



Evaluation Report CCMC 14204-R beonstone

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1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that “beonstone” when used as an exterior cladding in accordance with the conditions and limitations stated in Section 3 of this Report, complies with the National Building Code (NBC) of Canada 2015:

- Clause 1.2.1.1.(1)(a) of Division A, as an acceptable solution from Division B:
 - Article 4.3.1.1., Design Basis for Wood (Structural Support for Cladding)
 - Subsection 9.27.2., Required Protection from Precipitation
- Clause 1.2.1.1.(1)(b) of Division A, as an alternative solution that achieves at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the following applicable acceptable solutions:
 - Article 9.20.2.1., Masonry Unit Standards
 - Article 9.20.5.1., Masonry Support
 - Subsection 9.20.6., Thickness and Height

This opinion is based on the CCMC evaluation of the technical evidence in Section 4 provided by the Report Holder.

2. Description

“beonstone” is a concrete stone veneer panel with a standoff and embedded metal strip support structure used for exterior cladding. It is mechanically attached to a proprietary⁽¹⁾ engineered structural wood sheathing and stud framing design detailed in Appendix A.

The concrete stone veneer panel is composed of Portland cement, water, aggregates, pigments and paint. The product is cast in moulds that produce different textures. “beonstone” is 610 mm in length, 305 mm in width and approximately 38 mm in thickness. “beonstone” has four different profiles: “CLASSIC,” “CANYON,” “ELEMENT” and “HORIZON.” Figure 1 illustrates “beonstone” with the “ELEMENT” profile.

⁽¹⁾ The design must be in accordance with the requirements specified in Quail Engineering Ltd.’s Report No. 19-096-1 Rev 1, dated April 6, 2020.

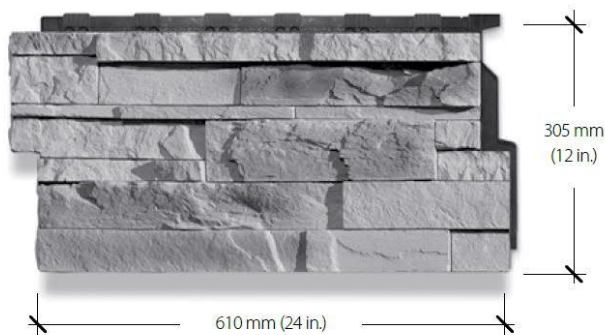


Figure 1. “beonstone” with “ELEMENT” profile

“beonstone” is mechanically attached to the supporting structure using an embedded metal strip with a polypropylene standoff. The beonstone” starter strip is attached to the bottom of the first row of “beonstone.” The top and bottom edges of “beonstone” are designed to interlock with each other. The embedded metal strip is Type 304 stainless steel and the fasteners are minimum No. 10 × 1 in. fully threaded stainless steel wood screws. The polypropylene standoff is designed as a spacer to create a 10-mm-deep drained and vented air space behind the cladding (i.e., a rainscreen system).

Instead of the masonry being supported on the foundation, the product is supported by the wood frame. Therefore, the product must be installed according to the proprietary wood-frame construction details. These construction details are in Appendix A, and include increased top and bottom plates, less stud spacing, horizontal sheathing, etc.



Figure 2. A typical “beonstone” installation

3. Conditions and Limitations

The CCMC compliance opinion in Section 1 is bound by “beonstone” being used in accordance with the conditions and limitations set out below.

3.1 General

- The product is intended for use as an exterior cladding in new construction. It is installed on structural grade wood sheathing boards that are attached to wood framing in accordance with the backup wall design specified in Appendix A of this Report.
- The product is NOT intended for use in retrofit construction.
- The product is limited to installation on buildings not exceeding two (2) storeys, with a maximum height of 3 m per floor, with a maximum building plan of 24 m × 12 m and with a maximum floor joist clear span of 8 m. The joist span tables referred to Article 9.23.4.2., Spans for Joists, Rafters and Beams, of Division B of the NBC 2015, apply to floors supported by sawn lumber joists. If the framing is other than sawn lumber (e.g., I-joist), the floors are required to be designed in conformance with Part 4, Structural Design, of Division B of the NBC 2015.
- The product is limited to installations in geographical areas where the 1-in-50 hourly wind pressure is ≤ 0.70 kPa and the building is Category 2 for internal pressure (C_{pi} : -0.45 to $+0.30$), as defined in Article 4.1.7.7., Internal Pressure Coefficient, of Division B of the NBC 2015. The wind design value has been validated for the product installed over horizontally installed plywood or oriented strandboard (OSB) structural sheathing with a minimum thickness of 12.5 mm for plywood and 11 mm for OSB.

- The product must be applied in geographical areas where the spectral response acceleration $S_a(0.2)$ is 1.2 or less, and the building is on a Class C site or better, as defined in Article 4.1.8.4., Site Properties, of Division B of the NBC 2015.
- The 10-mm air space that is created by the clips must remain unobstructed to form a clear drainage layer behind the product.
- At least one layer of wall-sheathing membrane conforming to Article 9.27.3.2., Sheathing Membrane Material Standard, of Division B of the NBC 2015, must be applied beneath the cladding products. The sheathing membrane must be applied in accordance with Article 9.27.3.3., Required Sheathing Membrane and Installation, of Division B of the NBC 2015.
- The product must be installed with suitable flashing to drain water from the drainage layer to the exterior and to protect the exposed top edge of the cladding.
- Flashing must be installed in accordance with the requirements of Articles 9.27.3.7., Flashing Materials, and 9.27.3.8., Flashing Installation, of Division B of the NBC 2015.
- The impact resistance of the product makes it susceptible to hard- and soft-body impacts. However, the ease of replacing the product makes it suitable for normal use in upper floors and protected ground floors. When used at ground floors exposed to high impacts, special precautions must be taken, such as installing guardrails or raised gardens.
- Fire blocks must be installed in accordance with the requirements of Article 9.10.16.2., Required Fire Blocks in Wall Assemblies, of Division B of the NBC 2015.
- The product must be installed in accordance with the manufacturer's current instructions "Technical Guide BEONSTONE PANELIZED STONE SIDING," version 19.12 dated December 2019.
- To obtain an acceptable performance, a high level of quality control at all stages of the exterior wall construction is imperative.
- This Evaluation Report is applicable only to products identified by the phrase "CCMC 14204-R."

3.2 Structural

- The product is to be installed on a pre-engineered wood frame designed to support this proprietary product. The installation of the product must be in accordance with the engineering analysis as prepared by Quaile Engineering Ltd. in Report No. 19-096-1 Rev 1, dated April 6, 2020. The pre-engineered design solutions are produced in the engineering analysis and reproduced in Appendix A of this Report along with the detailed design and construction requirements. The provided pre-engineered design solutions have the following features:
 - only applied to new construction;
 - the top and bottom plates are increased, and the stud spacings are reduced;
 - the nailing of the top and bottom plates is increased;
 - squash blocks are required to support the I-joists; and
 - exterior sheathing is installed with the strong axis (face grain) oriented horizontally.
- When the product is used outside the scope and limitations of Quaile Engineering Ltd.'s Report No. 19-096-1 Rev 1, dated April 6, 2020, a special engineering analysis must be carried out by a licensed professional engineer skilled in structural design, who must sign and seal the related analysis, confirming its conformance to Part 4 of Division B of the NBC 2015.
- The stud wall must consist of 38-mm × 140-mm stud grade Spruce-Pine-Fir (SPF). A hole not greater than 25 mm in diameter is permitted at the centreline of the stud. No. 2 grade SPF plates must be used in the framing of the backup wall.
- A horizontal joint must be provided at each floor level as indicated in Figure A-3.
- The fastening screws used to secure the cladding through the clips must be minimum No. 10 × 1 in fully threaded stainless steel wood screws.
- A roof overhang of up to 600 mm is permitted.
- For buildings with balconies, the tributary floor width applied to the wall shall be 4 m or less per floor.
- Cladding attachments must conform with Sentence 9.27.5.1.(1), Attachment (of Cladding) and Articles 9.27.5.5., Fastener Materials, and 9.27.5.7., Penetration of Fasteners, of Division B of the NBC 2015. For any other mode of attaching a cladding system to sheathing, the structural sufficiency of the sheathing and the whole backing, in conjunction with the clips and type of fasteners, must be in accordance with the engineering analysis as prepared by Quaile Engineering Ltd. in Report No. 19-096-1 Rev 1, dated April 6, 2020.

4. Technical Evidence

The Report Holder has submitted technical documentation for the CCMC evaluation. Testing was conducted at laboratories recognized by CCMC. The corresponding technical evidence for this product is summarized below.

4.1 Requirements

4.1.1 Material Requirements

Table 4.1.1.1 Results of Testing the Prescriptive Requirements of “beonstone”

Property		Unit	Requirement	Result
Dimensional tolerances	length	mm	$\leq \pm 4$	Pass
	width	mm	$\leq \pm 2$	Pass ⁽¹⁾
	thickness	mm	$\leq \pm 2$	Pass
Density		kg/m ³	Report values	1 336
Absorption		%	< 15	8.2
Compressive strength		MPa	> 15	18
Saturation coefficient		%	< 0.80	0.32
Freeze-thaw resistance	loss in mass	%	< 3	0.06
	loss in flexural strength	%	< 15	6.7
Linear drying shrinkage		%	> 0.045	0.046

Note to Table 4.1.1.1:

- (1) Some readings for the width were slightly less than the lower tolerance range. However, in this case, the slightly shorter width would be unlikely to affect the installation of the panels.

4.1.2 Performance Requirements

Table 4.1.2.1 Results of Testing the Impact Resistance of the Product

Impact Body		Requirements		Results
		Dynamic Mass (kg)	Energy (N·m)	
Safety impact	large soft	50	100	Pass ⁽¹⁾
	hard	1	10	Pass ⁽¹⁾
Retention of performance impact	large soft	50	34	Pass
	small soft	3	60	Pass ⁽²⁾
	hard	1	10	Pass ⁽²⁾

Notes to Table 4.1.2.1:

- (1) Some cracks were observed with several specimens; however, the specimens did not allow the impact body to penetrate, dislodge, or fall through and impair the safety of the structure. In the event of any damage resulting from the impact, the cladding units must be replaced immediately.
- (2) Some cracks were observed with several specimens; however, the specimens retained their functional characteristics and overall appearance. In the event of any damage resulting from the impact, the cladding units must be replaced immediately.

Table 4.1.2.2 Results of Testing the Wind Load Resistance of the Product for Non-post-disaster Buildings

Product	Frame	Stud Spacing (mm)	Fastening	Maximum Building Height (m)	Hourly Wind Pressure, Q_{50} (kPa)
"beonstone"	3 048 mm × 3 048 mm frame was built with 38 mm × 89 mm studs and sheathed with 15.9-mm-thick plywood	406	No. 10 × 1 in. self-tapping wood screws. Three screws per panel (two screws on top and one screw on the right-hand side) .	12	$Q_{50} < 1.00$
				100 ⁽¹⁾	$Q_{50} < 0.45$

Note to Table 4.1.2.2:

- (1) Buildings up to three storeys high (12 m) fall under the scope of Part 9, Housing and Small Buildings, of Division B of the NBC 2015. Buildings higher than 12 m fall under the scope of Part 4 of Division B of the NBC 2015. In accordance with the NBC 2015, the engineering design must be prepared by a professional engineer licenced to practice in Canada who has expertise in the relevant area.

Table 4.1.2.3 Results of Testing the Deflection from Wind Load Resistance of the Product

Product	Deflection (mm) ⁽¹⁾	Wind Pressure for Deflection Measurements ⁽²⁾ (Pa)
"beonstone"	25.86	2 180
	33.16	– 2 165

Notes to Table 4.1.2.3:

- (1) Maximum deflection values among five sensor locations
(2) Deflection measurement was taken at the gust wind pressure

Table 4.1.2.4 Results of Testing the Rain Penetration Resistance of the Product⁽¹⁾

Product	Frame	Stud Spacing (mm)	Fastening	Requirements	Results
"beonstone"	2 438 mm × 2 438 mm frame was built with 38 mm × 89 mm studs and sheathed with 15.9-mm-thick plywood	406	No. 10 × 1 in fully threaded Magni galvanized wood screws. Three screws per panel.	No water observed on the exposed interior surface	Pass

Notes to Table 4.1.2.4

- (1) The rain penetration resistance test have been conducted according to ASTM E331-00, "Water Penetration of Exterior Window, Curtain Walls, and Doors by Uniform Static Air Pressure Differential", except that the water-spray system has delivered water uniformly against the exterior surface of the test specimen at a minimum rate of 25 liters/linear meter/hour. Simultaneously with the application of the water, an air-pressure difference of 500 Pa has been constantly maintained.

Report Holder

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2020-06-23

Appendix A: Pre-engineered Design Solutions

The pre-engineered solutions must be in full accordance with the engineering analysis as prepared by Quaile Engineering Ltd.'s Report No. 19-096-1 Rev 1, dated April 6, 2020. Tables A-1.1 to A-3.1 provide the main pre-engineering solutions for buildings not exceeding two (2) storeys with 3 m height per floor.

A-1. Maximum Stud Spacing for Top Floor (Supporting Roof Only)

- Top plate: **two (2)** 38 mm × 140 mm No. 2 Grade SPF
- Bottom plate: **one (1)** 38 mm × 140 mm No. 2 Grade SPF
- Stud materials: 38 mm × 140 mm stud grade SPF
- Maximum roof truss span: 12 m

Table A-1.1 Maximum Stud Spacing (mm) for Top Floor

Design Snow Load (kPa)	Wall Height (m)	1-in-50 1/50 yr Hourly Wind Pressure (kPa)						
		0.4	0.45	0.5	0.55	0.6	0.65	0.7
1	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–
1.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–
2	2.4	300	300	300	300	300	300	300
	2.7	300	300	300	300	300	300	300
	3.0	300	300	300	300	300	–	–
2.5	2.4	300	300	300	300	300	300	300
	2.7	300	300	300	300	300	300	300
	3.0	300	300	300	300	300	–	–
3	2.4	–	–	–	–	–	–	–
	2.7	–	–	–	–	–	–	–
	3.0	–	–	–	–	–	–	–

Notes to Table A-1.1:

- With conventional two (2) top plates and one (1) bottom plate, the stud spacing is reduced (i.e., 300 mm compared to 600 mm as prescribed in the NBC 2015).
- The wall must be constructed in accordance with Part 9 of Division B of the NBC 2015 unless indicated otherwise.
- The grade and number of wall plates must be as required for this Table.
- The inside plate must be end-nailed to the studs with 3 – 82 mm nails.
- The double plates must be nailed together with 3 – 82 mm nails between studs.
- Upper walls must be located directly over the lower walls.
- Engineered rim board and squash blocks must be provided along with I-joist floors in all cases. The rim board must be at least 28 mm thick. Minimum 38 × 89 mm squash blocks in the rim joist space must be at the same spacing and in line with the studs directly below, except for the rim joist space at the foundation where the squash blocks must be at the same spacing as the studs in the wall above.
- I-joist blocking at 400 mm on centre (o.c.) is required at the top of the wall where the floor joists are parallel to the wall.
- The floor joists and blocking must be fastened to the top plate of the wall with 3 – 82 mm nails.
- Gypsum wall board is assumed to be attached to the interior side of the studs.
- Exterior sheathing must be 11 mm OSB (in compliance with CSA O325, “Construction Sheathing”), or 12.5 mm plywood (in compliance with CSA O121, “Douglas fir plywood” or CSA O151, “Canadian softwood plywood”) installed horizontally across a minimum of three (3) stud spaces.
- A maximum 25 mm hole is permitted at the centre of the stud.
- A minimum 38 × 140 mm sill plate is required at the foundation level.

A-2. Maximum Stud Spacing for Top Floor with Increased Top and Bottom Plates (Supporting Roof Only)

- Top plate: **three (3)** 38 mm × 140 mm No. 2 Grade SPF
- Bottom plate: **two (2)** 38 mm × 140 mm No. 2 Grade SPF
- Stud materials: 38 mm × 140 mm stud grade SPF
- Maximum roof truss span: 12 m

Table A-2.1 Maximum Stud Spacing (mm) for Top Floor with Increased Top and Bottom Plates

Design Snow Load (kPa)	Wall Height (m)	1-in-50 Hourly Wind Pressure (kPa)						
		0.4	0.45	0.5	0.55	0.6	0.65	0.7
1	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–
1.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–
2	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–
2.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–
3	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	300
	3.0	400	400	300	300	300	–	–

Notes to Table A-2.1:

- With increased top and bottom plates, some stud spacings may be increased (i.e., 400 mm compared to 300 mm for the same design snow load, wall height and 1-in-50 1/50 year hourly wind pressure in Table A-1.1)
- The wall must be constructed in accordance with Part 9 of Division B of the NBC 2015 unless indicated otherwise.
- The grade and number of wall plates must be as required for this Table.
- The inside plate must be end-nailed to the studs with 3 – 82 mm nails.
- The double plates must be nailed together with 3 – 82 mm nails between studs.
- Upper walls must be located directly over the lower walls.
- Engineered rim board and squash blocks must be provided along with I-joist floors in all cases. The rim board must be at least 28 mm thick. Minimum 38 × 89 mm squash blocks in the rim joist space are to be at the same spacing and in line with the studs directly below, except for the rim joist space at the foundation where the squash blocks must be at the same spacing as the studs in the wall above.
- I-joist blocking at 400 mm o.c. is required at the top of the wall where the floor joists are parallel to the wall.
- The floor joists and blocking must be fastened to the top plate of the wall with 3 – 82 mm nails.
- Gypsum wall board is assumed to be attached to the interior side of the studs.
- Exterior sheathing must be 11 mm OSB (in compliance with CSA O325), or 12.5 mm plywood (in compliance with CSA O121 or O151) installed horizontally across a minimum of three (3) stud spaces.
- A maximum 25-mm hole is permitted at the centre of the stud.
- A minimum 38 × 140 mm sill plate is required at the foundation level.

A-3. Maximum Stud Spacing for Ground Floor (Supporting Roof and One Floor)

- Top plate: **two (2)** 38 mm × 140 mm No. 2 Grade SPF
- Bottom plate: **two (2)** 38 mm × 140 mm No. 2 Grade SPF
- Stud materials: 38 mm × 140 mm stud grade SPF
- Maximum roof truss span: 12 m
- Maximum floor joist span: 8 m

Table A-3.1 Maximum Stud Spacing (mm) for Ground Floor

Design Snow Load (kPa)	Wall Height (m)	1-in-50 Hourly Wind Pressure (kPa)						
		0.4	0.45	0.5	0.55	0.6	0.65	0.7
1	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	–
	3.0	400	400	300	300	300	–	–
1.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	–
	3.0	400	400	300	300	300	–	–
2	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	–
	3.0	400	400	300	300	300	–	–
2.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	300	300	300	–
	3.0	300	300	300	300	300	–	–
3	2.4	400	400	400	400	300	300	300
	2.7	300	300	300	300	300	300	–
	3.0	300	300	300	300	300	–	–

Notes to Table A-3.1:

- With two (2) top plates and two (2) bottom plates, the stud spacing must be either 300 mm or 400 mm as per Table A-3.1.
- The wall must be constructed in accordance with Part 9 of Division B of the NBC 2015 unless indicated otherwise.
- The grade and number of wall plates must be as required for this Table.
- The inside plate must be end-nailed to the studs with 3 – 82 mm nails.
- The double plates must be nailed together with 3 – 82 mm nails between studs.
- Upper walls must be located directly over the lower walls.
- Engineered rim board and squash blocks must be provided along with I-joist floors in all cases. The rim board must be at least 28 mm thick. Minimum 38 × 89 mm squash blocks in the rim joist space must be at the same spacing and in line with the studs directly below, except for the rim joist space at the foundation where the squash blocks must be at the same spacing as the studs in the wall above.
- I-joist blocking at 400 mm o.c. is required at the top of the wall where the floor joists are parallel to the wall.
- The floor joists and blocking must be fastened to the top plate of the wall with 3 – 82 mm nails.
- Gypsum wall board is assumed to be attached to the interior side of the studs.
- Exterior sheathing to be 11 mm OSB (in compliance with CSA O325), or 12.5 mm plywood (in compliance with CSA O121 or O151) installed horizontally across a minimum of three (3) stud spaces.
- A maximum 25 mm hole is permitted at the centre of the stud.
- A minimum 38 × 140 mm sill plate is required at the foundation level.

A-4. Exterior Sheathing and Fastening

The exterior sheathing requirements are illustrated in Figure A-1, and their fastening schedules are shown in Table A-4.1.

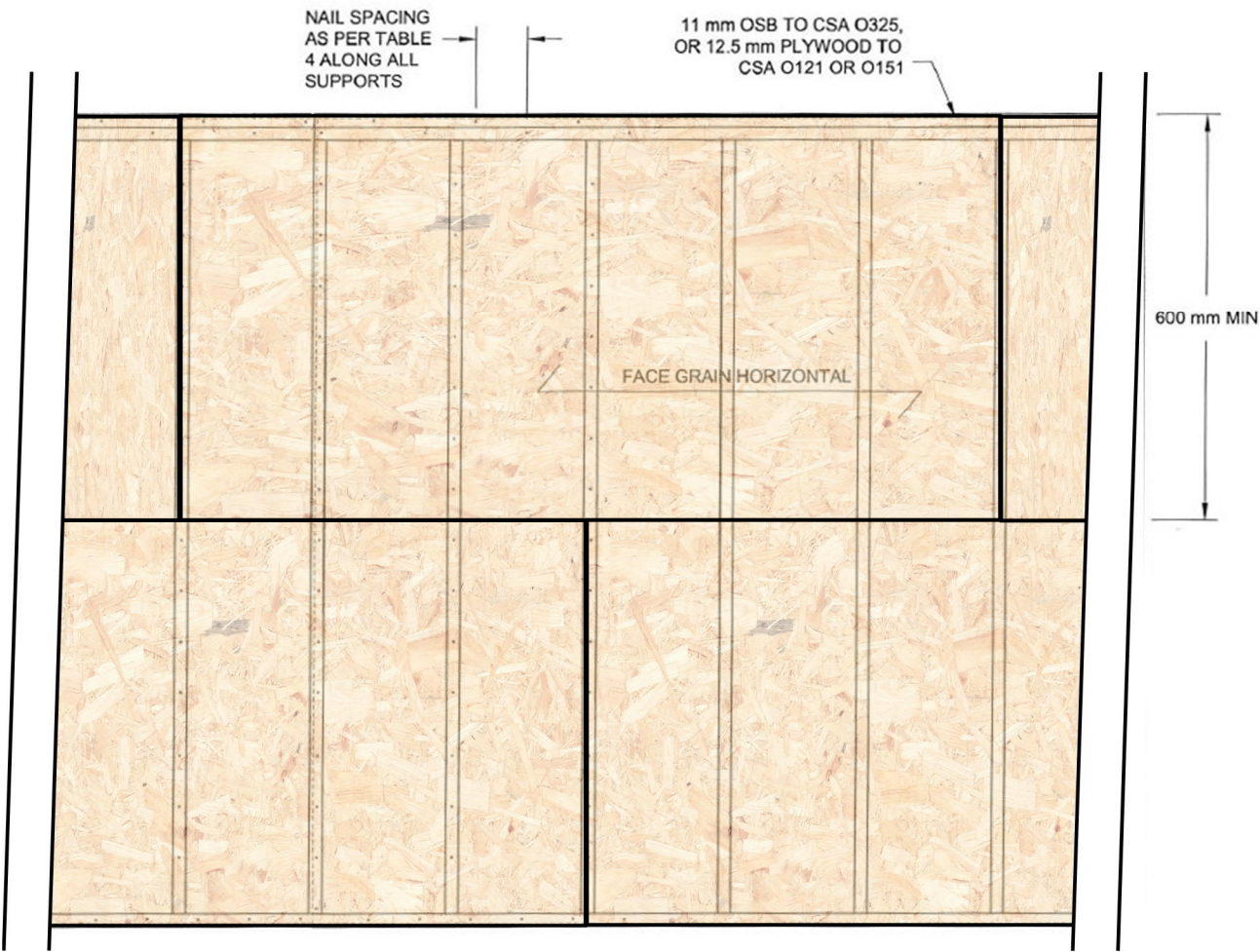


Figure A-1. Exterior sheathing and fastening for the product

Table A-4.1 Nail Spacing for 11 mm OSB or 12.5 mm Plywood Sheathing Fastened to 38 mm × 140 mm SPF Studs

Stud Spacing (mm)	Spiral Nail Size		Maximum Nail Spacing (mm) ⁽¹⁾					
			1-in-50 Hourly Wind Pressure (kPa)					
	Length (mm)	Diameter (mm)	0.45	0.5	0.55	0.6	0.65	0.7
300	63	2.77	150	150	150	150	150	140
	76	3.1	150	150	150	150	150	150
400	63	2.77	150	140	130	120	110	100
	76	3.1	150	150	150	150	150	140

Note to Table A-4.1:

(1) Nails to be spaced as shown along edges of panels and all intermediate studs

A-5. Details of Stud Wall Construction

The details of the stud wall construction are illustrated in Figure A-2. The details in Figure A-2 are designed to accommodate the worst-case scenario for the range of conditions covered by the pre-engineered solutions.

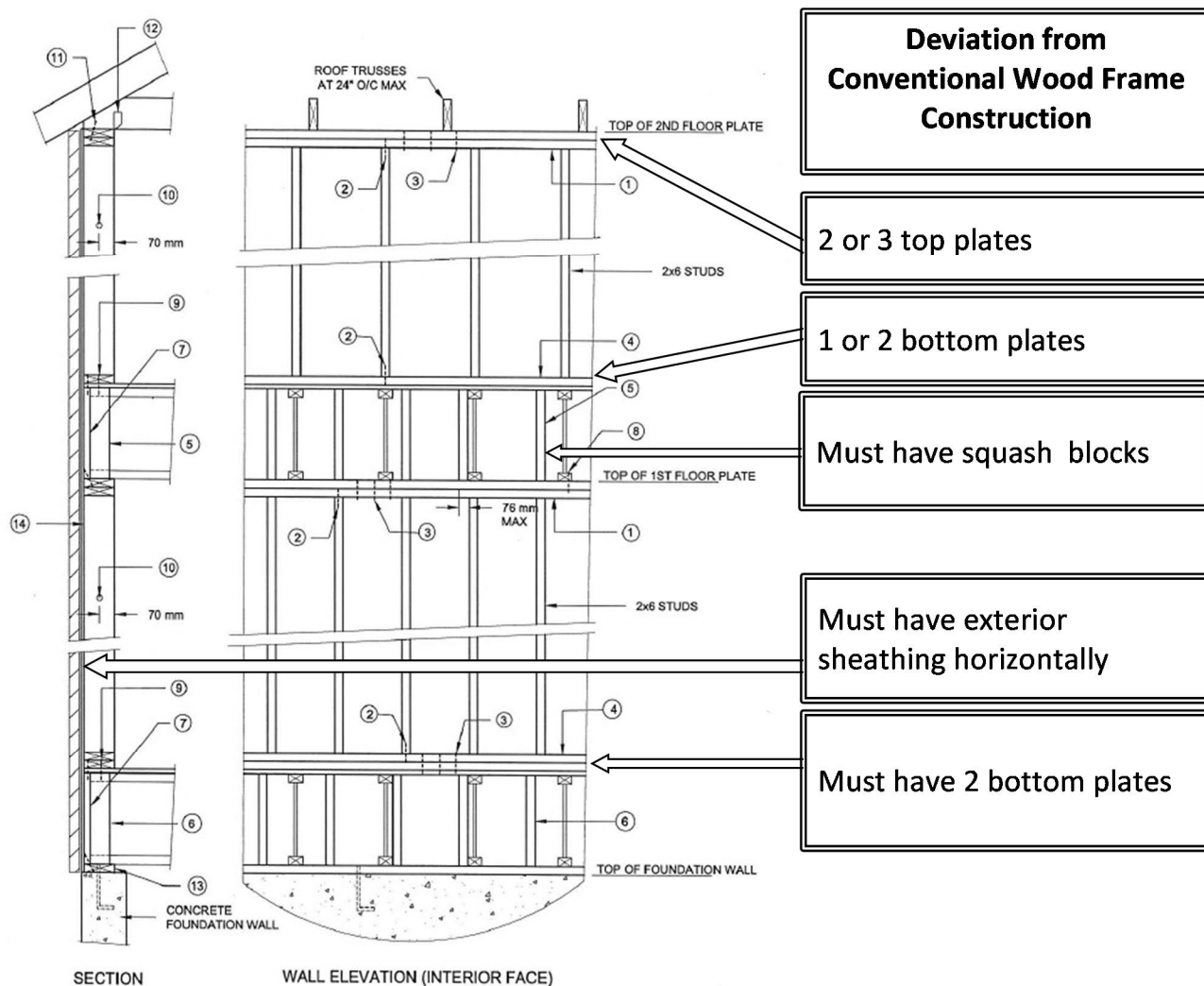


Figure A-2. Stud wall construction for the product (wall elevation, interior face)

1. 2 × 6 top plate (2 or 3 ply as per stud tables)
2. 3 – 82 mm end nails per stud
3. 3 – 82 mm plate-to-plate nails between studs
4. 2 × 6 bottom plate (1 or 2 ply as per stud tables)
5. 2 × 4 squash block aligned with wall studs below (maximum 76 mm offset from stud below)
6. 2 × 4 squash blocks above foundation at the same spacing as the studs in the wall above
7. minimum 28 mm engineered rim board fastened with 82 mm toe nails at 150 mm o.c.
8. floor joist or blocking at maximum of 406 mm o.c., fastened with 3 – 82 mm nails
9. bottom plate fastened to floor with 82 mm nails at 150 mm o.c.
10. maximum 25 mm diameter hole at centre of stud
11. 3 – 82 mm toe nails from truss to plate
12. Simpson strong G-Tie H 10A anchor on each truss
13. 2 × 6 sill plate
14. 11 mm 1 R 24/2f 16 OSB or 12.5 mm softwood or Douglas fir plywood fastened as per Table A-4.1.

A-6. Maximum Lintel Span

The maximum lintel span is provided in Table A-6.1. It is important to note that the lintel span tables provided in Part 9 of Division B of the NBC 2015 are not applicable to walls supporting this product.

Table A-6.1 Maximum Lintel Span⁽¹⁾

Design Snow Load (kPa)	Maximum Lintel Clear Span (m)					
	Lintel Supporting Roof Only			Lintel Supporting Roof and One (1) Floor		
	3 – 38 mm × 184 mm	3 – 38 mm × 235 mm	3 – 38 mm × 286 mm	3 – 38 mm × 184 mm	3 – 38 mm × 235 mm	3 – 38 mm × 286 mm
1	1.89	2.33	2.68	1.26	1.56	1.79
1.5	1.67	2.06	2.37	1.21	1.50	1.72
2	1.51	1.87	2.14	1.15	1.38	1.63
2.5	1.39	1.72	1.97	1.09	1.24	1.54
3	1.29	1.60	1.83	1.04	1.12	1.47

Note to Table A-6.1:

(1) Applicable to No. 2 grade SPF, with a maximum roof truss span of 12 m and a maximum floor joist span of 8 m

A-7. Movement Joints

The movement joints required for this product are illustrated in details in Figure A-3.

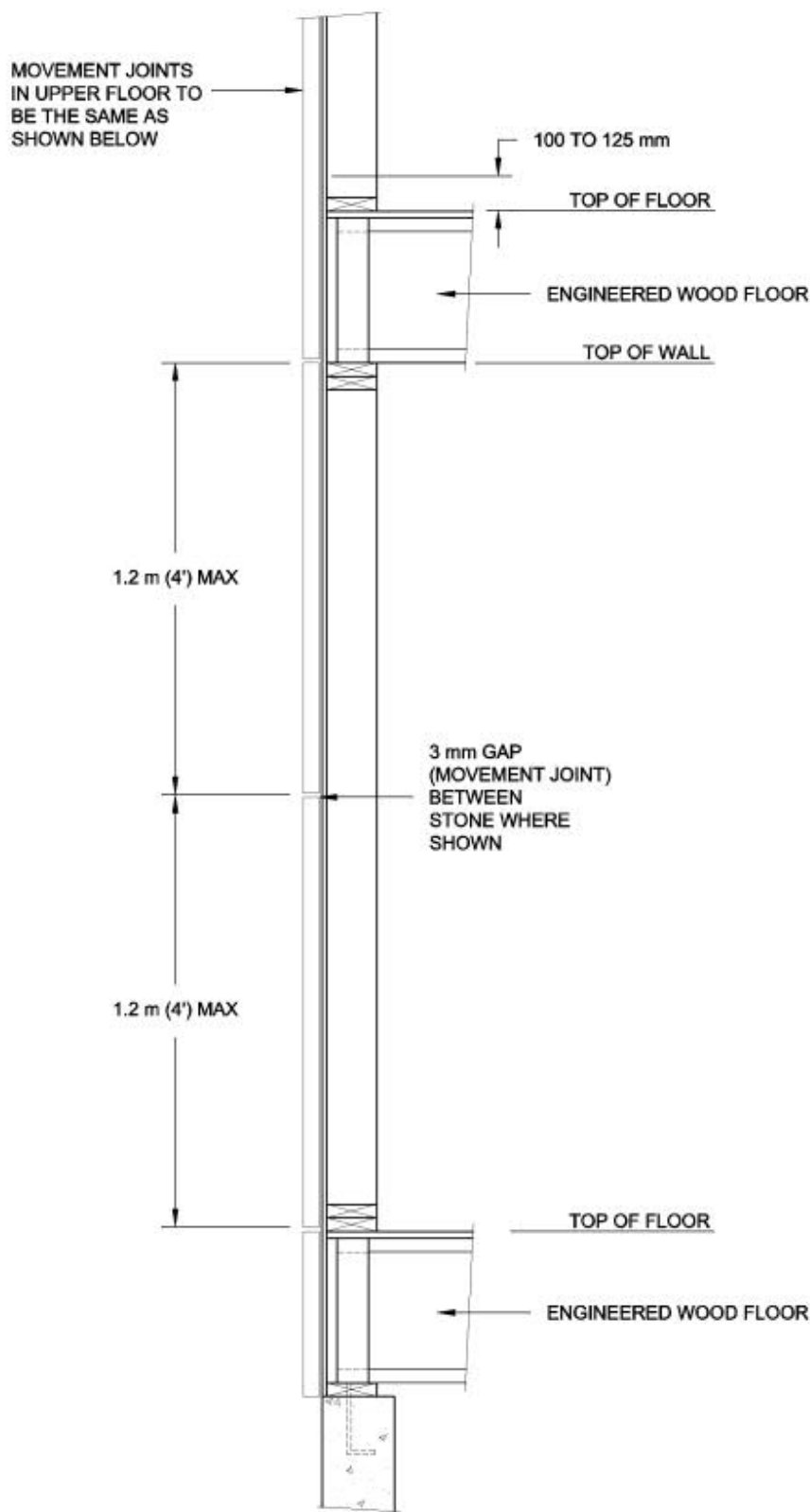


Figure A-3. Required movement joints in applications for the product