Evaluation Report CCMC 14008-R
Shouldice Fusion Stone

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1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "Shouldice Fusion Stone," 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:
  - Subsection 9.27.2., Required Protection from Precipitation
  - Sentence 9.20.6.4.(4), Masonry Veneer

- 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 9.20.2.7., Compressive Strength
  - Article 9.20.5.1., Masonry Support
  - Subsection 9.20.6., Thickness and Height

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

2. Description

The product is a concrete stone veneer cladding that is attached mechanically to Shouldice's specific engineered structural wood sheathing and stud framing design.

The product is composed of Portland cement, natural aggregates, and mineral oxide pigments. Other additives such as water repellant and air entraining agents could be added to the mix. The product is cast in rectangular or square moulds that reflect different textures. The finished product is available in different sizes, varying from 203 mm to 508 mm long, 95 mm to 190 mm wide, and 32 mm to 56 mm thick.

The concrete stones are affixed individually to the structural wood sheathing using metal anchors/clips and metal screws. The metal anchors/clips are Type 304 stainless steel that are 50 mm long and 0.61 mm thick. The fasteners are #8 - 19-mm-long Robertson head stainless steel wood screws. One screw is used per anchor/clip. A metal starter strip anchor is affixed to the bottom of the first row of stones. Contrary to a conventional brick veneer, the product is not supported directly on the foundation wall, but instead is attached independently to the specific structural sheathing and back-up wall design. The top and bottom edges of the concrete stones include grooves to clip the anchors that are attached to the wood sheathing.

Once installed, the joints between the concrete stones could be grouted or left ungrouted (dry-stack), depending on the chosen design. Figure 1 shows the product installed in the dry-stack joint design, and Figure 2 shows the product installed for the grouted

joint design just before grouted. Corner stones are plant-manufactured using two stones cut at 45 degree angles and fixed together with an adhesive (see Figure 3).

Instead of masonry 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 and horizontal sheathing, etc.

Figure 1. "Shouldice Fusion Stone" Installed in Dry-Stack Design

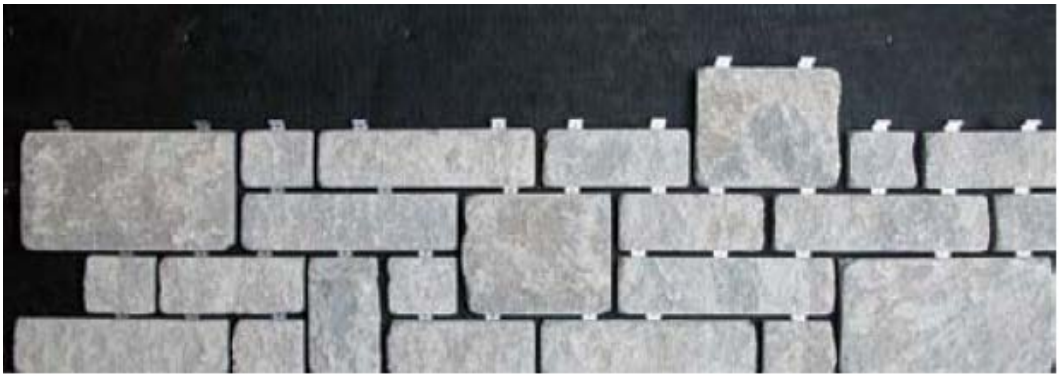

Figure 2. "Shouldice Fusion Stone" installed for the Grouted Joint Design Just Before Grouted

Figure 3. Corner piece of "Shouldice Fusion Stone" assembly

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "Shouldice Fusion Stone" 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 applied on structural grade wood sheathing boards that are attached to wood framing in accordance with the Shouldice back-up wall design specified below.
- The product is permitted to be installed in either a grouted and/or dry-stack joint design.
- The product is limited to installation on buildings not exceeding two (2) storeys with 3 m height per floor.
- The product is limited to installations in geographical areas where the 1/50 design wind load pressure is ≤ 0.85 kPa and the building is Category 2 for internal pressure as defined in the NBC 2015. The wind design value has been validated for the product installed over horizontally-installed plywood or oriented strand board (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.
- The 10-mm air space that is created by the anchors 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 guardrails or raised gardens.
- The requirements of the NBC 2015 regarding fire blocks must be implemented when required.
- The product must be installed in accordance with the manufacturer's current instructions
- . A high level of quality control at all stages of the exterior wall construction is imperative for obtaining an acceptable performance.
- This Evaluation Report is applicable only to products identified by the phrase "CCMC 14008-R."

3.2 Structural

- The product is to be installed on Shouldice's 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., Report 13-166-2, dated January 27, 2014. 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 pre-engineered design solutions are provided having the following features:
    - only applied to "new" construction;
    - the top and bottom plates are increased and the stud spacings are reduced;
    - nailing of the top and bottom plates are 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 the report "Quaile Engineering Ltd., Report 13-166-2, dated January 27, 2014", 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. The plates used in the framing of the back-up wall must be No. 2 grade SPF plates. The anchor clips must be attached to a minimum 11-mm-thick OSB that is supported by untreated wood studs spaced at 406 mm or less, or 12.5-mm plywood sheathing conforming to CSA O121, "Douglas Fir Plywood," or CSA O151, "Canadian Softwood Plywood."
- A horizontal joint must be provided in the stone at each floor level as indicated in Figure A-3.
- The maximum anchor clip spacing along the horizontal joints between stone rows is 150 mm for both the grouted and the dry-stack applications.

- For dry-stack applications, the cladding is installed so that there is at least one row of 95-mm stone above and below any 190-mm stones.
- The fastening screws used to secure the cladding through the anchors/clips must be # 8 - 19-mm-long Robertson-head stainless steel wood screws.
- The cladding attachment must conform with Sentence 9.27.5.1.(1), Article 9.27.5.5., Fastener Materials, and Article 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 anchors/clips and type of fasteners, must be in accordance with the engineering analysis as prepared by Quaile Engineering Ltd., Report 13-166-2, dated January 27, 2014.

4. Technical Evidence

The Report Holder has submitted technical documentation for CCMC's 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 of the Material and Physical Properties (Stone)

Property		Requirement	Results
Dimensions (mm)	**length**	≤ 900	510
	width	≤ 900	128
	thickness	≤ 70	47
Area (m^2)		≤ 0.26	0.07
Deviation from plane of the back face (mm)		≤ 1.0	0.67
Warpage/out-of-square (mm)		Parallel edge dimensions, and out-of-square I any direction ≤ 2	0.01
Dimensional tolerances (mm)	**length**	±3.0	+1.6
	height	±2.0	+0.9
	thickness	±2.0	Pass
Groove thickness (mm)		Report value	1.72
Groove thickness tolerance (mm)		+2.0, –1.0 from specified thickness	0.19 Pass
Weight (kg/m^2)		≤ 75.0	70
Density (kg/m^3)		Report value	1 860
Moisture properties	**water absorption (24 h) (%)**	Report value	5
	water vapour transmission (if any water repellent coating or additive is used) ($kg/m^2 \cdot s \cdot Pa$)	Report value	NA[(1)]
	coefficient of water absorption ($kg/m^2/sec^{½}$)	Report value	0.012[(2)]
			0.011[(3)]
Drying shrinkage (mm/m)		≤ 0.65	0.43
Strength (MPa)	**flexural**	Report value	2.31
	compressive	15	28
Freeze-thaw resistance	**loss of weight (%)**	≤ 1	−0.9
	visual observation	Specimen must not show any deleterious effects such as spalling such as spalling, cracking, or crazing	None

Notes to Table 4.1.1.1:

(1) Not applicable
(2) Back side
(3) Face side

Table 4.1.1.2 Results of Testing of the Materials and Physical Properties (Clip/Anchor)

Property	Requirements	Results		Comments
		P_{ult}	Factored Resistance[(1)]	
Pullout test (N)	≥ 1000	464[(2)]	278	Pass
Pullout test (N)	≥ 1000	427[(2)]	256	Pass
Shear bending (N)	Report value	45	27	Pass

Notes to Table 4.1.1.2:

(1) Factored resistance calculated as per Section 9.4.2.1.1 of CAN/CSA-A370-04,"Connectors for Masonry Welding Requirements," using ϕ =0.6 (buckling failure of the clip).
(2) The specified minimum pullout strength of 1 000 N is based on the requirements of CAN/CSA-A370 that cover specific types of masonry and anchors/clips that fall within the intent of the standard. As the spacing for the product is much closer than the standard veneer ties covered by CAN/CSA-A370, and through the engineering analysis provided for the product, the obtained ultimate and factored resistance of the product's clip/anchors are deemed to meet the intent of the established requirements.

4.1.2. Performance Requirements

Table 4.1.2.1 Results of Testing for Impact Resistance of the Product

Impact Body		Dynamic Mass (kg)	Energy (N•m)	Results
Safety impact	**large soft**	50	100	Pass
	hard	1	10	Pass
Retention of performance impact	**large soft**	50	34	Deemed to pass
	small soft	30	60	Fail[(1)]
	hard	1	10	Fail[(1)]

Note to Table 4.1.2.1:

(1) The product is susceptible to small soft and hard impacts related to the energy levels stated in Table 4.1.2.1. Consequently, the cladding must be sheltered from such impact energies and, in the event of any damage resulting from such impact, the cladding units must be replaced immediately.

Table 4.1.2.2 Results of Testing of Wind Load Resistance of the Product

Cycle	Pressure (Pa) $Q_{50} \leq 0.85$ kPa @ 20 m	Deflection at Midspan of Specimen
Sustained loads (P_1, P_1')	± 235	+0.2/−0.2
	± 470	+0.2/−0.2
	± 705	+0.1/−0.1
	± 940 (P_1)	+0.5/+0.5
	Residual	+1.3/0.0
Cyclic loads (P_2, P_2')	0 to ± 1 370 (P_2)	+0.5/0.0
	Residual	+1.3/+2.1
Gust loads (P_3, P_3')	0 to ± 2 050 (P_3)	+1.0/+0.6
	Residual	0.0/0.0

Report Holder

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Plant(s)

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Date modified:
2019-01-08

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., Report 13-166-2, dated January 27, 2014. 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: **2** – 38 mm × 140 mm No. 2 Grade SPF
- Bottom plate: **1** – 38 mm × 140 mm No. 2 Grade SPF
- Stud materials: 38 mm × 140 mm stud grade SPF
- Maximum roof truss span: 12 m
- Dry-stack design of the product

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

Design Snow Load (kPa)	Wall Height (m)	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	–
	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	300	300	300	300	300	300	300
	2.7	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	–
	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 in the NBC 2015)
- The wall must be constructed in accordance with Part 9 of the NBC 2015 unless indicated otherwise.
- The grade and number of wall plates must be as shown in the table heading.
- The inside plate is to be end-nailed to the studs with 3 – 82 mm nails.
- The double plates are to be nailed together with 3 – 82 mm nails between studs.
- Upper walls are to be located directly over the lower walls.
- Engineered rim board and squash blocks are to be provided along with I-joist floors in all cases. The rim board shall 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 are to 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 are to 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 (to CSA O325), or 12.5 mm plywood (to CSA O121 or O151) installed horizontally across a minimum of three stud spaces.

Notes to Table A-1.1, cont.:

- 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: **3** – 38 mm × 140 mm No. 2 Grade SPF
- Bottom plate: **2** – 38 mm × 140 mm No. 2 Grade SPF
- Stud materials: 38 mm × 140 mm stud grade SPF
- Maximum roof truss span: 12 m
- Dry-stack design of the product

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

Design Snow Load (kPa)	Wall Height (m)	1/50 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	–
	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	400	400	300	300	300	–	–
3	2.4	400	400	400	400	300	300	300
	2.7	400	400	400	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 1/50 year hourly wind pressure in Table A-1.1)
- The wall must be constructed in accordance with Part 9 of the NBC 2015 unless indicated otherwise.
- The grade and number of wall plates must be as shown in the table heading.
- The inside plate is to be end-nailed to the studs with 3 – 82 mm nails.
- The double plates are to be nailed together with 3 – 82 mm nails between studs.
- Upper walls are to be located directly over the lower walls.
- Engineered rim board and squash blocks are to be provided along with I-joist floors in all cases. The rim board shall 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 are to 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 are to 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 (to CSA O325), or 12.5 mm plywood (to CSA O121 or O151) installed horizontally across a minimum of three stud spaces.

Notes to Table A-2.1, cont.:

- 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 1 floor)

- Top plate: **2** – 38 mm × 140 mm No. 2 Grade SPF
- Bottom plate: **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)	1/50 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	300	300	300	300	–
	3.0	400	300	300	300	300	–	–
1.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	300	300	300	300	–
	3.0	400	300	300	300	300	–	–
2	2.4	400	400	400	400	300	300	300
	2.7	400	400	300	300	300	300	–
	3.0	400	300	300	300	300	–	–
2.5	2.4	400	400	400	400	300	300	300
	2.7	400	400	300	300	300	300	–
	3.0	400	300	300	300	300	–	–
3	2.4	400	400	400	400	300	300	300
	2.7	400	400	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 the NBC 2015 unless indicated otherwise.
- The grade and number of wall plates must be as shown in the table heading.
- The inside plate is to be end-nailed to the studs with 3 – 82 mm nails.
- The double plates are to be nailed together with 3 – 82 mm nails between studs.
- Upper walls are to be located directly over the lower walls.
- Engineered rim board and squash blocks are to be provided along with I-joist floors in all cases. The rim board shall 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 are to 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 are to 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 (to CSA O325), or 12.5 mm plywood (to CSA O121 or O151) installed horizontally across a minimum of three 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 4 and their fastening schedules are shown in Table A-4.1.

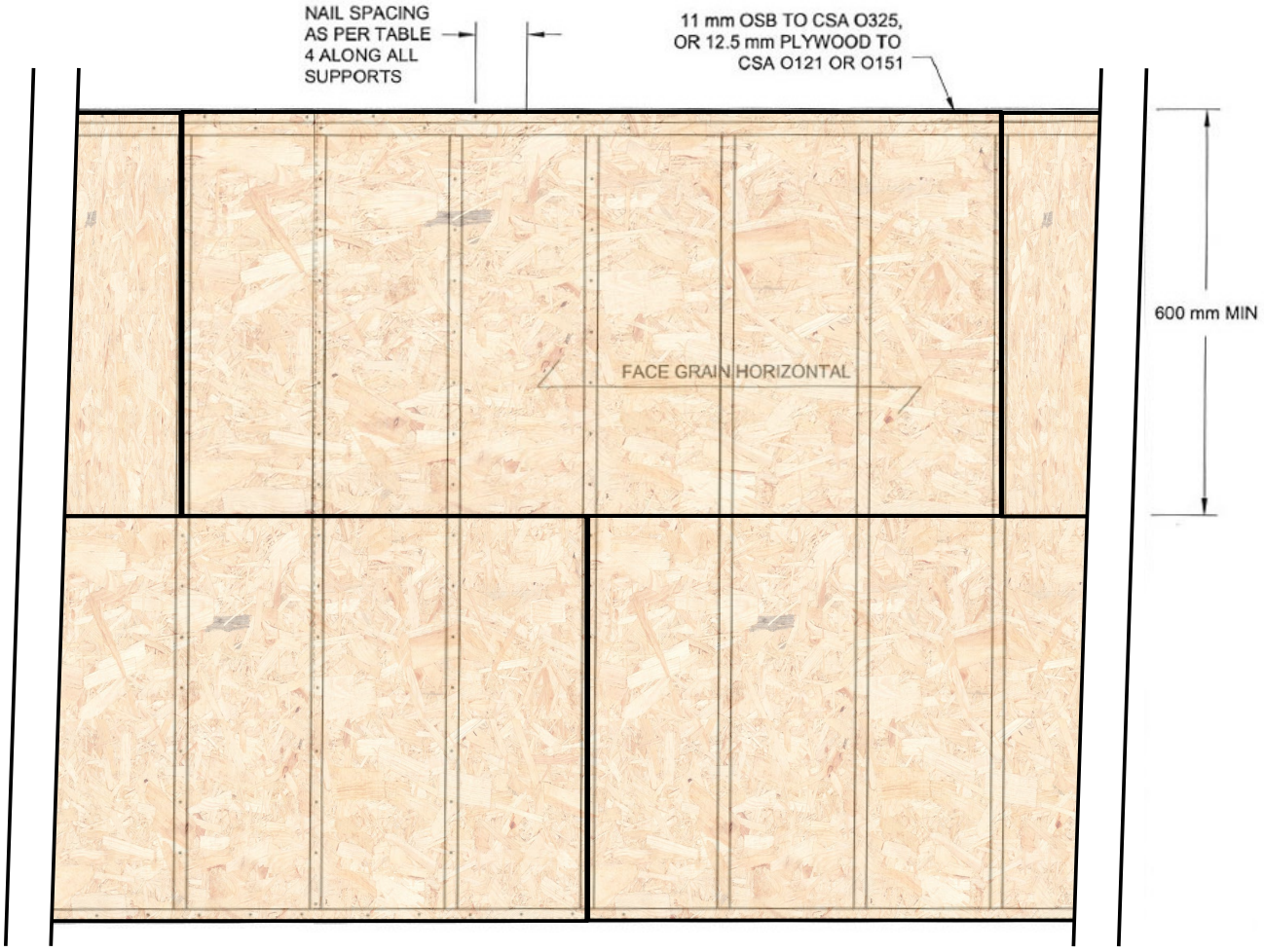

Figure A-1. Exterior sheathing and fastening for the product

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)					
			1/50 yr 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	140	–
	76	3.1	150	150	150	150	150	–
400	63	2.77	140	130	120	110	105	95
	76	3.1	150	150	150	150	145	135

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.

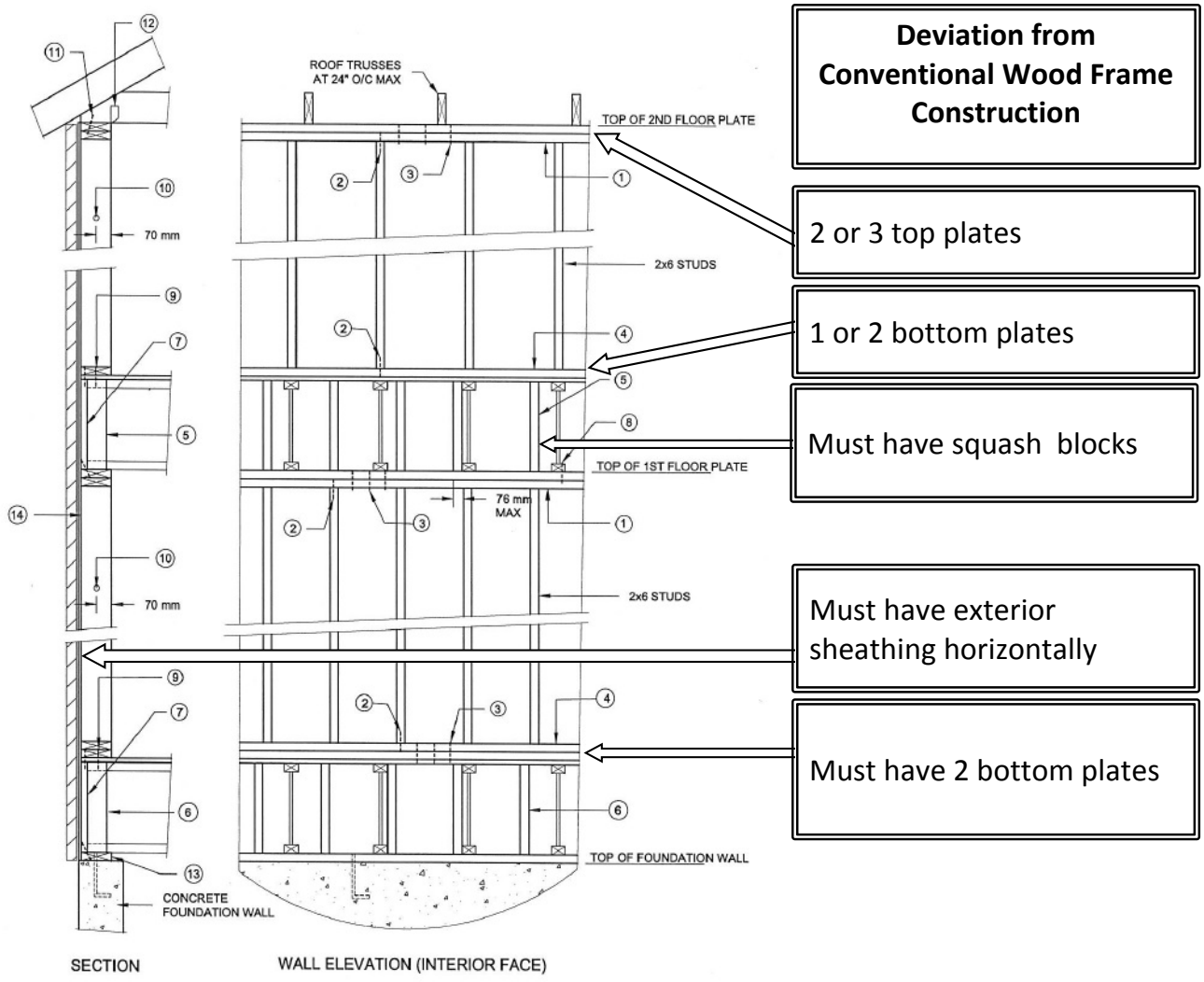

Figure A-2. Stud wall construction for the product (wall elevation, interior face)

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)**

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

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 4.3.4.**

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 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	1.97	2.43	2.79	1.29	1.59	1.82
1.5	1.72	2.13	2.44	1.27	1.58	1.80
2	1.55	1.91	2.20	1.21	1.50	1.71
2.5	1.42	1.75	2.01	1.14	1.37	1.62
3	1.32	1.63	1.86	1.08	1.19	1.53

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.

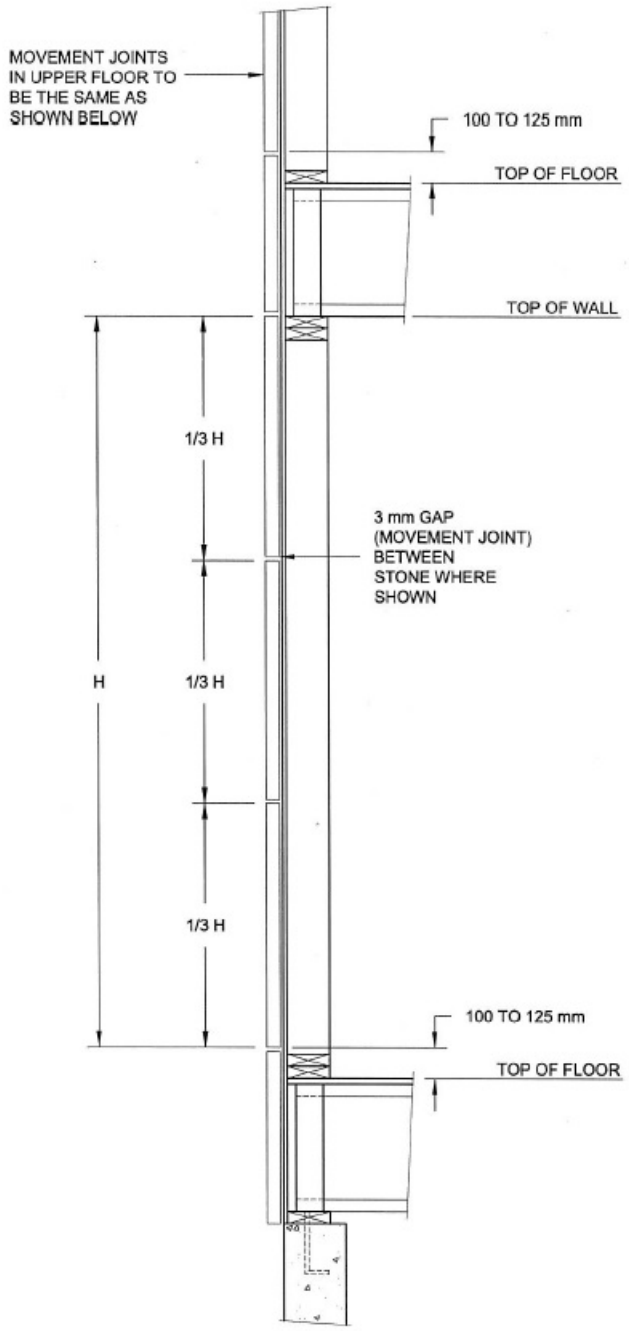

Figure A-3. Required movement joints in applications for the product