	1.10	0.58	0.50	0.46	0.41
		6.1	1.08	DR (4.07)	4.72	3.50	2.85	1.90	1.00	0.87	0.79	0.71
		9.1	1.53	DR (5.77)	6.70	4.96	4.04	2.69	1.42	1.23	1.12	1.01
		12.2	1.99	DR (7.52)	8.74	6.48	5.27	3.52	1.85	1.61	1.47	1.32
		15.2	2.44	DR (9.07)	10.53	7.81	6.36	4.31	2.27	1.97	1.80	1.62
		18.3	2.91	DR (10.98)	12.75	9.46	7.70	5.13	2.70	2.35	2.14	1.93
		3.1	1.48	DR	DR	DR (2.40)	DR (1.96)	2.61	1.37	1.19	1.09	0.98
		6.1	2.44	DR	DR (5.35)	DR (3.97)	DR (3.23)	4.31	2.26	1.97	1.80	1.62
		9.1	3.41	DR	DR (7.47)	DR (5.54)	DR (4.51)	6.01	3.16	2.75	2.50	2.26
		12.2	4.40	DR	DR (9.65)	DR (7.16)	11.65	7.77	4.08	3.55	3.24	2.92
		15.2	5.37	DR	DR (11.08)	DR (8.58)	13.97	9.47	4.98	4.33	3.95	3.56
		18.3	6.36	DR	DR (13.95)	DR (10.35)	16.84	11.23	5.90	5.13	4.68	4.22
		3.1	2.33	DR	DR	DR	DR (3.08)	DR	2.16	1.88	1.71	1.54
		6.1	3.81	DR	DR	DR	DR (5.04)	DR	3.53	3.07	2.80	2.52
		9.1	5.28	DR	DR	DR (8.59)	DR (7.00)	DR	4.90	4.26	3.89	3.50
		12.2	6.81	DR	DR	DR (11.08)	DR (9.02)	12.02	6.32	5.50	5.01	4.51

		15.2	8.29	DR	DR	DR (13.26)	DR (11.00)	14.63	7.69	6.69	6.10	5.49
		18.3	9.82	DR	DR	DR (15.96)	DR (13.00)	17.32	9.11	7.92	7.22	6.51
2.0 < S_{max} ≤ 2.6		3.1	0.81	DR (3.07)	DR (1.79)	2.65	2.15	1.44	0.75	0.66	0.60	0.54
		6.1	1.40	DR (5.28)	DR (3.07)	4.55	3.70	2.47	1.30	1.13	1.03	0.93
		9.1	1.99	DR (7.50)	8.70	6.45	5.25	3.50	1.84	1.60	1.46	1.32
		12.2	2.59	DR (9.78)	11.36	8.42	6.86	4.57	2.40	2.09	1.90	1.72
		15.2	3.18	DR (11.79)	13.69	10.15	8.27	5.60	2.95	2.56	2.34	2.11
		18.3	3.78	DR (14.28)	16.58	12.30	10.01	6.67	3.51	3.05	2.78	2.51
		3.1	1.92	DR	DR	DR	DR (2.54)	DR	1.78	1.55	1.41	1.27
		6.1	3.17	DR	DR	DR (5.16)	DR (4.20)	5.60	2.94	2.56	2.33	2.10
		9.1	4.43	DR	DR	DR (7.20)	DR (5.86)	7.81	4.11	3.57	3.26	2.93
		12.2	5.72	DR	DR	DR (9.31)	DR (7.58)	10.10	5.31	4.62	4.21	3.79
		15.2	6.98	DR	DR (15.05)	DR (11.16)	DR (9.58)	12.31	6.47	5.63	5.13	4.62
		18.3	8.27	DR	DR (18.14)	DR (13.45)	DR (10.95)	14.60	7.67	6.67	6.08	5.48
		3.1	3.03	DR	DR	DR	DR	DR	2.81	2.44	2.23	2.01
		6.1	4.95	DR	DR	DR	DR	DR	4.59	3.99	3.64	3.28
		9.1	6.87	DR	DR	DR	DR (9.09)	DR	6.37	5.54	5.05	4.55
		12.2	8.86	DR	DR	DR	DR (11.72)	DR	8.22	7.14	6.51	5.87
		15.2	10.78	DR	DR	DR	DR (14.03)	DR	10.00	8.69	7.92	7.14
		18.3	12.76	DR	DR	DR	DR (16.89)	DR	11.84	10.30	9.38	8.46

Notes to Table [9.23.13.7.-C] :

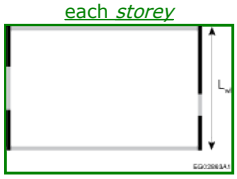
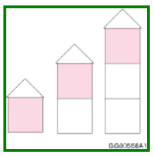
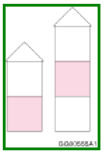
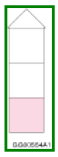
(1) Unadjusted minimum total *braced wall panel* lengths are for the applicable conditions corresponding to an adjustment factor of 1 in the equation for L_s.

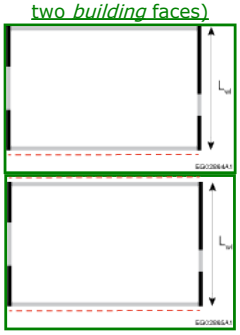
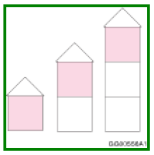
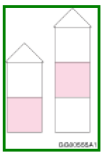
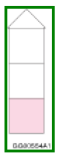
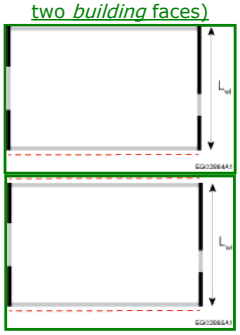
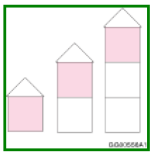
(2) DR = design required, using the procedure outlined in Note A-9.23.13.7.(4) or according to Part 4, for *braced wall panels* with typical sheathing. L_{us} values within round brackets, to which the reduction set out in Sentence (6)-2025 has been applied, are permitted for *braced wall panels* with gypsum board installed on both sides.

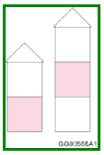
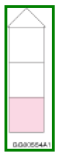
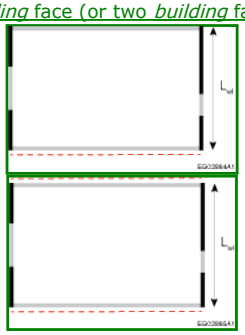
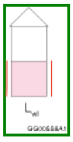
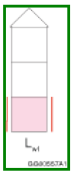
(3) See Sentence 9.23.3.5.(3) for a description of framing types and fastening requirements.

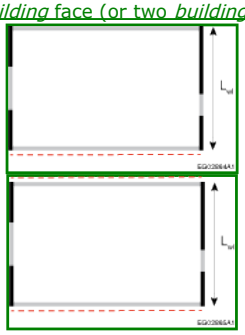
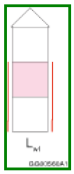
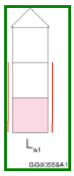
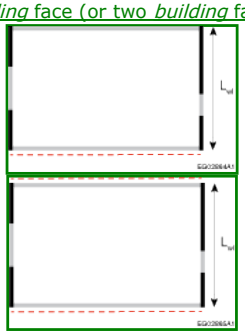
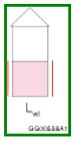
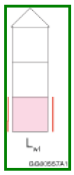
(4) See Sentence (6)-2025 for *braced wall panels* with gypsum board installed on both sides.

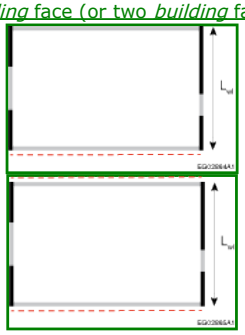
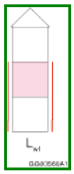
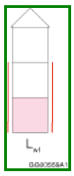
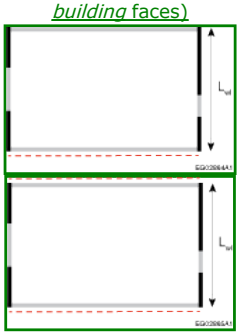
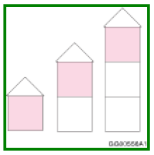
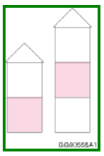
Table [9.23.13.7.-D]
Adjustment Factors for the Determination of Minimum Total Braced Wall Panel Lengths for Seismic Forces
Forming Part of Sentence [9.23.13.7.] -- ([4] --)

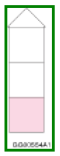
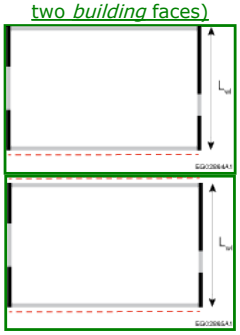
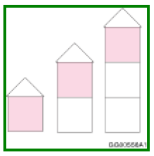
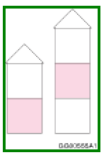
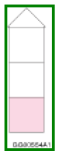
Symbol	Description	*Storey*	Condition	Adjustment Factor
K_{weight} (1) (2)	Normal-weight construction	Any *storey*	Any L_{wl}	1.00
	Heavy construction: apply factor corresponding to L_{wl} separately to each *storey* 	 *Storey* supporting roof only	$L_{wl} \le 3.1$ m	1.72
			$L_{wl} = 6.1$ m	1.54
			$L_{wl} = 9.1$ m	1.46
			$L_{wl} = 12.2$ m	1.42
			$L_{wl} = 15.2$ m	1.39
			$L_{wl} \ge 18.3$ m	1.38
		 *Storey* supporting roof and 1 floor	$L_{wl} \le 3.1$ m	1.92
			$L_{wl} = 6.1$ m	1.71
			$L_{wl} = 9.1$ m	1.62
			$L_{wl} = 12.2$ m	1.57
			$L_{wl} = 15.2$ m	1.54
			$L_{wl} \ge 18.3$ m	1.51
		 *Storey* supporting roof and 2 floors	$L_{wl} \le 3.1$ m	1.97
			$L_{wl} = 6.1$ m	1.76
			$L_{wl} = 9.1$ m	1.67
			$L_{wl} = 12.2$ m	1.61
			$L_{wl} = 15.2$ m	1.58
			$L_{wl} \ge 18.3$ m	1.56
	Masonry veneer half *storey* above *foundation*: apply factor corresponding to one *building* face (or two *building* faces)	*Storey* supporting roof and up to 2 floors	Any L_{wl}	1.00 (1.00)

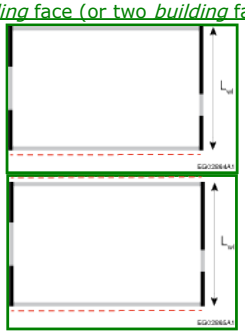
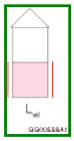
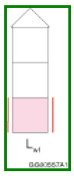
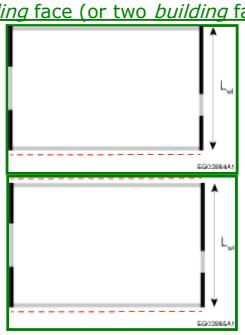
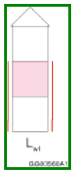
	Masonry veneer cladding perpendicular to *braced wall band*, fully clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof only	$L_{wl} \le 3.1$ m	1.54 (2.13)
			$L_{wl} = 6.1$ m	1.30 (1.64)
			$L_{wl} = 9.1$ m	1.21 (1.45)
			$L_{wl} = 12.2$ m	1.15 (1.34)
			$L_{wl} = 15.2$ m	1.12 (1.28)
			$L_{wl} \ge 18.3$ m	1.10 (1.23)
		 *Storey* supporting roof and 1 floor	$L_{wl} \le 3.1$ m	1.69 (2.43)
			$L_{wl} = 6.1$ m	1.40 (1.85)
			$L_{wl} = 9.1$ m	1.28 (1.60)
			$L_{wl} = 12.2$ m	1.21 (1.46)
			$L_{wl} = 15.2$ m	1.17 (1.38)
			$L_{wl} \ge 18.3$ m	1.14 (1.31)
		 *Storey* supporting roof and 2 floors	$L_{wl} \le 3.1$ m	1.73 (2.51)
			$L_{wl} = 6.1$ m	1.43 (1.91)
			$L_{wl} = 9.1$ m	1.30 (1.65)
			$L_{wl} = 12.2$ m	1.22 (1.50)
			$L_{wl} = 15.2$ m	1.18 (1.41)
			$L_{wl} \ge 18.3$ m	1.15 (1.33)
	Masonry veneer cladding perpendicular to *braced wall band*, partially clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof only	$L_{wl} \le 3.1$ m	1.23 (1.52)
			$L_{wl} = 6.1$ m	1.13 (1.29)
			$L_{wl} = 9.1$ m	1.08 (1.20)
			$L_{wl} = 12.2$ m	1.06 (1.15)
			$L_{wl} = 15.2$ m	1.04 (1.12)
			$L_{wl} \ge 18.3$ m	1.03 (1.09)

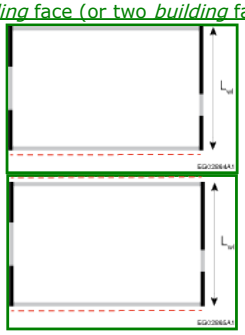
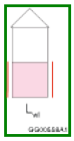
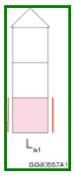
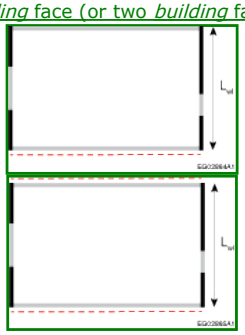
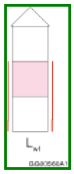
		 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.30 (1.66)
			L_{wl} = 6.1 m	1.17 (1.39)
			L_{wl} = 9.1 m	1.11 (1.27)
			L_{wl} = 12.2 m	1.08 (1.20)
			L_{wl} = 15.2 m	1.06 (1.16)
			L_{wl} ≥ 18.3 m	1.05 (1.13)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.31 (1.70)
			L_{wl} = 6.1 m	1.18 (1.42)
			L_{wl} = 9.1 m	1.12 (1.29)
			L_{wl} = 12.2 m	1.08 (1.21)
			L_{wl} = 15.2 m	1.07 (1.17)
			L_{wl} ≥ 18.3 m	1.05 (1.14)
	Masonry veneer cladding perpendicular to *braced wall band*, 1-*storey* height, partially clad: [3] apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.23 (1.48)
			L_{wl} = 6.1 m	1.13 (1.28)
			L_{wl} = 9.1 m	1.09 (1.20)
			L_{wl} = 12.2 m	1.07 (1.15)
			L_{wl} = 15.2 m	1.06 (1.13)
			L_{wl} ≥ 18.3 m	1.05 (1.10)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.15 (1.30)
			L_{wl} = 6.1 m	1.09 (1.18)
			L_{wl} = 9.1 m	1.06 (1.13)
			L_{wl} = 12.2 m	1.04 (1.10)
			L_{wl} = 15.2 m	1.04 (1.08)
			L_{wl} ≥ 18.3 m	1.03 (1.07)

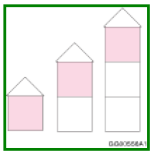
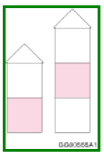
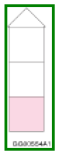
	Masonry veneer cladding perpendicular to *braced wall band*, 2-*storey* height, partially clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.10 (1.22)
			L_{wl} = 6.1 m	1.06 (1.13)
			L_{wl} = 9.1 m	1.04 (1.09)
			L_{wl} = 12.2 m	1.03 (1.07)
			L_{wl} = 15.2 m	1.02 (1.05)
			L_{wl} ≥ 18.3 m	1.02 (1.04)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.19 (1.42)
			L_{wl} = 6.1 m	1.11 (1.25)
			L_{wl} = 9.1 m	1.07 (1.17)
			L_{wl} = 12.2 m	1.05 (1.13)
			L_{wl} = 15.2 m	1.04 (1.10)
			L_{wl} ≥ 18.3 m	1.03 (1.08)
	Masonry veneer cladding perpendicular to *braced wall band*, 1-*storey* height, fully clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.23 (1.48)
			L_{wl} = 6.1 m	1.13 (1.28)
			L_{wl} = 9.1 m	1.09 (1.20)
			L_{wl} = 12.2 m	1.07 (1.15)
			L_{wl} = 15.2 m	1.06 (1.13)
			L_{wl} ≥ 18.3 m	1.05 (1.10)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.15 (1.30)
			L_{wl} = 6.1 m	1.09 (1.18)
			L_{wl} = 9.1 m	1.06 (1.13)
			L_{wl} = 12.2 m	1.04 (1.10)
			L_{wl} = 15.2 m	1.04 (1.08)
			L_{wl} ≥ 18.3 m	1.03 (1.07)

	Masonry veneer cladding perpendicular to *braced wall band*, 2-*storey* height, fully clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.23 (1.48)
			L_{wl} = 6.1 m	1.13 (1.28)
			L_{wl} = 9.1 m	1.09 (1.20)
			L_{wl} = 12.2 m	1.07 (1.15)
			L_{wl} = 15.2 m	1.06 (1.13)
			L_{wl} ≥ 18.3 m	1.05 (1.10)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.44 (1.91)
			L_{wl} = 6.1 m	1.26 (1.55)
			L_{wl} = 9.1 m	1.18 (1.39)
			L_{wl} = 12.2 m	1.13 (1.30)
			L_{wl} = 15.2 m	1.11 (1.24)
			L_{wl} ≥ 18.3 m	1.09 (1.20)
	Stone veneer half *storey* above *foundation*: apply factor corresponding to one *building* face (or two *building* faces)	*Storey* supporting roof and up to 2 floors	Any L_{wl}	1.00 (1.00)
	Stone veneer cladding perpendicular to *braced wall band*, fully clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof only	L_{wl} ≤ 3.1 m	1.95 (2.95)
			L_{wl} = 6.1 m	1.54 (2.13)
			L_{wl} = 9.1 m	1.38 (1.79)
			L_{wl} = 12.2 m	1.28 (1.60)
			L_{wl} = 15.2 m	1.23 (1.49)
			L_{wl} ≥ 18.3 m	1.19 (1.40)
		 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	2.21 (3.48)
			L_{wl} = 6.1 m	1.72 (2.50)
			L_{wl} = 9.1 m	1.51 (2.06)
			L_{wl} = 12.2 m	1.38 (1.82)
			L_{wl} = 15.2 m	1.31 (1.66)

			L_{wl} ≥ 18.3 m	1.26 (1.55)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	2.28 (3.63)
			L_{wl} = 6.1 m	1.77 (2.60)
			L_{wl} = 9.1 m	1.55 (2.14)
			L_{wl} = 12.2 m	1.41 (1.88)
			L_{wl} = 15.2 m	1.33 (1.72)
			L_{wl} ≥ 18.3 m	1.28 (1.60)
	Stone veneer cladding perpendicular to *braced wall band*, partially clad: [3] apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof only	L_{wl} ≤ 3.1 m	1.44 (1.94)
			L_{wl} = 6.1 m	1.25 (1.54)
			L_{wl} = 9.1 m	1.17 (1.37)
			L_{wl} = 12.2 m	1.13 (1.28)
			L_{wl} = 15.2 m	1.10 (1.23)
			L_{wl} ≥ 18.3 m	1.08 (1.18)
		 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.56 (2.19)
			L_{wl} = 6.1 m	1.33 (1.71)
			L_{wl} = 9.1 m	1.22 (1.50)
			L_{wl} = 12.2 m	1.17 (1.38)
			L_{wl} = 15.2 m	1.13 (1.31)
			L_{wl} ≥ 18.3 m	1.11 (1.25)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.59 (2.26)
			L_{wl} = 6.1 m	1.35 (1.76)
			L_{wl} = 9.1 m	1.24 (1.53)
			L_{wl} = 12.2 m	1.18 (1.41)
			L_{wl} = 15.2 m	1.14 (1.33)
			L_{wl} ≥ 18.3 m	1.12 (1.27)

	Stone veneer cladding perpendicular to *braced wall band, 1-storey* height, partially clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.19 (1.40)
			L_{wl} = 6.1 m	1.11 (1.24)
			L_{wl} = 9.1 m	1.07 (1.17)
			L_{wl} = 12.2 m	1.06 (1.13)
			L_{wl} = 15.2 m	1.04 (1.10)
			L_{wl} ≥ 18.3 m	1.04 (1.08)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.12 (1.25)
			L_{wl} = 6.1 m	1.07 (1.15)
			L_{wl} = 9.1 m	1.05 (1.11)
			L_{wl} = 12.2 m	1.04 (1.08)
			L_{wl} = 15.2 m	1.03 (1.07)
			L_{wl} ≥ 18.3 m	1.02 (1.05)
	Stone veneer cladding perpendicular to *braced wall band, 2-storey* height, partially clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	L_{wl} ≤ 3.1 m	1.19 (1.40)
			L_{wl} = 6.1 m	1.11 (1.24)
			L_{wl} = 9.1 m	1.07 (1.17)
			L_{wl} = 12.2 m	1.06 (1.13)
			L_{wl} = 15.2 m	1.04 (1.10)
			L_{wl} ≥ 18.3 m	1.04 (1.08)
		 *Storey* supporting roof and 2 floors	L_{wl} ≤ 3.1 m	1.36 (1.76)
			L_{wl} = 6.1 m	1.21 (1.45)
			L_{wl} = 9.1 m	1.14 (1.32)
			L_{wl} = 12.2 m	1.11 (1.24)
			L_{wl} = 15.2 m	1.09 (1.20)
			L_{wl} ≥ 18.3 m	1.07 (1.16)

	Stone veneer cladding perpendicular to *braced wall band, 1-storey* height, fully clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	$L_{wl} \leq 3.1$ m	1.40 (1.83)
			$L_{wl} = 6.1$ m	1.24 (1.50)
			$L_{wl} = 9.1$ m	1.17 (1.35)
			$L_{wl} = 12.2$ m	1.13 (1.27)
			$L_{wl} = 15.2$ m	1.10 (1.22)
			$L_{wl} \geq 18.3$ m	1.09 (1.18)
		 *Storey* supporting roof and 2 floors	$L_{wl} \leq 3.1$ m	1.26 (1.53)
			$L_{wl} = 6.1$ m	1.15 (1.32)
			$L_{wl} = 9.1$ m	1.11 (1.23)
			$L_{wl} = 12.2$ m	1.08 (1.18)
			$L_{wl} = 15.2$ m	1.07 (1.14)
			$L_{wl} \geq 18.3$ m	1.06 (1.12)
	Stone veneer cladding perpendicular to *braced wall band, 2-storey* height, fully clad: (3) apply factor corresponding to L_{wl} for one *building* face (or two *building* faces) 	 *Storey* supporting roof and 1 floor	$L_{wl} \leq 3.1$ m	1.40 (1.83)
			$L_{wl} = 6.1$ m	1.24 (1.50)
			$L_{wl} = 9.1$ m	1.17 (1.35)
			$L_{wl} = 12.2$ m	1.13 (1.27)
			$L_{wl} = 15.2$ m	1.10 (1.22)
			$L_{wl} \geq 18.3$ m	1.09 (1.18)
		 *Storey* supporting roof and 2 floors	$L_{wl} \leq 3.1$ m	1.77 (2.58)
			$L_{wl} = 6.1$ m	1.46 (1.96)
			$L_{wl} = 9.1$ m	1.33 (1.68)
			$L_{wl} = 12.2$ m	1.25 (1.53)
			$L_{wl} = 15.2$ m	1.20 (1.43)
			$L_{wl} \geq 18.3$ m	1.17 (1.36)

K_{snow} (4)	Roof snow load: apply factor in accordance with the specified roof snow load	 *Storey* supporting roof only	≤ 2kPa	1.00
			3 kPa	1.20
			4 kPa	1.40
			5 kPa	1.60
			6 kPa	1.80
		 *Storey* supporting roof and 1 floor	≤ 2kPa	1.00
			3 kPa	1.10
			4 kPa	1.20
			5 kPa	1.30
			6 kPa	1.40
		 *Storey* supporting roof and 2 floors	≤ 2kPa	1.00
			3 kPa	1.06
			4 kPa	1.10
			5 kPa	1.20
			6 kPa	1.24
$K_{Sspacing}$ (5) (6)	*Braced wall band* spacing: apply factor to all *braced wall panels* per *building* plan direction	Any *storey*	3.8 m	0.60
			7.6 m	1.00
			10.6 m	1.35
			15 m (7)	1.90
$K_{Snumber}$	Number of parallel *braced wall bands*: apply factor to all *braced wall panels* per *building* plan direction	Any *storey*	2	1.00
			3	1.33
			4	1.50
			≥ 5	1.60
K_{gyp}	Interior gypsum board: apply factor in accordance with whether gypsum board is installed or omitted on interior side of *braced wall panels*	Any *storey*	Installed	1.00
			Omitted, blocked wall	1.20
			Omitted, unblocked wall	1.40
K_{sheath}	Intermittent *braced wall panels*: apply factor in accordance with continuity of sheathing within *braced wall band*	Any *storey*	Continuously sheathed	1.00
			Intermittently sheathed	1.15

Notes to Table [9.23.13.7.-D] :

(1) See Sentence 9.23.13.2.(3).

(2) For K_{weight}, linear interpolation between L_{wl} values and between fully clad and partially clad veneer conditions is permitted.

(3) "Fully clad" means that there are no openings, and "partially clad" means 50% or less coverage of an elevation.

(4) For K_{snow}, linear interpolation between roof snow loads is permitted.

(5) For $K_{Sspacing}$, linear interpolation between *braced wall band* spacings is permitted.

(6) An average *braced wall band* spacing is permitted to be used for the determination of $K_{Sspacing}$. See Sentence (5).

(7) A *braced wall band* spacing of 15 m is only permitted in *basements* and crawl spaces.

[5] -- For 3 or more parallel *braced wall bands* that are not evenly spaced, an average *braced wall band* spacing is permitted to be used for the determination of $K_{Wspacing}$ or $K_{Sspacing}$, provided that no single *braced wall band* spacing exceeds 10.6 m, except as provided in Sentence 9.23.13.6.(3)-2025.

[6] -- Where *braced wall panels* of a gypsum-sheathed framing type have gypsum board installed on both sides, the minimum total length of the *braced wall panels* determined in Sentence 9.23.13.7.(3) or (4)-2025 is permitted to be reduced by 50%.

[9.23.13.8.] --- Foundation Cripple Walls

(See Note A-9.23.13.8.)

[1] -- Except as provided in Sentences (2) and (3), *foundation* cripple walls supporting *braced wall panels* shall be

[a] -- considered as an additional *storey*, or

[b] -- designed in accordance with Part 4.

[2] -- Where the seismic design parameter, S_{max}, is not greater than 0.60, *foundation* cripple walls need not comply with Sentence (1), provided they

[a] -- are not more than 1.2 m in height,

[b] -- are not more than 6 m in length,

[c] -- are either

[i] -- framed with solid blocking, or

[ii] -- of the same construction as the *braced wall panels* of the *storey* above but sheathed with wood sheathing regardless of the construction, where the length of the cripple wall bracing is equal to the length of the *braced wall panels* multiplied by an adjustment factor of 1.2, in addition to any adjustments required by Sentences 9.23.13.7.(1) and (2)-2025, and

[d] -- do not support heavyweight construction, masonry veneer or stone veneer.

(See Note A-9.23.13.8.(2).)

[3] -- Where the seismic design parameter, S_{max}, is greater than 0.60, *foundation* cripple walls need not comply with Sentence (1), provided they

[a] -- comply with Clauses (2)(c) and (d),

[b] -- are not more than 350 mm in height, and

[c] -- are not more than 5 m in length.

(See Note A-9.23.13.8.(3).)

[4] -- Where interior finish, such as gypsum board, is omitted from the interior side of the cripple wall referred to in Sentence (2) or (3), the interior gypsum board adjustment factor described in Sentence 9.23.13.7.(3) or (4)-2025 shall be applied to the length of the cripple wall bracing.

[9.23.13.9.] --- Cripple Walls in Stepped Foundations

[1] -- Cripple walls in stepped *foundations* need not be braced in accordance with Sentences 9.23.13.8.(2) to (4), provided

[a] -- the lowest floor framing rests directly on a sill plate anchored to a *foundation* not less than 2.4 m in length within a *braced wall band* not more than 7.6 m in length,

[b] -- the top plate of the cripple wall extends not less than 1.2 m along the *foundation*, and

[c] -- anchor bolts are located not more than 300 mm and 900 mm from the step in the *foundation*.

(See Note A-9.23.13.9.(1).)

[9.23.13.10.] 9.23.13.7. Additional System Considerations

[1] -- This Article applies where

[a] -- the seismic design parameter, S_{max}, is not greater than 1.2, and

[b] -- the 1-in-50-year hourly wind pressure (HWP) is not greater than 1.2 kPa.

[2] 3) Portions of the perimeter of a single open or enclosed space need not comply with Sentence 9.23.13.5.(1), where

[a] a) the roof of the space projects not more than

[i] i) 3.5 m from the face of the framing of the nearest parallel *braced wall band*, and

[ii] ii) the perpendicular plan dimension,

[b] b) that portion of the perimeter structure does not support a floor,

[c] c) the roof of the space is

[i] i) integral with the roof of the rest of the *building* with framing members not more than 400 mm o.c. where roof sheathing edges are not supported on blocking and not more than 600 mm o.c. where roof sheathing edges are supported on blocking securely fastened between framing members, or

[ii] ii) constructed with roof framing not more than 400 mm o.c. where roof sheathing edges are not supported on blocking and not more than 600 mm o.c. where roof sheathing edges are supported on blocking securely fastened between framing members, and fastened to the wall framing (see Table 9.23.3.4. and Article 9.23.9.1. for balloon framing), and

[d] d) the end-joists or end-rafters for the roof of the space are fastened to a 3-ply, 38 mm × 140 mm built-up column or a 5-ply, 38 mm × 89 mm built-up column that is integral with the wall framing.

(See Note A-9.23.13.10.(2).)

[3] 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 9.23.13.5.(1) where these walls do not support a floor.

[4] 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 9.23.13.5.(1), provided

[a] a) the maximum spacing between the front of the garage and the back wall of the garage does not exceed 7.6 m,

[b] b) there is not more than one floor above the garage,

[c] c) not less than 50% of the length of the back wall of the garage is constructed of wood-sheathed *braced wall panels*, and

[d] d) not less than 25% of the length of the side walls is constructed of wood-sheathed *braced wall panels*.

[5] 1) Except as provided in Sentences (~~2~~6) and (~~3~~7)-2025, 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] a) is spaced not more than 10.6 m from the exterior wall of the *storey* below the setback wall,

[b] b) consists of *braced wall panels* that are constructed of a wood-based material in conformance with Sentence 9.23.13.6.(1~~2~~),

[c] c) extends to the *foundation*, and

[d] 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.(3~~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.

[7] 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] 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] b) have their top plate splices fastened with twice the number of nails specified in Sentence~~s~~ 9.23.11.4.~~(4) and~~ (5).

[8] 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.

~~[9] 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] a) consists of *braced wall panels* that are constructed of a wood-based material in conformance with Sentence 9.23.13.6.(2),~~

~~[b] b) extends to the *foundation*, and~~

~~[c] 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).~~

~~[10] 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] a) is spaced not more than 10.6 m from the exterior wall,~~

~~[b] 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] c) extends to the *foundation*, and~~

~~[d] 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).~~

~~[11] 7) Where the length of required *braced wall panels* of an exterior wall is reduced as described in Sentence (10) 2020, 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 exterior *braced wall band* shall not exceed 2.~~

[9.23.13.11.] --- Simplified Approach for Determining Braced Wall Panel Length

[1] --) This Article applies where

[a] --) the seismic design parameter, S_{max}, is not greater than 0.47,

[b] --) the 1-in-50-year hourly wind pressure (HWP) is not greater than 0.6 kPa,

[c] --) the specified roof snow load, as calculated in accordance with Article 9.4.2.2., is not greater than 2 kPa,

[d] --) the plan dimensions of the *building* are each not greater than 21.2 m,

[e] --) the *building* is located in rough terrain, as described in Note A-9.23.13.7.(3) and (4),

[f] --) the greatest eave-to-ridge height of the roof is not greater than 3 m,

[g] --) the *braced wall panels* are constructed with gypsum board on at least one side,

[h] --) the *braced wall bands* are continuously sheathed, and

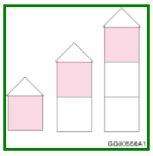
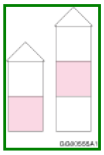
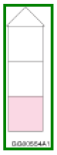
[i] --) the *building* is of normal-weight construction, as defined in Clause 9.23.13.2.(3)(a), except as provided in Sentence (4).

[2] --) Except as provided in Sentence (3), the minimum total length of all *braced wall panels* in each *braced wall band* in each direction shall be determined in accordance with

[a] --) Table 9.23.13.11-A where the seismic design parameter, S_{max}, is not greater than 0.3 and the 1-in-50-year hourly wind pressure (HWP) is not greater than 0.5 kPa, or

[b] --) Table 9.23.13.11-B.

Table [9.23.13.11.-A]
Minimum Total Length of Braced Wall Panels Where HWP ≤ 0.5 kPa and S_{max} ≤ 0.3
Forming Part of Sentence [9.23.13.11.] -- ([2] --)

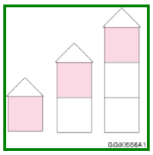
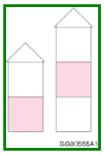
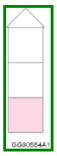
Storey	Minimum Total Length of *Braced Wall Panels*, m									
	Diagonal-Lumber-Sheathed Framing Type (with gypsum board on opposite side) (1)	Gypsum-Sheathed Framing Type (with gypsum board on only one side) (1) (2)				Wood-Sheathed Framing Type (with gypsum board on opposite side) (1)				
	DWB	GWB-A	GWB-B	GWB-C	GWB-D	WSP-A	WSP-B	WSP-C	WSP-D	WSP-E
	1.89	9.47 (4.74)	5.50 (2.75)	4.08 (2.04)	3.32 (1.66)	3.32	1.76	1.53	1.39	1.26
	3.89	19.45 (9.73)	11.30 (5.65)	8.38 (4.19)	6.82 (3.41)	6.82	3.61	3.14	2.86	2.59
	5.88	NP (14.71)	17.09 (8.55)	12.67 (6.34)	10.31 (5.16)	10.31	5.46	4.74	4.33	3.92

Notes to Table [9.23.13.11.-A] :

(1) See Sentence 9.23.3.5.(3) for a description of framing types and fastening requirements.

(2) NP = not permitted. Values within round brackets are permitted for *braced wall panels* with gypsum board installed on both sides.

Table [9.23.13.11.-B]
Minimum Total Length of Braced Wall Panels Where HWP ≤ 0.6 kPa and S_{max} ≤ 0.47
Forming Part of Sentence [9.23.13.11.] -- ([2] --)

Storey	Minimum Total Length of *Braced Wall Panels*, m									
	Diagonal-Lumber-Sheathed Framing Type (with gypsum board on opposite side) (1)	Gypsum-Sheathed Framing Type (with gypsum board on only one side) (1) (2)				Wood-Sheathed Framing Type (with gypsum board on opposite side) (1)				
	DWB	GWB-A	GWB-B	GWB-C	GWB-D	WSP-A	WSP-B	WSP-C	WSP-D	WSP-E
	2.27	11.36 (5.68)	6.60 (3.30)	4.89 (2.45)	3.98 (1.99)	3.98	2.11	1.83	1.67	1.51
	4.66	NP (11.68)	13.56 (6.78)	10.06 (5.03)	8.18 (4.09)	8.18	4.34	3.76	3.44	3.11
	7.05	NP (17.96)	20.86 (10.43)	15.47 (7.74)	12.59 (6.30)	12.37	6.56	5.69	5.19	4.70

Notes to Table [9.23.13.11.-B] :

(1) See Sentence 9.23.3.5.(3) for a description of framing types and fastening requirements.

(2) NP = not permitted. Values within round brackets are permitted for *braced wall panels* with gypsum board installed on both sides.

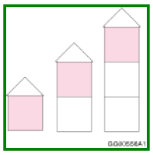
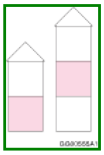
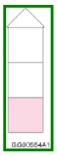
[3] --) Except as provided in Sentence (4), the minimum total length of all *braced wall panels* in each *braced wall band* in the direction perpendicular to a single *building* face partially clad with masonry veneer shall be determined in accordance with

[a] --) Table 9.23.13.11-C where the seismic design parameter, S_{max}, is not greater than 0.3 and the 1-in-50-year hourly wind pressure (HWP) is not greater than 0.5 kPa, or

[b] --) Table 9.23.13.11-D.

Table [9.23.13.11.-C]
Minimum Total Length of Braced Wall Panels in a Braced Wall Band Perpendicular to a Building Face Partially Clad with Masonry Veneer Where HWP ≤ 0.5 kPa and S_{max} ≤ 0.3
Forming Part of Sentence [9.23.13.11.] -- ([3] --)

Storey	Minimum Total Length of *Braced Wall Panels*, m									
	Diagonal-Lumber-Sheathed Framing Type (with gypsum board on opposite side) (1)	Gypsum-Sheathed Framing Type (with gypsum board on only one side) (1) (2)				Wood-Sheathed Framing Type (with gypsum board on opposite side) (1)				
	DWB	GWB-A	GWB-B	GWB-C	GWB-D	WSP-A	WSP-B	WSP-C	WSP-D	WSP-E

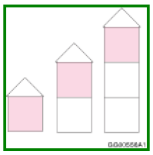
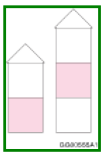
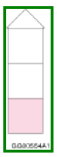
	1.89	9.47 (4.74)	5.50 (2.75)	4.08 (2.04)	3.25 (1.63)	3.32	1.76	1.53	1.39	1.26
	3.89	19.45 (9.73)	11.30 (5.65)	8.38 (4.19)	6.75 (3.37)	6.82	3.61	3.14	2.86	2.59
	5.88	NP (15.01)	17.44 (8.72)	12.93 (6.46)	10.49 (5.25)	10.31	5.46	4.74	4.33	3.92

Notes to Table [9.23.13.11.-C] :

(1) See Sentence 9.23.3.5.(3) for a description of framing types and fastening requirements.

(2) NP = not permitted. Values within round brackets are permitted for *braced wall panels* with gypsum board installed on both sides.

Table [9.23.13.11.-D]
Minimum Total Length of Braced Wall Panels in a Braced Wall Band Perpendicular to a Building Face Partially Clad with Masonry Veneer Where HWP ≤ 0.6 kPa and S_{max} ≤ 0.47
Forming Part of Sentence [9.23.13.11.] -- ([3] --)

Storey	Minimum Total Length of *Braced Wall Panels*, m									
	Diagonal-Lumber-Sheathed Framing Type (with gypsum board on opposite side) (1)	Gypsum-Sheathed Framing Type (with gypsum board on only one side) (1) (2)				Wood-Sheathed Framing Type (with gypsum board on opposite side) (1)				
	DWB	GWB-A	GWB-B	GWB-C	GWB-D	WSP-A	WSP-B	WSP-C	WSP-D	WSP-E
	2.27	13.12 (6.56)	7.63 (3.81)	5.66 (2.83)	4.89 (2.44)	3.98	2.11	1.83	1.67	1.51
	4.66	NP (15.14)	17.59 (8.79)	13.04 (6.52)	10.57 (5.28)	8.18	4.34	3.76	3.44	3.11
	7.05	NP	NP (13.66)	20.27 (10.13)	16.49 (8.24)	12.37	6.56	5.69	5.19	4.70

Notes to Table [9.23.13.11.-D] :

(1) See Sentence 9.23.3.5.(3) for a description of framing types and fastening requirements.

(2) NP = not permitted. Values within round brackets are permitted for *braced wall panels* with gypsum board installed on both sides.

[4] --) Wall portions clad with masonry veneer that are located both perpendicular to a *braced wall band* and within a *braced wall band* are permitted to be considered as normal-weight construction.

[5] --) Bracing to resist lateral loads shall be designed and constructed in accordance with Articles 9.23.13.4. to 9.23.13.6. and 9.23.13.8. to 9.23.13.10.

Note A-9.23.13. Bracing for Resistance to Lateral Loads.

Subsection 9.23.13. along with Articles 9.4.2.5., Article 9.23.3.4., 9.23.3.5., 9.23.6.1., 9.23.9.8., 9.23.11.4., 9.23.15.5., 9.29.5.8., 9.29.5.9., 9.29.6.3. and 9.29.9.3. provide explicit requirements to contain design and bracing provisions that address the resistance of light wood-frame structures and non-structural components to wind and earthquake loads in higher wind and earthquake regions of Canada.

Table [A-9.23.13.-A] A-9.23.13.
Application of Lateral Load Requirements

Applicable Requirements	Wind (HWP)			Earthquake $S_a(0.2)$				
	Low to Moderate	High	Extreme	Low to Moderate	High	Extreme	High	Extreme
	HWP < 0.80 kPa	0.80 ≤ HWP < 1.20 kPa	HWP ≥ 1.20 kPa	$S_a(0.2) \leq 0.70$	$0.70 < S_a(0.2) \leq 1.8$	$S_a(0.2) > 1.8$	$0.70 < S_a(0.2) \leq 1.8$	$S_a(0.2) > 1.8$
	All Construction			All Construction	Heavy Construction (1)		Light Construction	
Design requirements in 9.23.16.2., 9.27., 9.29.	X (2)	N/A	N/A	X	N/A	N/A	N/A	N/A
Bracing requirements in 9.23.13.	X	X	N/A	X	X (3) (4)	N/A	X (4) (5)	N/A
Part 4 or CWC Guide	X	X	X	X	X	X	X	X
X = requirements are applicable								

Notes to Table [A-9.23.13.-A] A-9.23.13.:

(1) See Note A-9.23.13.2.(1)(a)(i).

(2) Requirements apply to exterior walls only.

(3) Requirements apply where lowest exterior frame walls support not more than one floor.

(4) All constructions may include the support of a roof in addition to the stated number of floors.

(5) Requirements apply where lowest exterior frame walls support not more than two floors.

The bracing provisions were developed based on a combination of performance history and engineering calculations, as are most Part 9 provisions. The placement and construction methods for braced walls were determined by the following approach. The lateral forces were analyzed in accordance with Part 4 for various configurations of buildings in different locations across Canada. The lateral resistance of walls was established using an approach adapted from CSA O86, "Engineering Design in Wood." Construction details and required lengths for braced walls were determined based on location, building height, wind exposure and construction weight. This approach relied on the following assumptions:

• A short-term load duration factor, K_D, of 1.25 was used for the calculation of resistance to wind and seismic shear forces.

• The ductility- and overstrength-related force modification factors, R_d and R_o, were assumed to have the values listed in the following table:

Seismic Force Resisting System (SFRS)	R_d	R_o
Nailed or screwed wood-based shear walls in combination with gypsum board	3.0	1.7
Nailed or screwed diagonal lumber board shear walls in combination with gypsum board	3.0	1.7
Nailed or screwed gypsum board shear walls	2.0	1.7

• A level of resistance of up to 50% of the wind or seismic lateral load demand was assumed to be provided by interior partitions and other non-structural components, such as cabinetry and cladding.

It is important to note that not all buildings satisfying the bracing provisions will have the configurations or details assumed in the calculations, which are necessary to provide adequate resistance against lateral loads. For example, buildings with a limited number of interior partitions and other non-structural components may have a lower lateral resistance than predicted. In such cases, the Part 9 provisions for bracing to resist lateral loads may not be adequate to satisfy the objectives of the NBC, and bracing requirements should instead be determined in accordance with Part 4.

See Note A-9.4.2.5. for more information on the seismic design parameter, S_{max}, used in the seismic design provisions.

~~Note A-9.23.13.1.~~

~~Bracing to Resist Lateral Loads in Low Load Locations~~

~~Of the 679 locations identified in Appendix C, 614 are locations where the seismic spectral acceleration, $S_a(0.2)$, is less than or equal to 0.70 and the 1-in-50 hourly wind pressure is less than 0.80 kPa. For buildings in these locations, Sentence 9.23.13.1.(2) requires only that exterior walls be braced using the acceptable materials and fastening specified. There are no spacing or dimension requirements for braced wall panels in these buildings.~~

~~Structural Design for Lateral Wind and Earthquake Loads~~

~~In cases where lateral load design is required, CWC 2014, "Engineering Guide for Wood Frame Construction", provides acceptable engineering solutions as an alternative to Part 4. The CWC Guide also contains alternative solutions and provides information on the applicability of the Part 9 prescriptive structural requirements to further assist designers and building officials to identify the appropriate design approach.~~

Note A-9.23.13.2.(3~~1~~)~~(a)(i)~~ ~~Heavy~~Weight of Construction and Cladding.

Normal-Weight Construction

Normal-weight floor construction (with a maximum average dead weight of 0.5 kPa) accommodates ceramic tile, hardwood, carpet and other finishes weighing no more than 0.25 kPa. Normal-weight roof construction (with a maximum average dead weight of 0.5 kPa) accommodates asphalt shingles, wood shingles, steel roofing and other roofing weighing no more than 0.12 kPa. Normal-weight exterior wall construction (with a maximum average dead weight of 0.4 kPa) accommodates fibre-cement board, wood, vinyl, lightweight metal panels and other cladding weighing no more than 0.10 kPa.

These finish, roofing and cladding weights are based on typical light wood-frame construction where

- floor assemblies include a plywood subfloor, 38 mm by 286 mm lumber floor joists spaced at 400 mm o.c., and a gypsum board ceiling;
- roof assemblies include plywood roof sheathing, trusses, RSI 10.6 (R60) insulation, and a gypsum board ceiling; and
- wall assemblies include OSB exterior sheathing, strapping, 38 mm by 140 mm studs spaced at 400 mm o.c., insulation, and gypsum board interior finish.

Heavyweight Construction

In a building of "heavyweight construction," the average dead weight per storey of the floors, roof or exterior walls is permitted to exceed the value stated in Clause 9.23.13.2.(3)(a), but must not exceed the maximum average dead weight per storey stated in Clause 9.23.13.2.(3)(b). The three possible cases are described in Table A-9.23.13.2.(3).

Heavyweight floor construction, which allows for an additional average dead weight of 1.0 kPa compared to normal-weight floor construction, accommodates a 38 mm thick normal-weight concrete topping, for example. Heavyweight roof construction accommodates slate or clay tile shingles weighing up to 0.65 kPa (provided they are not installed over existing normal-weight roofing). Heavyweight roof construction also accommodates the installation of solar panels (which weigh approximately 0.12 kPa) over normal-weight roofing such as asphalt shingles. Heavyweight wall construction, which allows for cladding weighing up to 0.85 kPa, accommodates cementitious stucco, heavier weight metal panels and, if averaged with lighter claddings, adhered manufactured or natural stone veneer. Heavyweight wall construction does not accommodate masonry or stone veneer, unless it is averaged with lighter claddings using an "area-weighted average," as explained below.

Table [9.23.13.2.(31)(a)(i)] A-9.23.13.2.(3)
Maximum Average Dead Weights per Storey for Heavyweight Construction
Forming Part of Note A-9.23.13.2.(3)

Description of Heavyweight Construction	Maximum Average Dead Weight per Storey, kPa			
	Floors	Partitions and Interior Walls	Roof	Exterior Walls
Normal-weight floors and roof with heavyweight exterior walls	0.5	0.5	0.5	1.2
Normal-weight floors and exterior walls with heavyweight roof	0.5	0.5	1.0	0.4
Normal-weight exterior walls and roof with heavyweight floors	1.5	0.5	0.5	0.4

Masonry or Stone Veneer Wall Cladding

Clay brick, concrete block, concrete brick, concrete stone and calcium silicate masonry veneers with a bed thickness of not more than 90 mm are considered to meet the weight limit of 1.9 kPa provided in Clause 9.23.13.2.(3)(c) for buildings clad with masonry veneer.

Natural stone veneers of limestone and sandstone (but not granite) with a bed thickness of not more than 125 mm are considered to meet the weight limit of 3.2 kPa provided in Clause 9.23.13.2.(3)(d) for buildings clad with stone veneer.

Area-Weighted Average

An "area-weighted average" can be used to determine the average dead weight per storey of a building's walls, floors or roof. The area-weighted average is calculated for each assembly by averaging the weights of materials, weighted by their respective areas, over the total area of the assembly.

For instance, using an area-weighted average, wall cladding weights can be averaged over exterior wall areas to determine whether the exterior walls are of normal-weight or heavyweight construction according to Sentence 9.23.13.2.(3). Exterior walls that are partially clad with heavier materials, such as stucco, masonry veneer or stone veneer, may qualify as normal-weight construction if an area-weighted average of the cladding weights does not exceed 0.4 kPa per storey or as heavyweight construction if the area-weighted average does not exceed 1.2 kPa per storey. The same approach can be applied to floor and roof assemblies.

For example, if a floor has a total area of 400 m^2, of which 25 m^2 has a concrete topping (floor assembly weight of 1.25 kPa) and the remaining 375 m^2 has hardwood floors (floor assembly weight of 0.45 kPa), the area-weighted average dead weight per storey is calculated as follows:

$$\frac{(1.25\ \text{kPa})\left(25\ \text{m}^2\right) + (0.45\ \text{kPa})\left(375\ \text{m}^2\right)}{400\ \text{m}^2} = 0.5\ \text{kPa}$$

With an average dead weight per storey of 0.5 kPa, the floor qualifies as normal-weight construction.

~~"Heavy construction" refers to buildings with tile roofs, stucco walls or floors with concrete topping, or that are clad with directly-applied heavyweight materials.~~

~~Heavyweight construction assemblies increase the lateral load on the structure during an earthquake. Assemblies should be considered as heavyweight where their average dead weight is as follows (an additional partition weight of 0.5 kPa per floor is assumed):~~

- ~~floor: 0.5 to 1.5 kPa~~
- ~~roof: 0.5 to 1.0 kPa~~
- ~~wall (vertical area): 0.32 to 1.2 kPa~~

Note A-9.23.13.4. Braced Wall Bands.

Article 9.23.13.4. specifies the required characteristics of braced wall bands and their position in the building. Figures A-9.23.13.4.-A, A-9.23.13.4.-B and A-9.23.13.4.-C illustrate these requirements.

Figure [A-9.23.13.4.-A] A-9.23.13.4.-A
Braced wall bands in an example building section ~~([~~Clauses 9.23.13.4.(1)~~(a),~~ (b), (c) and (e~~d~~)-2025)~~]~~

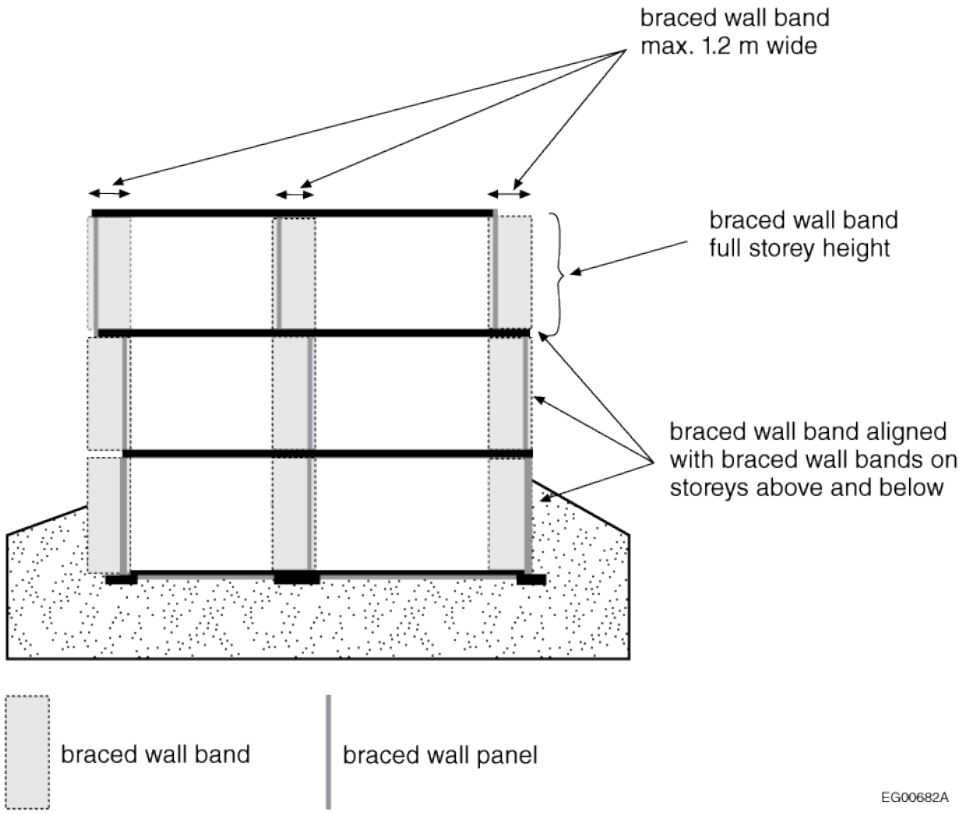


Figure [A-9.23.13.4.-B] A-9.23.13.4.-B
Lapping bands and building perimeter within braced wall bands ({[Clauses 9.23.13.4.(1)(~~c~~a) and (d)-2025~~Sentence 9.23.13.4.(2)~~]})

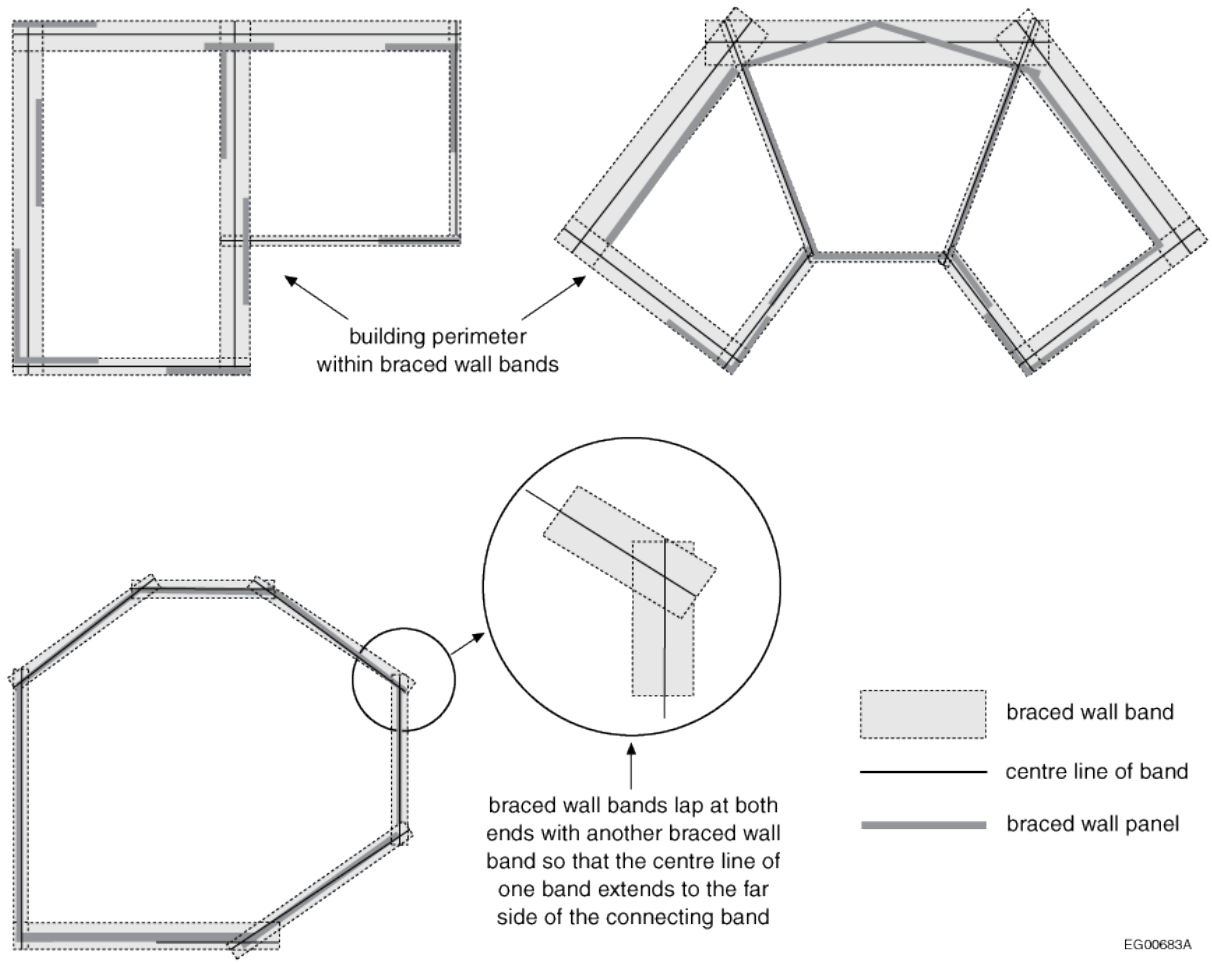
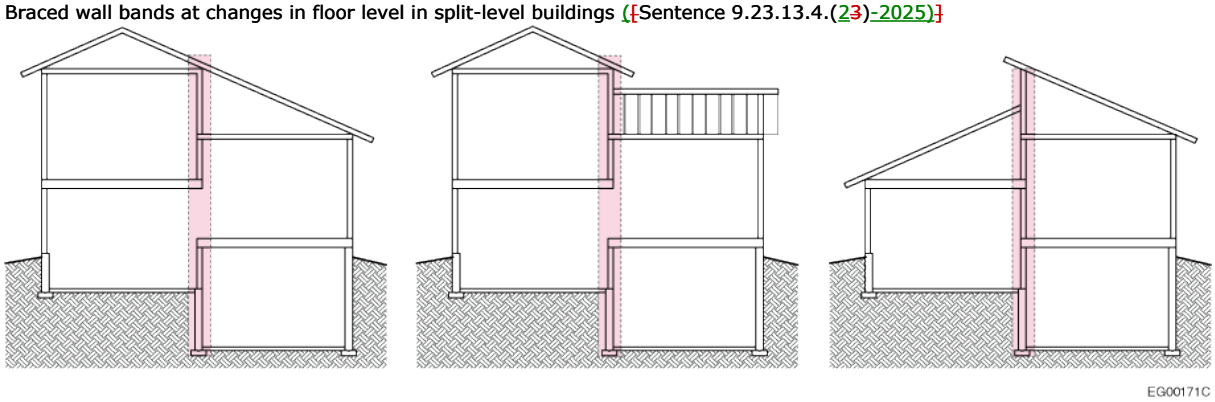


Figure [A-9.23.13.4.-C] A-9.23.13.4.-C
Braced wall bands at changes in floor level in split-level buildings ({Sentence 9.23.13.4.(2~~3~~)-2025)}



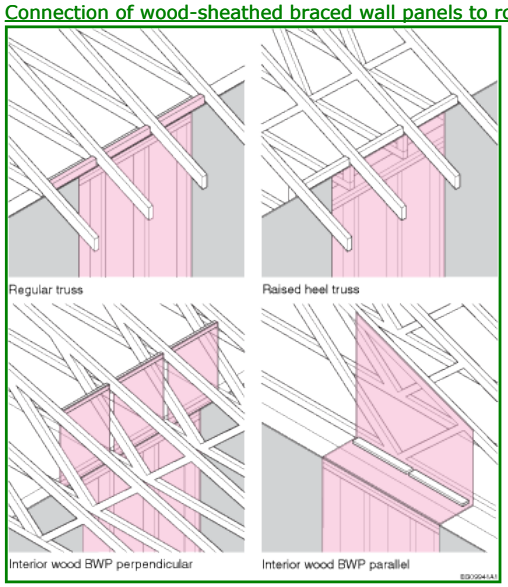
Note A-9.23.13.5.(3) and (4) Connection of Braced Wall Panels to Roof Framing.

Braced wall panels that are sheathed with gypsum board alone have a significantly lower lateral resistance than wood-sheathed braced wall panels. For gypsum-sheathed braced wall panels, the typical lateral bracing of trusses is usually adequate to transfer the lateral loads from the bottom chords to the top chords of the truss.

The connection of interior gypsum-sheathed braced wall panels to trusses also needs to accommodate vertical movement of the roof framing in order to facilitate "truss uplift" and to prevent the gypsum board from cracking.

The connection of interior or exterior wood-sheathed braced wall panels (BWP), other than panels of WSP-A framing type, to roof framing is illustrated in Figure A-9.23.13.5.(3) and (4).

Figure [A-9.23.13.5.(3) and (4)]
Connection of wood-sheathed braced wall panels to roof framing (Sentence 9.23.13.5.(3)-2025)



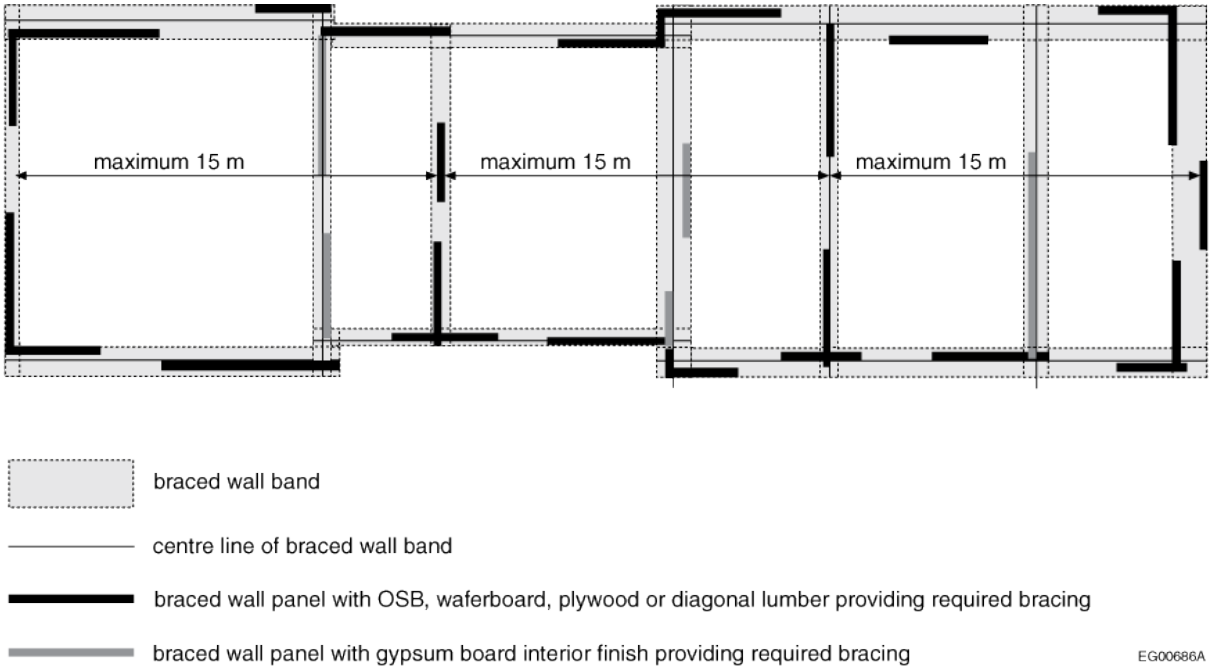
Note A-9.23.13.6.(1) Materials in Braced Wall Panels.

Clause 9.23.13.6.(1)(a)-2025 describes wood-based exterior braced wall panels that are finished on the interior side with gypsum board fastened in accordance with Subsection 9.29.5.; these panels correspond to framing types WSP-A, WSP-B, WSP-C, WSP-D, WSP-E and DWB, with framing type GWB-O on the interior side, as specified in Table 9.23.3.5.-C. Clause 9.23.13.6.(1)(b)-2025 describes exterior braced wall panels that are sheathed with gypsum board only, corresponding to framing types GWB-O, GWB-A, GWB-B, GWB-C and GWB-D, as specified in Table 9.23.3.5.-C. Such panels are typically applied to the interior side of exterior walls to allow the option of not using wood-based structural sheathing on the exterior side of the walls.

Note A-9.23.13.6.(3~~5~~) ~~and (6)~~ Use of Gypsum Board ~~Interior Finish~~ to Provide Required Bracing.

Braced wall panels constructed with gypsum board alone provide less resistance to lateral loads than panels constructed with OSB, waferboard, plywood or diagonal lumber board.~~;~~ ~~Sentence (5)~~Sentence 9.23.13.6.(3)-2025 ~~therefore~~ limits the use of gypsum board ~~to interior walls. Sentence (6) further limits its use~~ to provide the required lateral resistance by requiring that walls in basements and crawl spaces~~not more than 15 m apart~~ be constructed with braced wall panels made of ~~wood or~~ wood-based sheathing at braced wall band spacing intervals of not more than 15 m~~.~~ (s~~S~~ee Figure A-9.23.13.6.(3~~5) and (6~~)).

Figure [A-9.23.13.6.(35) and (6)] A-9.23.13.6.(5) and (6)
Braced wall panels constructed of wood-based ~~material~~sheathing in basements and crawl spaces



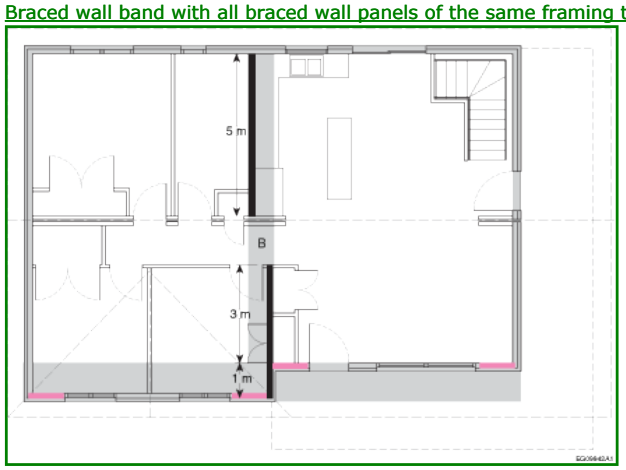
Note A-9.23.13.6.(5) Mixing of Braced Wall Panel Framing Types in Braced Wall Bands.

The primary reason for mixing braced wall panel framing types in braced wall bands is to accommodate situations where an interior panel of a GWB framing type aligns with an exterior panel of a WSP framing type along the same braced wall band. Clause 9.23.13.6.(5)(a)-2025 permits panels of a GWB framing type to be mixed with panels of "low-strength" WSP-A or WSP-B framing type. Mixing of high-strength or very stiff walls with low-strength or less stiff walls requires analysis based on accepted engineering principles (Clause 9.23.13.6.(5)(b)-2025), as this type of mixing has not been sufficiently studied.

The following example is provided to assist in the application of Clause 9.23.13.6.(5)(a)-2025. Figures A-9.23.13.6.(5)-A and A-9.23.13.6.(5)-B illustrate the same braced wall band (B) without and with mixed braced wall panel framing types, respectively.

In Figure A-9.23.13.6.(5)-A, the braced wall band (B) consists of an exterior wall with a length of 1 m, which continues into the building as a first interior wall with a length of 3 m and a second interior wall with a length of 5 m for a total wall length of 9 m. The wall construction along the braced wall band qualifies as braced wall panels of GWB-B framing type. For this example, it is determined according to Article 9.23.13.7. that a total length of braced wall panels of at least 8 m is required for the GWB-B framing type. Therefore, the wall length of 9 m is sufficient to satisfy this requirement.

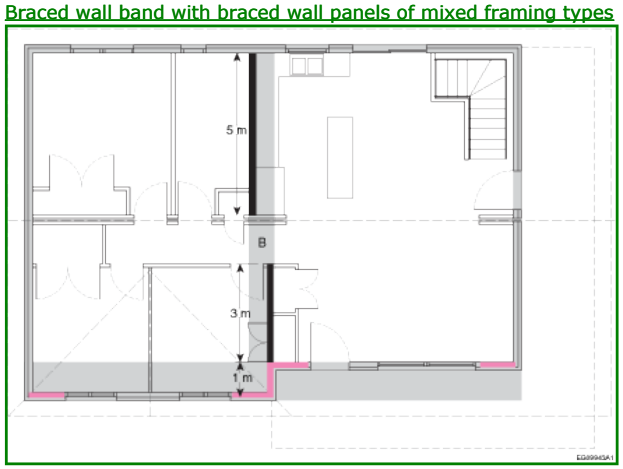
Figure [A-9.23.13.6.(5)-A]
Braced wall band with all braced wall panels of the same framing type



In Figure A-9.23.13.6.(5)-B, the exterior walls are constructed with braced wall panels of WSP-A framing type. The builder would like to substitute WSP-A framing type for GWB-B framing type in the 1 m exterior wall portion of the braced wall band

(B). Clause 9.23.13.6.(5)(a)-2025 permits such a substitution, as long as the total length of braced wall panels is determined based on the GWB-B framing type. As mentioned above, in this example, the required total length of braced wall panels is 8 m for this framing type. Therefore, the total wall length of 9 m (1 m (WSP-A) + 3 m (GWB-B) + 5 m (GWB-B)) is sufficient to meet the requirement.

Figure [A-9.23.13.6.(5)-B]
Braced wall band with braced wall panels of mixed framing types



Note A-9.23.13.7.(3) Alternative Procedure for Calculating L_w.

To facilitate the calculation of the minimum total length of braced wall panels for resistance to wind, L_w, unadjusted minimum total braced wall panel lengths, L_{uw}, are provided in Table 9.23.13.7.-A for various ranges of 1-in-50-year hourly wind pressure (HWP), in kPa. The L_{uw} values are based on the highest HWP in each range and must be adjusted by the factors provided in Table 9.23.13.7.-C.

In lieu of following this procedure, L_w may be calculated directly using the following equation:

$$L_w = C_{Wstorey} K_{Wframe} HWP(K_{exp} K_{roof} K_{Wspacing} K_{Wnumber} K_{gyp} K_{sheath}) \geq BWP_{min}$$

where:

$C_{Wstorey}$ = coefficient for storey location for wind,
= 3.84 for braced wall panels supporting a roof only,
= 7.89 for braced wall panels supporting a roof and 1 floor, and
= 11.93 for braced wall panels supporting a roof and 2 floors,

K_{Wframe} = framing type adjustment factor for wind, as provided in Table A-9.23.13.7.(3), and

K_{exp}, K_{roof}, $K_{Wspacing}$, $K_{Wnumber}$, K_{gyp}, K_{sheath}, BWP_{min} = as defined in Sentence 9.23.13.7.(3).

Table A-9.23.13.7.(3) provides framing type adjustment factors for wind and for seismic forces, K_{Wframe} and K_{Sframe}, along with factored shear resistance values based on CSA O86, "Engineering design in wood," for the reference framing types specified in Table 9.23.3.5.-C. This information can be used to calculate the minimum total length of braced wall panels for wind or for seismic forces, L_w or L_s, using the alternative calculation procedure set out in this Note or in Note A-9.23.13.7.(4).

Table [9.23.13.7.(3)] A-9.23.13.7.(3)
Framing Type Adjustment Factors and Factored Shear Resistance Values

Reference Framing Type	K_{Wframe}	K_{Sframe} (1) (2)	Factored Shear Resistance, kN/m (3) (4)
GWB-O (interior side of WSP and DWB framing types)	–	–	0.61
GWB-A	2.85	4.28	1.15
GWB-B	1.65	2.48	1.98
GWB-C	1.23	1.84	2.67
GWB-D	1.00	1.50	3.28

WSP-A	1.00	1.00	3.28
WSP-B	0.53	0.53	6.22
WSP-C	0.46	0.46	7.15
WSP-D	0.42	0.42	7.85
WSP-E	0.38	0.38	8.71
DWB	0.57	0.57	5.77

Notes to Table [9.23.13.7.(3)] A-9.23.13.7.(3):

(1) See Note A-9.23.13.7.(4).

(2) K_{Sframe} accounts for the difference in ductility-related force modification factor, R_d, for WSP (R_d = 3) and GWB (R_d = 2) framing types.

(3) Factored shear resistance values for WSP and DWB framing types include a contribution of 0.61 kN/m from GWB-O installed on opposite side of the *braced wall panel*. The value for the DWB framing type is based on spruce-pine-fir (SPF) studs and northern species diagonal lumber boards. Compared to CSA O86, "Engineering design in wood," the value for the WSP-C framing type was reduced by a factor of 0.20, the value for the WSP-D framing type was reducd by a factor of 0.30, and the value for the WSP-E framing type was reduced by a factor of 0.40, to account for the absence of hold-downs.

(4) Factored shear resistance values for GWB framing types are derived from allowable stress shear resistance values (average peak shear divided by safety factor of 3), soft converted to specified shear resistances, consistent with the practice used in CSA O86, "Engineering design in wood." The resulting factored resistance values are determined in the same way as for WSP framing types, except that a resistance factor of 0.7 is applied for GWB framing types instead of the factor of 0.8 applicable to WSP framing types.

If the value of L_w calculated by either the procedure set out in Sentence 9.23.13.7.(3) or the alternative calculation procedure exceeds the available wall length, a stronger framing type or a closer braced wall band spacing may be considered.

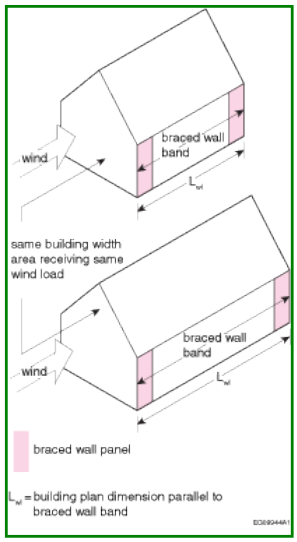
Note A-9.23.13.7.(3) and (4) Factors in Determining L_w and L_s.

Parallel Building Plan Dimension

The equations provided in Sentences 9.23.13.7.(3) and (4)-2025 are used to calculate the minimum total length of braced wall panels, L_w or L_s, within a braced wall band parallel to the direction of the wind or seismic forces.

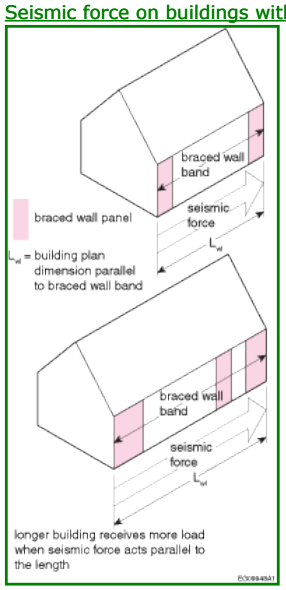
For resistance to wind, the building plan dimension (length) parallel to the direction of the wind is irrelevant to determining the amount of bracing required. As shown in Figure A-9.23.13.7.(3) and (4)-A, a building with a smaller length receives the same wind force as a building of the same width with a larger length. Therefore, in calculating L_w, the braced wall band spacing along the building width needs to be considered, but the building length does not.

Figure [A-9.23.13.7.(3) and (4)-A]
Wind force on buildings with different lengths



In contrast, for resistance to seismic forces, the building plan dimension (length) parallel to the direction of the seismic force is the most important consideration in determining the amount of bracing required. The force demand exerted on a building by seismic motion is directly proportional to the building's mass, which is generally evenly distributed along its length and width. As shown in Figure A-9.23.13.7.(3) and (4)-B, a building with a larger length has more mass—and thus receives greater seismic force—than a building of the same width with a smaller length. Therefore, a longer building will require a larger amount of bracing. The calculated value of L_w is highly dependent on the building length and is less dependent on the building width.

Figure [A-9.23.13.7.(3) and (4)-B]
Seismic force on buildings with different lengths



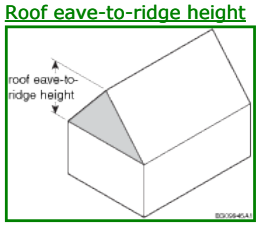
Wind Exposure (L_w only)

K_{exp} accounts for the effects of the local terrain where the building in located. Rough terrain, defined as urban, suburban or wooded terrain extending upwind from the building uninterrupted for a least 1 km, offers a sheltered exposure. A building located in open terrain, defined as level terrain with only scattered trees, buildings or other obstructions, open water or shorelines, will experience a higher wind load than would the same building located in rough terrain and will require a larger amount of bracing.

Roof Eave-to-Ridge Height (L_w only)

K_{roof} accounts for the effects of the roof eave-to-ridge height, as illustrated in Figure A-9.23.13.7.(3) and (4)-C.

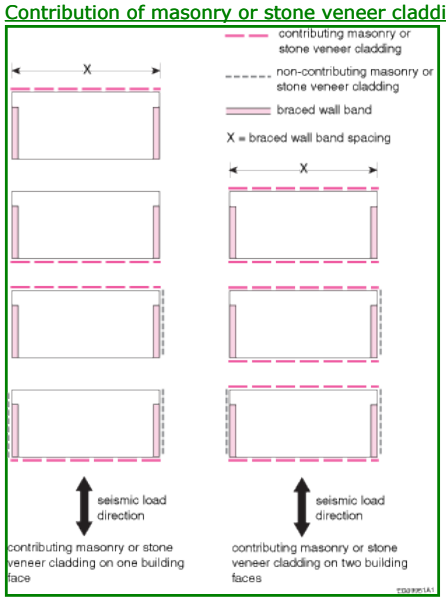
Figure [A-9.23.13.7.(3) and (4)-C]
Roof eave-to-ridge height



Weight of Construction and Cladding (L_s only)

K_{weight} accounts for construction weights higher than normal-weight construction, since heavier buildings generate higher seismic loads. The value of K_{weight} depends on the building's weight of construction and on the presence of masonry or stone veneer cladding on one or two building faces. As illustrated in Figure A-9.23.13.7.(3) and (4)-D, only veneer cladding on building faces perpendicular to the direction of the seismic motion is assumed to contribute to the seismic load.

Figure [A-9.23.13.7.(3) and (4)-D]
Contribution of masonry or stone veneer cladding to seismic loading



Braced wall panels that run perpendicular to masonry- or stone-veneer-clad walls must have a higher lateral strength to resist the increased lateral loading due to the higher mass of the veneer-clad walls. Under seismic action perpendicular to the veneer-clad walls, the lateral load due to the mass of the masonry or stone veneer is transferred into the wall immediately behind the veneer. The load is then transferred, via the load path and diaphragm action, into the roof and floors, and is resisted by the braced wall panels oriented parallel to the seismic motion.

Therefore, only braced wall panels running perpendicular to the masonry- or stone-veneer-clad walls are required to be adjusted by K_{weight}. If the entire building is clad with masonry or stone veneer, all braced wall panels are required to be adjusted by the appropriate K_{weight} value for "both building faces." If only two parallel faces of a four-sided building are clad with masonry or stone veneer, only the two braced wall panels perpendicular to those faces are required to be adjusted by the appropriate K_{weight} value for "both building faces." If only one face of the building is clad with masonry or stone veneer, the two braced wall panels perpendicular to that face are required to be adjusted by the appropriate K_{weight} value for "one building face."

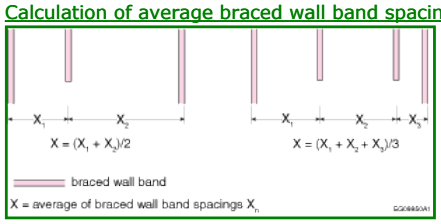
Roof Snow Load (L_s only)

K_{snow} accounts for the effects of a specified roof snow load larger than 2 kPa.

Braced Wall Band Spacing

$K_{Wspacing}$ and $K_{Sspacing}$ account for the effects of the spacing between braced wall bands, X. When the spacing between three or more parallel braced wall bands is not uniform, the average spacing may be used in lieu of the largest spacing for the determination of $K_{Wspacing}$ and $K_{Sspacing}$, as set out in Sentence 9.23.13.7.(5) and illustrated in Figure A-9.23.13.7.(3) and (4)-E.

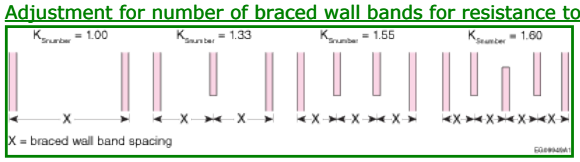
Figure [A-9.23.13.7.(3) and (4)-E]
Calculation of average braced wall band spacing



Number of Parallel Braced Wall Bands

$K_{Wnumber}$ and $K_{Snumber}$ account for the effects of having more than two braced wall bands resist the wind or seismic load, as illustrated for $K_{Snumber}$ in Figure A-9.23.13.7.(3) and (4)-F. Since the total minimum braced wall panel lengths are determined based on the braced wall band spacing, the $K_{Wnumber}$ and $K_{Snumber}$ is needed to account for the actual distribution of loads over the braced wall bands.

Figure [A-9.23.13.7.(3) and (4)-F]
Adjustment for number of braced wall bands for resistance to seismic forces



For example, consider a building 15 m wide with one interior and two exterior braced wall bands at a spacing of 7.5 m. A uniform seismic load of 10 kN/m is applied to the width area of the building. Equally distributing this seismic load to the three braced wall bands results in a force distribution of (10 kN/m × 15 m)/3 = 50 kN per braced wall band. However, based on the braced wall band spacing of 7.5 m, each braced wall band would receive only (10 kN/m × 7.5 m)/2 = 37.5 kN per braced wall band. $K_{Snumber}$ corrects the calculated minimum total braced wall panel length by applying, for 3 braced wall bands, a factor of 50 kN/37.5 kN = 1.33. As the number of braced wall bands increases, the effect diminishes.

The same explanation applies for $K_{Wnumber}$, except that the wind forces are not evenly distributed because the critical load case occurs when the wind blows at an angle to the building. As a result, the $K_{Wnumber}$ values differ slightly from the $K_{Snumber}$ values.

Interior Gypsum Board

K_{gyp} accounts for the effects of omitting gypsum board from the interior side of braced wall panels. If gypsum board is omitted, the minimum total braced wall panel length is increased.

Intermittent Braced Wall Panels

K_{sheath} accounts for the effects of intermittent sheathing of braced wall bands. Where the braced wall band is intermittently sheathed, the minimum total braced wall panel length is increased. In braced wall bands with intermittent braced wall panels, non-structural sheathing may be used for wall segments where bracing is not required (Figure A-9.23.13.7.(3) and (4)-G). The K_{sheath} factor adjusts for the lack of additional resistance that would have been provided by structural sheathing above and below openings and on other wall segments not designated as braced wall panels if the entire braced wall band were continuously sheathed (Figure A-9.23.13.7.(3) and (4)-H).

Figure [A-9.23.13.7.(3) and (4)-G]
Intermittent braced wall panels in braced wall bands

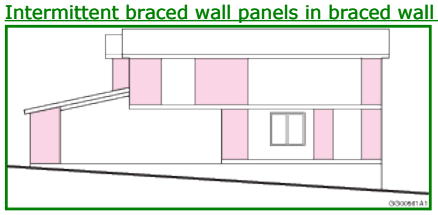
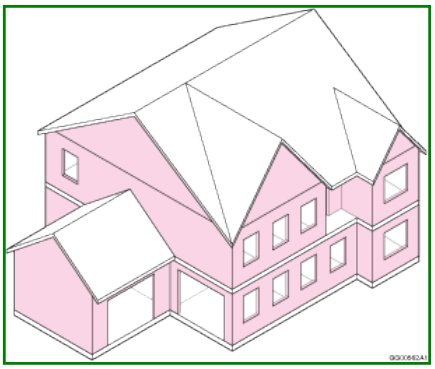


Figure [A-9.23.13.7.(3) and (4)-H]
Continuously sheathed braced wall bands



In continuously wood-sheathed braced wall bands, wall segments not designated as braced wall panels must be constructed with wood sheathing, but must not necessarily be constructed with the same sheathing and fastening as used in the designated braced wall panels. Instead, the non-designated wall segments may be constructed with any of the wood sheathing element options (plywood, OSB, or waferboard) and corresponding fastening as specified in Table 9.23.3.5.-A, anchored in accordance with Sentence 9.23.6.1.(2).

Note A-9.23.13.7.(4) Alternative Procedure for Calculating L_s.

To facilitate the calculation of the minimum total length of braced wall panels for resistance to seismic forces, L_s, unadjusted minimum total braced wall panel lengths, L_{us}, are provided in Table 9.23.13.7.-C for various ranges of seismic design parameter, S_{max}. The L_{us} values are based on the highest S_{max} in each range and must be adjusted by the factors provided in Table 9.23.13.7.-D.

In lieu of following this procedure, L_s, may be calculated directly using the following equation:

$$L_s = (C_{Sstorey} C_{walls} C_{roof} S)(K_{Sframe} S_{max} K_{weight} K_{Sspacing} K_{Snumber} K_{gyp} K_{sheath}) \geq BWP_{min}$$

where:

$C_{Sstorey}$	= coefficient of storey location for seismic forces, = 1 for braced wall panels supporting a roof only, = 3 for braced wall panels supporting a roof and 1 floor, and = 5 for braced wall panels supporting a roof and 2 floors,
C_{walls}	= coefficient accounting for seismic weight based on L_{wl} for walls, as provided in Table A-9.23.13.7.(4),
C_{roof}	= coefficient accounting for seismic weight based on L_{wl} for roofs, as provided in Table A-9.23.13.7.(4),
S	= specified roof snow load, in kPa, as calculated in accordance with Article 9.4.2.2.,
K_{Sframe}	= framing type adjustment factor, as provided in Table A-9.23.13.7.(3), and
K_{weight}, K_{snow}, $K_{Sspacing}$, $K_{Snumber}$, K_{gyp}, K_{sheath}, BWP_{min}	= as defined in Sentence 9.23.13.7.(4).

Table [9.23.13.7.(4)] A-9.23.13.7.(4)
Coefficients for Seismic Forces, C_{walls} and C_{roof}

Building Plan Dimension Parallel to Braced Wall Band, L_{wl}, m	C_{walls} (1)	C_{roof} (1)
3.1	0.38	0.09
6.1	0.60	0.17
9.1	0.83	0.26
12.2	1.06	0.35
15.5	1.29	0.43
18.3	1.52	0.52

Note to Table [9.23.13.7.(4)] A-9.23.13.7.(4):

(1) Linear interpolation between L_{wl} values is permitted.

This alternative calculation procedure may be used to determine L_s for cases designated as "DR" (design required) in Table 9.23.13.7.-C.

If the value of L_s calculated by either the procedure set out in Sentence 9.23.13.7.(4) or the alternative calculation procedure exceeds the available wall length, a stronger framing type or a closer braced wall band spacing may be considered.

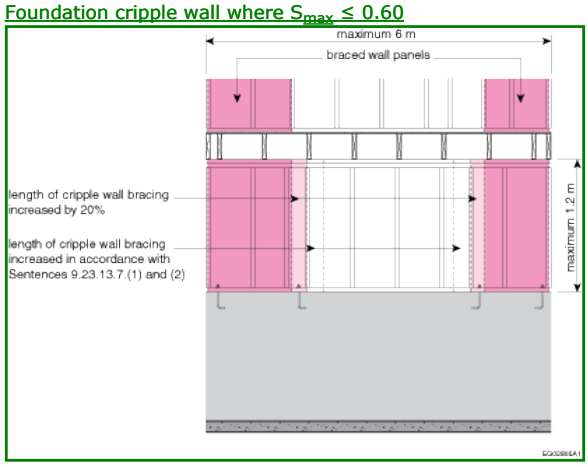
Note A-9.23.13.8. Foundation Cripple Walls.

Cripple walls are also known as "pony walls" or "knee walls." In Section 9.23., the term "cripple walls" refers to short wood-frame stud walls extending from the top of the foundation wall to the underside of the lowest floor framing.

Studies have demonstrated that wood-frame foundation walls with low racking resistance, such as unbraced or insufficiently braced cripple walls, do not have adequate capacity to resist seismic loading. Such walls have led to the failure of buildings in earthquakes. Where cripple walls do not meet the conditions of Sentences 9.23.13.8.(2) to (4)-2025, they need to be considered as an additional storey, or designed in accordance with Part 4 to ensure that they resist both in-plane and out-of-plane forces. Information on cripple walls can be found in the Commentary entitled Design for Seismic Effects in the "Structural Commentaries (User's Guide – NBC 2020: Part 4 of Division B)."

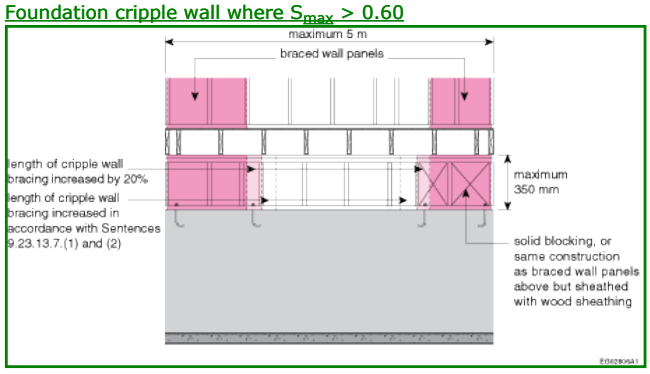
Note A-9.23.13.8.(2) Foundation Cripple Walls Where $S_{max} \leq 0.60$.

Figure [A-9.23.13.8.(2)]
Foundation cripple wall where $S_{max} \leq 0.60$



Note A-9.23.13.8.(3). Foundation Cripple Walls Where $S_{max} > 0.60$.

Figure [A-9.23.13.8.(3).]
Foundation cripple wall where $S_{max} > 0.60$



Note A-9.23.13.9.(1) Cripple Walls in Stepped Foundations.

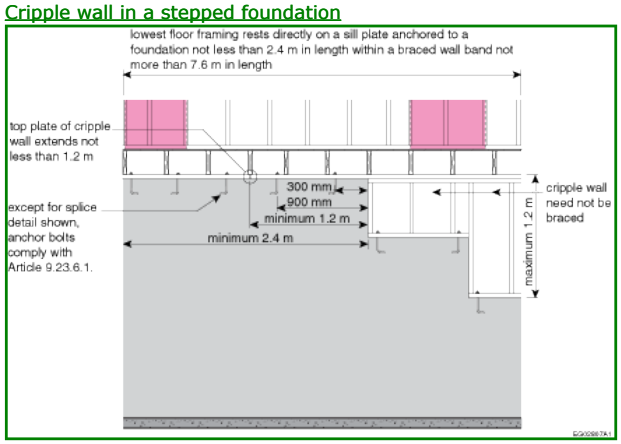
The conditions of Sentence 9.23.13.9.(1) are intended to establish whether the stepped foundation provides sufficient bracing for the braced wall band it supports. If the bracing is not considered to be sufficient, the provisions of Sentences 9.23.13.8.(2) to (4) for the appropriate value of S_{max} apply.

Where the foundation is less than 2.4 m in length, the attachment to the foundation is insufficient to complete the lateral load path for the first-storey braced wall band. In this case, the cripple wall needs to be braced, and there is no need for the top plate to be anchored to the foundation, although it would be good practice.

Where the foundation is at least 2.4 m in length and the top plate of the cripple wall is adequately anchored to the foundation wall, the cripple wall itself does not need to be braced, provided its height does not exceed 1.2 m.

Where the cripple wall exceeds 1.2 m in height, it must be considered as a storey or designed in accordance with Part 4 (see Sentence 9.23.13.8.(1)), regardless of the adequacy of the bracing it provides.

Figure [A-9.23.13.9.(1)]
Cripple wall in a stepped foundation



Note A-9.23.13.105.(23) Attachment of a Porch Roof to Exterior Wall Framing.

Figure [A-9.23.13.105.(23)-A] A-9.23.13.5.(3)-A
Porch roof framing perpendicular to wall framing between floors

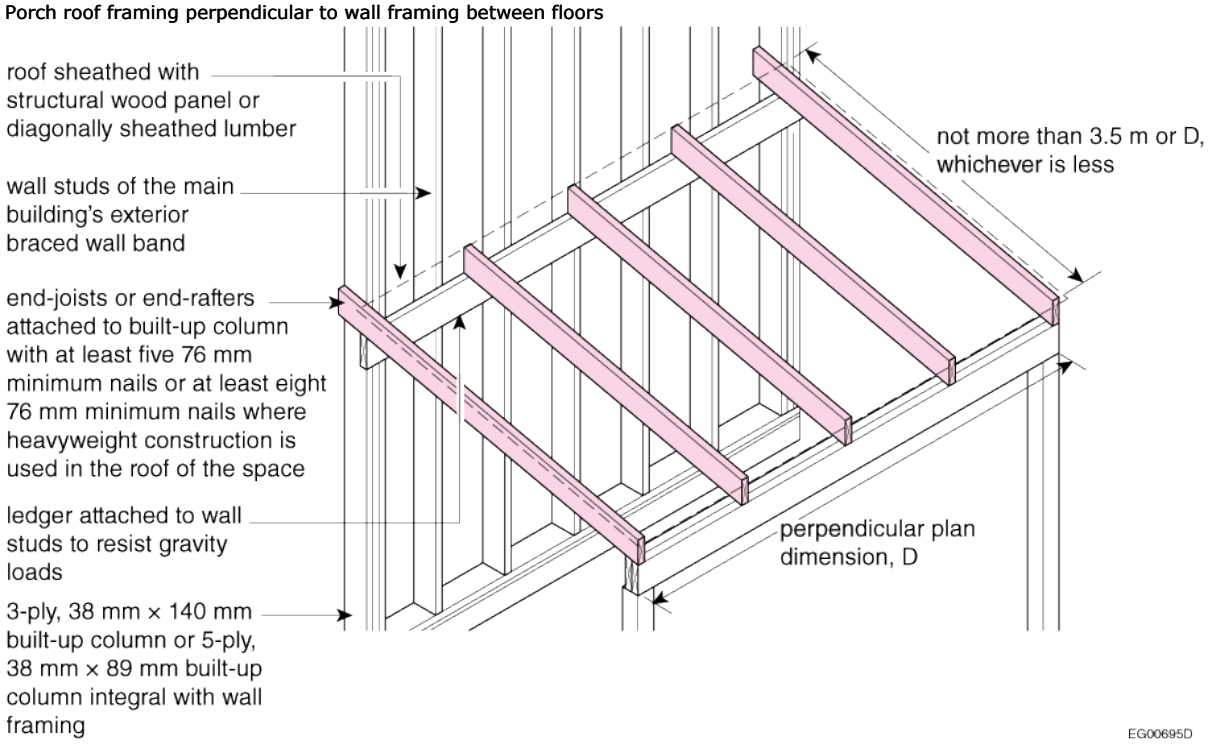
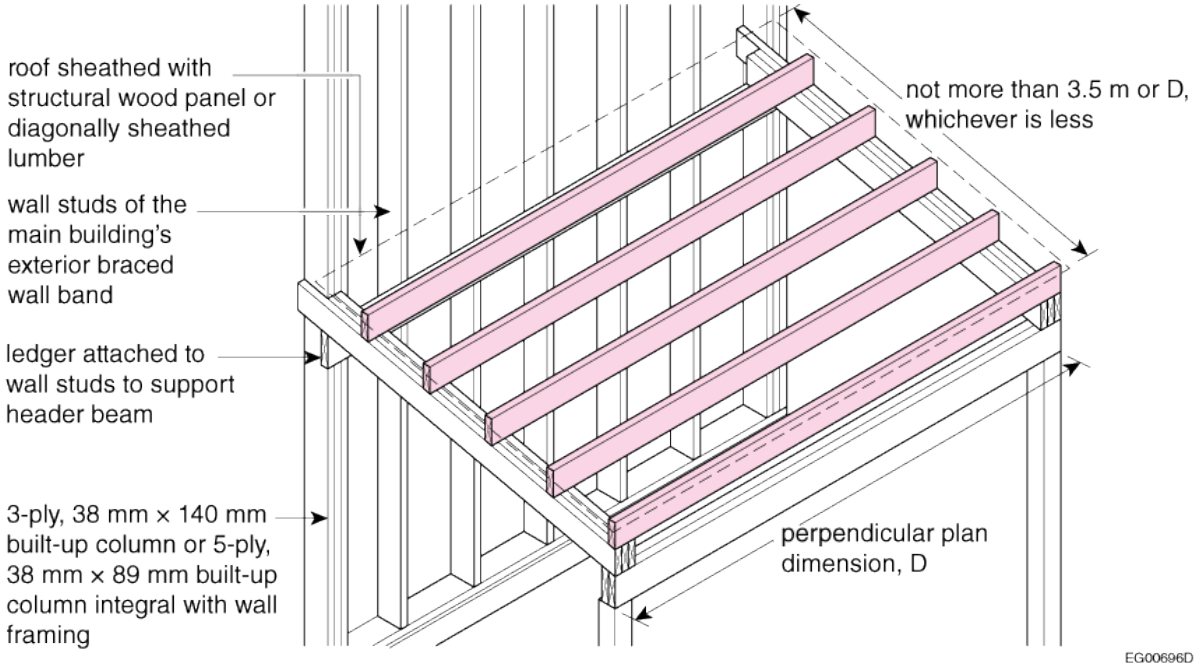


Figure [A-9.23.13.105.(23)-B] A-9.23.13.5.(3)-B
Porch roof framing parallel to wall framing between floors



[9.23.16.1.] 9.23.16.1. Required Roof Sheathing

[1] 1) Except where the 1-in-50-year hourly wind pressure (HWP) is less than 0.8 kPa and the seismic ~~spectral acceleration~~design parameter, ~~$S_a(0.2)$~~S_{max}, for Site Class C is less than or equal to ~~0.70~~0.47, continuous lumber or panel-type roof sheathing shall be installed to support the roofing.

[9.23.16.5.] 9.23.16.5. Lumber Roof Sheathing

[1] 1) Lumber roof sheathing shall not be more than 286 mm wide and shall be applied so that all ends are supported with end joints staggered.

[2] 2) Lumber roof sheathing shall be installed diagonally, where

[a] a) the seismic ~~spectral acceleration~~design parameter, ~~$S_a(0.2)$~~S_{max}, for Site Class C is greater than ~~0.70~~0.47 but not greater than ~~1.2~~0.8, or

[b] b) the 1-in-50-year hourly wind pressure (HWP) is equal to or greater than 0.8~~0~~ kPa but less than 1.2~~0~~ kPa.

[3] 3) Lumber roof sheathing shall be designed according to Part 4, where

[a] a) the seismic ~~spectral acceleration~~design parameter, ~~$S_a(0.2)$~~S_{max}, for Site Class C is greater than ~~1.2~~0.8, or

[b] b) the 1-in-50-year hourly wind pressure (HWP) is equal to or greater than 1.2~~0~~ kPa.

[9.31.6.2.] 9.31.6.2. Equipment and Installation

[1] 3) Where the *building* is in a location where the ~~spectral acceleration~~seismic design parameter, ~~$S_a(0.2)$~~S_{max}, for Site Class C is greater than ~~0.55~~0.37, *service water heaters* shall be secured to the structure to prevent overturning. (See Note A-9.31.6.2.(3).)

[9.33.4.7.] 9.33.4.7. Structural Movement

[1] 2) Where the *building* is in a location where the ~~spectral acceleration~~seismic design parameter, ~~$S_a(0.2)$~~S_{max}, for Site Class C is greater than ~~0.55~~0.37, heating and air-conditioning equipment with fuel or power connections shall be secured to the structure to resist overturning and displacement. (See Note A-9.31.6.2.(3).)

Impact analysis

The impact analysis looks at the cost difference between a base scenario (NBC 2020 lateral loads provisions with the seismic values in Table C-3 of the NBC 2020) and two other scenarios (Scenario A: NBC 2020 lateral loads provisions with updated seismic hazard values; and Scenario B: proposed lateral loads provisions with updated seismic hazard values).

Several iterations of the impact analysis were completed using the seismic design parameters and 1-in-50-year hourly wind pressures for 7 locations (Victoria, BC; Lethbridge AB; Winnipeg, MB; Ottawa, ON; Montréal, QC; St. John's, NL; and Whitehorse, YT). For each of these locations a duplex, stacked town, and bungalow archetypes were used. The costs for various

wall assemblies representing braced wall panels from the NBC 2020 and braced wall framing types included in the proposed change were costed using RSMeans software. The cost analysis does not determine the overall wall or building costs; instead it compares the difference in cost between the above-noted scenarios.

The impact analysis (refer to the supporting documents) found that, in general, there will be an increased cost in each of the locations analyzed, with the difference in cost ranging from −0.01% to 0.59% (−$43.60 to $1,142.43) of the average building cost of a home (obtained from Altus Group's 2022 Canadian Cost Guide).

The impact analysis shows how the two types of changes within PCF 1475 affect the cost increase in different ways. Scenario A evaluates how the increase in seismic hazard values impacts construction costs. This impact affects locations like Victoria, which sees a construction cost increase ranging from 0.24% to 1.15% ($1,242.73 to $2,955.67) across the three archetypes. The increase in seismic hazard values also pushes some locations, like Montréal, above the existing lateral loads design trigger value, which is why Montréal sees a construction cost increase ranging from 0.4% to 0.76% ($1,095.89 to $1,525.99) across the archetypes. The other five cities that were analyzed were not pushed above the existing lateral loads design trigger values and therefore do not see an increase in construction cost as a result of the updated seismic hazard values.

PCF 1475 introduces new lateral loads design provisions that are more precise and therefore less conservative than the existing provisions. Consequently, when Scenario B evaluates the construction cost increase associated with updating the seismic hazard values in conjunction with the proposed lateral loads provisions, we see a softening of the increased construction cost for locations that require lateral loads design when subjected to the updated seismic hazard values. Victoria goes from a cost increase range of 0.24% to 1.15% ($1,242.73 to $2,955.67) in Scenario A to a range of −0.01% to 0.25% (−$43.60 to $633.35) in Scenario B. Montréal sees a similar softening of the cost increase in Scenario B relative to Scenario A. The other five cities analyzed see an increase in construction cost ranging from 0.05% to 0.45% ($165.10 to $863.05).

PCF 1475 also includes a Simplified Approach for lateral loads design, which provides conservative minimum braced wall lengths, as evidenced by the resulting construction cost increase of 0.62% ($1,230.03) compared to the 0.41% ($800.81) cost increase for that same location using the normal lateral loads design approach.

Finally, for construction of exterior walls where rigid insulation is used as exterior sheathing in low wind and seismic zones, the impact is greater than typical exterior wall construction, with a difference in construction cost increase range of 0.11% to 0.55% ($352.25 to $1,088.17) compared to that location’s cost increase range of 0.05% to 0.41% ($165.10 to $800.81) when using typical exterior wall construction.

Assumptions:

Where Part 4 design was required, it was assumed that the wall lengths would be increased by 10%, and the cost of hiring a professional engineer was represented as a 1% increase to the construction cost of the home.

Where a city that was analyzed had several options for the type of braced wall panel assembly that could be used, the weakest assembly was selected, unless other portions of that wall façade required another thickness of exterior sheathing, in which case the sheathing thickness dictated the assembly selection.

The Altus Group housing construction data did not include average prices for energy efficient homes, so the cost analysis for an energy efficient home used the cost of normal construction as a comparison.

The labour cost to nail exterior sheathing to the studs was assumed to represent 25% of the overall labour cost to install sheathing (used when data from RSMeans needed to be interpolated).

Limitations:

This is a small subset of all the locations in Canada. The general conclusions above will not necessarily apply everywhere.

Three archetypes were analyzed and the duplex and stacked town archetypes were selected because they included an analysis of a party wall situation, which was meant to represent how a row house could be impacted by PCF 1475.

The analysis was limited to normal weight construction.

The analysis did not examine the benefits of finding a Site Class of A, B, C or D.

National average material costs were used.

To be consistent with the guidelines for impact analysis in Appendix G of the CCBFC Policies and Procedures 2016, this impact analysis did not account for escalation costs (e.g., fluctuations in direct costs for wood materials).

Enforcement implications

This proposed change will require some additional review of building permit applications to ensure that the proper design and construction approach has been taken.

Who is affected

Designers and builders with respect to design, build and construction.

Building owners would bear any increase in costs but would benefit from a reduced probability or degree of property loss in the case of an earthquake.

Supporting Document(s)

Review of Structural Materials and Methods for Home Building in the United States: 1900 to 2000 (review_of_structural_materials_and_methods.pdf)
PCFs 1475 and 1775 on Lateral Loads: Combined Impact Analysis (pcfs_1475_and_1775_combined_impact_analysis.pdf)

OBJECTIVE-BASED ANALYSIS OF NEW OR CHANGED PROVISIONS

[9.4.1.1.] 9.4.1.1. ([1] 1) no attributions

[9.4.1.1.] 9.4.1.1. ([2] 2) no attributions

[9.4.1.1.] 9.4.1.1. ([3] 3) no attributions

[9.4.2.1.] 9.4.2.1. ([1] 1) no attributions

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[9.4.2.2.] 9.4.2.2. ([1] 1) [F20-OP2.1,OP2.3] [F22-OP2.3]

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[9.4.2.5.] -- ([1] --) [F20-OS2.1]

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[9.20.1.1.] 9.20.1.1. ([2] 2) no attributions

[9.20.1.2.] 9.20.1.2. ([1] 1) no attributions

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[9.23.3.5.] 9.23.3.5. ([7] 7) [F22-OH4]

[9.23.3.5.] 9.23.3.5. ([7] 7) [F22-OS3.1]

[9.23.3.5.] 9.23.3.5. ([7] 7) [F20-OS1.2]

~~[9.23.3.5.] 9.23.3.5. ([8] 8) [F20-OS2.1] [F20,F22-OS2.5] [F20,F22-OS2.3]~~

~~[9.23.3.5.] 9.23.3.5. ([8] 8) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]~~

~~[9.23.3.5.] 9.23.3.5. ([8] 8) [F20,F22-OH1.1,OH1.2,OH1.3]~~

[9.23.6.1.] 9.23.6.1. ([1] 1) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.6.1.] 9.23.6.1. ([1] 1) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.6.1.] 9.23.6.1. ([1] 1) [F20-OH1.1,OH1.2,OH1.3]

[9.23.6.1.] 9.23.6.1. ([1] 1) [F22-OH4]

[9.23.6.1.] 9.23.6.1. ([1] 1) [F20-OS3.1]

[9.23.6.1.] 9.23.6.1. ([2] 2) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.6.1.] 9.23.6.1. ([2] 2) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.6.1.] 9.23.6.1. ([2] 2) [F20-OH1.1,OH1.2,OH1.3]

[9.23.6.1.] 9.23.6.1. ([2] 2) [F22-OH4]

[9.23.6.1.] 9.23.6.1. ([2] 2) [F20-OS3.1]

[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OH1.1,OH1.2,OH1.3]

[9.23.6.1.] 9.23.6.1. ([4] 4) [F22-OH4]

[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OS3.1]

~~[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]~~

~~[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]~~

~~[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OH1.1,OH1.2,OH1.3]~~

~~[9.23.6.1.] 9.23.6.1. ([4] 4) [F22-OH4]~~

~~[9.23.6.1.] 9.23.6.1. ([4] 4) [F20-OS3.1]~~

[9.23.6.1.] 9.23.6.1. ([5] 5) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.6.1.] 9.23.6.1. ([5] 5) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.6.1.] 9.23.6.1. ([5] 5) [F20-OH1.1,OH1.2,OH1.3]

[9.23.6.1.] 9.23.6.1. ([5] 5) [F22-OH4]

[9.23.6.1.] 9.23.6.1. ([5] 5) [F20,F22-OS3.1]

~~[9.23.6.1.] 9.23.6.1. ([6] 6) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]~~

~~[9.23.6.1.] 9.23.6.1. ([6] 6) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]~~

~~[9.23.6.1.] 9.23.6.1. ([6] 6) [F20-OH1.1,OH1.2,OH1.3]~~

~~[9.23.6.1.] 9.23.6.1. ([6] 6) [F22-OH4]~~

~~[9.23.6.1.] 9.23.6.1. ([6] 6) [F20-OS3.1]~~

-- (--) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

-- (--) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

-- (--) [F20-OH1.1,OH1.2,OH1.3]

-- (--) [F22-OH4]

-- (--) [F20-OS3.1]

[9.23.11.4.] 9.23.11.4. ([1] 1) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] 9.23.11.4. ([1] 1) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] 9.23.11.4. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] 9.23.11.4. ([1] 1) [F22-OH4]

[9.23.11.4.] 9.23.11.4. ([1] 1) [F22-OS1.2]

[9.23.11.4.] 9.23.11.4. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.11.4.] 9.23.11.4. ([2] 2) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] 9.23.11.4. ([2] 2) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] 9.23.11.4. ([2] 2) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] 9.23.11.4. ([2] 2) [F22-OH4]

[9.23.11.4.] 9.23.11.4. ([2] 2) [F20,F22-OS1.2]

[9.23.11.4.] 9.23.11.4. ([2] 2) [F22-OS3.1] [F22-OS3.7]

[9.23.11.4.] 9.23.11.4. ([3] 3) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] 9.23.11.4. ([3] 3) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] 9.23.11.4. ([3] 3) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] 9.23.11.4. ([3] 3) [F22-OH4]

[9.23.11.4.] 9.23.11.4. ([3] 3) [F20,F22-OS1.2]

[9.23.11.4.] 9.23.11.4. ([3] 3) [F22-OS3.1] [F22-OS3.7]

[9.23.11.4.] 9.23.11.4. ([4] 4) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] 9.23.11.4. ([4] 4) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] 9.23.11.4. ([4] 4) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] 9.23.11.4. ([4] 4) [F22-OH4]

[9.23.11.4.] 9.23.11.4. ([4] 4) [F20,F22-OS1.2]

[9.23.11.4.] 9.23.11.4. ([4] 4) [F22-OS3.1] [F22-OS3.7]

~~[9.23.11.4.] 9.23.11.4. ([5] 5) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]~~

~~[9.23.11.4.] 9.23.11.4. ([5] 5) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]~~

~~[9.23.11.4.] 9.23.11.4. ([5] 5) [F20,F22-OH1.1,OH1.2,OH1.3]~~

~~[9.23.11.4.] 9.23.11.4. ([5] 5) [F22-OH4]~~

~~[9.23.11.4.] 9.23.11.4. ([5] 5) [F20,F22-OS1.2]~~

~~[9.23.11.4.] 9.23.11.4. ([5] 5) [F22-OS3.1] [F22-OS3.7]~~

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F22-OH4]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20,F22-OS1.2]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F22-OS3.1] [F22-OS3.7]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F22-OH4]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F20,F22-OS1.2]

[9.23.11.4.] 9.23.11.4. ([5] 5) [F22-OS3.1] [F22-OS3.7]

[9.23.11.4.] -- ([7] --) [F20-OS2.1,OS2.5] [F22-OS2.5] [F20,F22-OS2.3]

[9.23.11.4.] -- ([7] --) [F20-OP2.1,OP2.5] [F22-OP2.4,OP2.5] [F20,F22-OP2.3]

[9.23.11.4.] -- ([7] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.11.4.] -- ([7] --) [F22-OH4]

[9.23.11.4.] -- ([7] --) [F20,F22-OS1.2]

[9.23.11.4.] -- ([7] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.1.] 9.23.13.1. ([1] 1) no attributions

[9.23.13.1.] 9.23.13.1. ([2] 2) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.1.] 9.23.13.1. ([2] 2) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.1.] 9.23.13.1. ([2] 2) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.1.] 9.23.13.1. ([2] 2) [F20,F22-OS1.2]

[9.23.13.1.] 9.23.13.1. ([2] 2) [F22-OS3.1] [F22-OS3.7]

[9.23.13.1.] 9.23.13.1. ([2] 2) [F20,F22-OH4]

[9.23.13.2.] 9.23.13.2. ([1] 1) no attributions

[9.23.13.2.] 9.23.13.2. ([2] 2) no attributions

[9.23.13.2.] -- ([3] --) no attributions

[9.23.13.3.] 9.23.13.3. ([1] 1) no attributions

[9.23.13.3.] 9.23.13.3. ([2] 2) no attributions

[9.23.13.4.] 9.23.13.4. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.4.] 9.23.13.4. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.4.] 9.23.13.4. ([1] 1) [F20,F22-OS1.2]

[9.23.13.4.] 9.23.13.4. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.4.] 9.23.13.4. ([1] 1) [F20,F22-OH4]

[9.23.13.4.] 9.23.13.4. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

~~[9.23.13.4.] 9.23.13.4. ([2] 2) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]~~

~~[9.23.13.4.] 9.23.13.4. ([2] 2) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]~~

~~[9.23.13.4.] 9.23.13.4. ([2] 2) [F20,F22-OH1.1,OH1.2,OH1.3]~~

~~[9.23.13.4.] 9.23.13.4. ([2] 2) [F20,F22-OS1.2]~~

~~[9.23.13.4.] 9.23.13.4. ([2] 2) [F22-OS3.1] [F22-OS3.7]~~

~~[9.23.13.4.] 9.23.13.4. ([2] 2) [F20,F22-OH4]~~

[9.23.13.4.] 9.23.13.4. ([3] 3) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.4.] 9.23.13.4. ([3] 3) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.4.] 9.23.13.4. ([3] 3) [F20,F22-OS1.2]

[9.23.13.4.] 9.23.13.4. ([3] 3) [F22-OS3.1] [F22-OS3.7]

[9.23.13.4.] 9.23.13.4. ([3] 3) [F20,F22-OH4]

[9.23.13.4.] 9.23.13.4. ([3] 3) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([2] 2) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([2] 2) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([2] 2) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([2] 2) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([2] 2) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([2] 2) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] -- ([3] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] -- ([3] --) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] -- ([3] --) [F20,F22-OS1.2]

[9.23.13.5.] -- ([3] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] -- ([3] --) [F20,F22-OH4]

[9.23.13.5.] -- ([3] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] -- ([4] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] -- ([4] --) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] -- ([4] --) [F20,F22-OS1.2]

[9.23.13.5.] -- ([4] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] -- ([4] --) [F20,F22-OH4]

[9.23.13.5.] -- ([4] --) [F20,F22-OH1.1,OH1.2,OH1.3]

~~[9.23.13.5. 9.23.13.10.] 9.23.13.5. ([5 2] 3) no attributions~~

~~[9.23.13.5. 9.23.13.10.] 9.23.13.5. ([6 3] 4) no attributions~~

~~[9.23.13.5. 9.23.13.10.] 9.23.13.5. ([7 4] 5) no attributions~~

[9.23.13.6.] 9.23.13.6. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.6.] 9.23.13.6. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.6.] 9.23.13.6. ([1] 1) [F20,F22-OS1.2]

[9.23.13.6.] 9.23.13.6. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.6.] 9.23.13.6. ([1] 1) [F20,F22-OH4]

[9.23.13.6.] 9.23.13.6. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.6.] 9.23.13.6. ([8] 4) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.6.] 9.23.13.6. ([8] 4) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.6.] 9.23.13.6. ([8] 4) [F20,F22-OS1.2]

[9.23.13.6.] 9.23.13.6. ([8] 4) [F22-OS3.1] [F22-OS3.7]

[9.23.13.6.] 9.23.13.6. ([8] 4) [F20,F22-OH4]

[9.23.13.6.] 9.23.13.6. ([8] 4) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.6.] 9.23.13.6. ([3] 6) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.6.] 9.23.13.6. ([3] 6) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.6.] 9.23.13.6. ([3] 6) [F20,F22-OS1.2]

[9.23.13.6.] 9.23.13.6. ([3] 6) [F22-OS3.1] [F22-OS3.7]

[9.23.13.6.] 9.23.13.6. ([3] 6) [F20,F22-OH4]

[9.23.13.6.] 9.23.13.6. ([3] 6) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.6.] 9.23.13.6. ([7] 3) no attributions

[9.23.13.6.] 9.23.13.6. ([7] 3) no attributions

~~[9.23.13.6.] 9.23.13.6. ([6] 2) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]~~

~~[9.23.13.6.] 9.23.13.6. ([6] 2) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]~~

~~[9.23.13.6.] 9.23.13.6. ([6] 2) [F20,F22-OS1.2]~~

~~[9.23.13.6.] 9.23.13.6. ([6] 2) [F22-OS3.1]~~

~~[9.23.13.6.] 9.23.13.6. ([6] 2) [F20,F22-OH4]~~

~~[9.23.13.6.] 9.23.13.6. ([7] 3) no attributions~~

~~[9.23.13.6.] 9.23.13.6. ([8] 4) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]~~

~~[9.23.13.6.] 9.23.13.6. ([8] 4) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]~~

~~[9.23.13.6.] 9.23.13.6. ([8] 4) [F20,F22-OS1.2]~~

~~[9.23.13.6.] 9.23.13.6. ([8] 4) [F22-OS3.1] [F22-OS3.7]~~

~~[9.23.13.6.] 9.23.13.6. ([8] 4) [F20,F22-OH4]~~

~~[9.23.13.6.] 9.23.13.6. ([8] 4) [F20,F22-OH1.1,OH1.2,OH1.3]~~

~~[9.23.13.6.] 9.23.13.6. ([9] 5) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]~~

~~[9.23.13.6.] 9.23.13.6. ([9] 5) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]~~

~~[9.23.13.6.] 9.23.13.6. ([9] 5) [F20,F22-OS1.2]~~

~~[9.23.13.6.] 9.23.13.6. ([9] 5) [F22-OS3.1] [F22-OS3.7]~~

~~[9.23.13.6.] 9.23.13.6. ([9] 5) [F20,F22-OH4]~~

~~[9.23.13.6.] 9.23.13.6. ([9] 5) [F20,F22-OH1.1,OH1.2,OH1.3]~~

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.7.] -- ([5] --) no attributions

[9.23.13.7.] -- ([5] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.7.] -- ([5] --) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.7.] -- ([5] --) [F20,F22-OS1.2]

[9.23.13.7.] -- ([5] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.7.] -- ([5] --) [F20,F22-OH4]

[9.23.13.7.] -- ([5] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.8.] -- ([1] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.8.] -- ([1] --) [F20-OP2.1,OS2.3,OS2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.8.] -- ([1] --) [F20,F22-OS1.2]

[9.23.13.8.] -- ([1] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.8.] -- ([1] --) [F20,F22-OH4]

[9.23.13.8.] -- ([1] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.8.] -- ([2] --) no attributions

[9.23.13.8.] -- ([2] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.8.] -- ([2] --) [F20-OP2.1,OS2.3,OS2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.8.] -- ([2] --) [F20,F22-OS1.2]

[9.23.13.8.] -- ([2] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.8.] -- ([2] --) [F20,F22-OH4]

[9.23.13.8.] -- ([2] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.8.] -- ([3] --) no attributions

[9.23.13.8.] -- ([3] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.8.] -- ([3] --) [F20-OP2.1,OS2.3,OS2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.8.] -- ([3] --) [F20,F22-OS1.2]

[9.23.13.8.] -- ([3] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.8.] -- ([3] --) [F20,F22-OH4]

[9.23.13.8.] -- ([3] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.8.] -- ([4] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.8.] -- ([4] --) [F20-OP2.1,OS2.3,OS2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.8.] -- ([4] --) [F20,F22-OS1.2]

[9.23.13.8.] -- ([4] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.8.] -- ([4] --) [F20,F22-OH4]

[9.23.13.8.] -- ([4] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.9.] -- ([1] --) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.9.] -- ([1] --) [F20-OP2.1,OS2.3,OS2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.9.] -- ([1] --) [F20,F22-OS1.2]

[9.23.13.9.] -- ([1] --) [F22-OS3.1] [F22-OS3.7]

[9.23.13.9.] -- ([1] --) [F20,F22-OH4]

[9.23.13.9.] -- ([1] --) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.10.] -- ([1] --) no attributions

[9.23.13.5. 9.23.13.10.] 9.23.13.5. ([5 2] 3) no attributions

[9.23.13.5. 9.23.13.10.] 9.23.13.5. ([6 3] 4) no attributions

[9.23.13.5. 9.23.13.10.] 9.23.13.5. ([7 4] 5) no attributions

[9.23.13.10.] 9.23.13.7. ([5] 1) no attributions

[9.23.13.10.] 9.23.13.7. ([6] 2)

[9.23.13.10.] 9.23.13.7. ([7] 3) no attributions

[9.23.13.10.] 9.23.13.7. ([8] 4) no attributions

~~[9.23.13.10.] 9.23.13.7. ([9] 5) no attributions~~

~~[9.23.13.10.] 9.23.13.7. ([10] 6) no attributions~~

~~[9.23.13.10.] 9.23.13.7. ([11] 7) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]~~

~~[9.23.13.10.] 9.23.13.7. ([11] 7) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]~~

~~[9.23.13.10.] 9.23.13.7. ([11] 7) [F20,F22-OS1.2]~~

~~[9.23.13.10.] 9.23.13.7. ([11] 7) [F22-OS3.1] [F22-OS3.7]~~

~~[9.23.13.10.] 9.23.13.7. ([11] 7) [F20,F22-OH4]~~

~~[9.23.13.10.] 9.23.13.7. ([11] 7) [F20,F22-OH1.1,OH1.2,OH1.3]~~

[9.23.13.10.] -- ([1] --) no attributions

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OS1.2]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F22-OS3.1] [F22-OS3.7]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH4]

[9.23.13.5.] 9.23.13.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

-- (--) no attributions

-- (--) no attributions

-- (--) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

-- (--) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

-- (--) [F20,F22-OS1.2]

-- (--) [F22-OS3.1] [F22-OS3.7]

-- (--) [F20,F22-OH4]

-- (--) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.16.1.] 9.23.16.1. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.16.1.] 9.23.16.1. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.16.1.] 9.23.16.1. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.16.5.] 9.23.16.5. ([1] 1) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.5]

[9.23.16.5.] 9.23.16.5. ([1] 1) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.5]

[9.23.16.5.] 9.23.16.5. ([1] 1) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.16.5.] 9.23.16.5. ([1] 1) [F20,F22-OS1.2]

[9.23.16.5.] 9.23.16.5. ([2] 2) [F20-OS2.1,OS2.3,OS2.5] [F22-OS2.3,OS2.4,OS2.5]

[9.23.16.5.] 9.23.16.5. ([2] 2) [F20-OP2.1,OP2.3,OP2.5] [F22-OP2.3,OP2.4,OP2.5]

[9.23.16.5.] 9.23.16.5. ([2] 2) [F20,F22-OS1.2]

[9.23.16.5.] 9.23.16.5. ([2] 2) [F20,F22-OH1.1,OH1.2,OH1.3]

[9.23.16.5.] 9.23.16.5. ([3] 3) no attributions

[9.31.6.2.] 9.31.6.2. ([1] 3) [F23-OS3.4]

[9.31.6.2.] 9.31.6.2. ([1] 3) [F01-OS1.1]

[9.33.4.7.] 9.33.4.7. ([1] 2) [F20-OS3.3,OS3.4]

[9.33.4.7.] 9.33.4.7. ([1] 2) [F20-OS1.1]