Evaluation Report CCMC 13043-R
Amvic Building System (ICF)

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1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "Amvic Building System (ICF)", when used as an insulated concrete form in accordance with the conditions and limitations stated in Section 3 of this Report, complies with the National Building Code 2010:

- Clause 1.2.1.1.(1)(a), Division A, using the following acceptable solutions from Division B:
  - Article 4.1.1.3., Design Requirements (Structural Loads and Procedures)
  - Article 4.3.3.1., Design Basis for Plain, Reinforced and Pre-stressed Concrete
  - Subsection 9.3.1., Concrete
  - Section 9.4., Structural Requirements
  - Clause 9.15.1.1.(1)(c), General (Footings and Foundations)
  - Article 9.15.3.3., Application of Footing Width and Area Requirements
  - Clause 9.15.3.5.(1)(c), Adjustments to Footing Widths for Exterior Walls
  - Clause 9.20.1.1.(1)(b), General (Masonry and Insulating Concrete Form Walls Not In Contact with the Ground)
  - Sentence 9.20.1.1.(2), General (Masonry and Insulating Concrete Form Walls Not In Contact with the Ground)
  - Subsection 9.20.17., Above-Ground Flat Insulating Concrete Form Walls

- Clause 1.2.1.1.(1)(b), 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:
  - Subsection 9.15.4., Foundation Walls
  - Article 9.20.1.2., Earthquake Reinforcement

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 modular, interlocking concrete form system consisting of two expanded polystyrene panels. Embedded in the polystyrene panels are polypropylene connectors that are equally spaced at 150 mm horizontally and 200 mm vertically. The extremities of the polypropylene connectors are embedded close to the exterior surface of the polystyrene panels.

The polystyrene face panels have a preformed symmetrical interlocking EPS design along the top, and side edges, which make the forms reversible (top and bottom, left and right) to facilitate stacking and alignment, as well as to prevent leakage of freshly placed concrete.

The units are dry-laid and stacked in a running (staggered) configuration. The stacked units form a rectangular space that, after being filled with concrete, results in an insulated, monolithic concrete wall of uniform thickness. Reinforcement may be placed where required to satisfy strength requirements for above- or below-grade loadbearing walls, beams, lintels and shear walls.

The units have external dimensions of 1 213 mm in length and 406 mm in height. The polystyrene panels are each 64-mm thick, resulting

in an overall wall thickness of 228 mm, 278 mm, 328 mm or 378 mm that in turn encloses a 100-mm, 150-mm, 200-mm or 250-mm-thick concrete wall.

The product units are available in straight, 90° or 45° corner forms, tapered top and brick ledge forms.

Two units are illustrated in Figure 1.

Figure 1. "Amvic ICF Straight Reversible Block" and "Amvic ICF 90 Corner Reversible Block"

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "Amvic Building System (ICF)" being used in accordance with the conditions and limitations set out below.

- The product is permitted to be used in the construction of houses and small buildings up to two storeys above grade that do not include residences with walkout basements, and fall under the provisions of Part 9 of Division B of the NBC 2010, and subject to all of the conditions listed below.
- The structural applications of this product must be in strict accordance with the design analysis as prepared by Amvic Inc. and included in Report No. 110822.1, dated 23 July 2012, from which Tables 4.2.1.1 to 4.2.1.5 have been reproduced. When the product is used in structural applications outside the scope of the referenced design analysis, the engineering design analysis, related documents and drawings must bear the authorized seal of a registered professional engineer skilled in concrete design and licensed to practice under the appropriate provincial or territorial legislation. The engineer must certify that the construction provides a level of performance equivalent to that required by Part 4 and/or Part 9 of the NBC 2010.
- The maximum permitted building plan dimensions are 24 m × 18 m. Engineering is required on a case-by-case basis for buildings that exceed these dimensions.
- For loadbearing wall and shear wall applications, the minimum core thickness of the product must be 150 mm.
- For non-loadbearing wall applications, the minimum core thickness of the product must be 100 mm.
- Concrete used with this system must comply with Subsection 9.3.1. of Division B of the NBC 2010. It must be Type 10 or Type 30 with a minimum compressive strength of 20 MPa and a maximum slump of 150 ± 12 mm.
- The maximum aggregate size to be used in conjunction with this product must be no greater than 14 mm.
- For the wall heights indicated in Tables 4.2.1.1 and 4.2.1.2, the pouring of concrete must be made at a rate of 1.3 m per hour in consecutive lifts; each lift is limited to a maximum height of 1.3 m.
- All point loads, such as concentrated loads created by girder trusses, columns and beams, must bear directly on top of the concrete wall and must not be supported in any manner to create an eccentric loading on the concrete wall.
- Floor and roof connections to ICF walls must be designed to accommodate diaphragm action in seismic zones and zones of high wind pressure.
- The concrete must be cured a minimum of seven days before backfilling. The wall must be laterally supported at the top and bottom prior to backfilling.
- The EPS insulation used in this system must comply with CAN/ULC-S701-05, "Thermal Insulation, Polystyrene, Boards and Pipe Covering," Type 2, as a minimum.
- The product's EPS insulation panels must be aged for at least three weeks from their date of manufacturing.
- The concrete wall must be constructed on a footing designed as per Article 9.15.3.4., Basic Footing Widths and Areas, of Division B of the NBC 2010.
- The attachment of exterior cladding and interior finishing materials has not been assessed by the present evaluation.
- The interior face of the EPS panels must be protected from the inside of the building in accordance with Sentence 9.10.17.10.(1), Protection of Foamed Plastics, of Division B of the NBC 2010.
- For above-grade installations, the exterior face of the product must be protected with materials conforming to Article 9.20.6.4., Masonry Veneer, and Sections 9.27., Cladding, and/or 9.28., Stucco, of Division B of the NBC 2010.
- For below-grade installations, dampproofing must be provided in accordance with Article 9.13.2., Dampproofing, of Division B of the NBC 2010.
- Where hydrostatic pressure exists, waterproofing must be provided in accordance with Article 9.13.3., Waterproofing, of Division B of the NBC 2010.

- For foundation-wall installations, the backfill must be placed in such a way as to avoid damaging the wall, the exterior insulation panel and the waterproofing and dampproofing protection. The backfill material must be well drained and a drainage system must be installed around the footing in accordance with the requirements of the NBC 2010.

The installation of the product must be in strict compliance with the latest edition of "Amvic Technical Manual" without conflicting with the requirements stated in the NBC 2010 or in this Report. The wall system must be set up only installers trained and authorized by Amvic Inc.

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 Material Requirements

4.1.1 Conformance of the EPS

Compliance of the expanded polystyrene thermal insulation with the requirements of CAN/ULC-S701-05 is covered under Intertek Testing Services (NA) Ltd. Certificate and /or Label service.

4.2 Design Requirements

4.2.1 Conformance of Structural Capacity (Steel Reinforcement Designs)

The design analysis in the Engineering Analysis Report provided to CCMC of walls using the product provides a level of performance equivalent to that required by applicable provisions in Part 4 and/or Part 9 of Division B of the NBC 2010. The corresponding design analysis is summarized in Tables 4.2.1.1 to 4.2.1.5. The tables provide steel reinforcement specifications for a number of different wall and lintel applications based on specific structural loads. The design assumptions are indicated below each table.

Table 4.2.1.1 Vertical and Horizontal Steel Reinforcement for Below-grade Walls[1,2]

Wall Height (m)	Backfill Height (m)	Max. Spacing for Vertical Reinforcement (mm)			Max. Spacing for Horizontal Reinforcement (mm)		
		150-mm wall	200-mm wall	250-mm wall	150-mm wall	200-mm wall	250-mm wall
2.44	1.22	10M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	1.52	10M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	1.82	10M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.12	10M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.05	1.22	10M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	1.52	10M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	1.82	10M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.12	15M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.42	15M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.74	15M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.66	1.22	10M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	1.52	10M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	1.82	10M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.12	15M @ 300	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.52	15M @ 150	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
	2.82	–	–	10M @ 150	–	–	15M @ 400
	3.12	–	–	10M @ 150	–	–	15M @ 400
	3.35	–	–	10M @ 150	–	–	15M @ 400

Notes to Table 4.2.1.1:

1 Table 4.2.1.1 is based on the following assumptions:

- The design is applicable to all seismic zones.
- Maximum building width is 12.2 m.
- Maximum building length is 24.4 m.
- Maximum floor clear span is 6.1 m.
- Maximum roof clear span is 12.2 m with supports at mid-point.
- Maximum number of stories above grade is two (2).
- Maximum number of stories below grade is one (1).
- Roof slope from flat to maximum 1:1.
- Roof dead load is 0.72 kPa.
- Floor dead load is 0.72 kPa.
- Floor live load is 1.92 kPa.
- Snow load is 4.44 kPa.
- Surcharge load is 2.4 kPa.
- Loads include earth pressure and surcharge loads, plus gravity load. Gravity load assumes 2 ICF storeys and a wood roof frame.
- Below-grade walls are assumed to support a brick veneer with a maximum height of 7 320 mm, with an eccentricity of 220 mm for the 150-mm thick wall system and 245 mm for the 200-mm thick wall system.
- Design earth pressure of 960 kg/m^3 (equivalent fluid density).
- All above-grade walls are assumed to be on top of the ICF foundation walls.
- Openings in the foundation wall must be less than 1 220 mm in width and the total openings in the wall must be less than 25% of the wall area.
- When the length of the wall between windows is less than the average length of the windows, the wall is considered unsupported and additional engineering is required.
- Reinforcing bars must be hard grade deformed bars conforming to CSA G30.18-09, "Carbon Steel Bars for Concrete Reinforcement," Grade 400. Specified yield strength of reinforcement, f_y, is 400 MPa.
- Wall design detailing bends, placement, spacing, splicing and protection of reinforcement must be in accordance with CSA A23.3-04 (R2010), "Design of Concrete Structures."
- Minimum concrete cover for vertical reinforcement is 38 mm from the inside face (tension face) of concrete.
- Minimum concrete cover for horizontal reinforcement is 28 mm from the inside face of concrete.
- Two 10M bars must be placed around all openings and extend 600 mm (24 in.) beyond each side of the openings.
- Minimum 28-day concrete yield strength of 20 MPa. Mix designs in accordance with the manufacturer's recommendations.
- Concrete must be allowed to cure for a minimum of seven days prior to backfilling.
- Below-grade walls are considered to be supported by the floor system at the top.
- All materials and workmanship must conform to the requirements of the NBC 2010 including any Revisions and Errata that have been released as of the issue date of this table.

2 Table cells without a value indicate that the spacing is not feasible with respect to the proposed backfill height.

Table 4.2.1.2 Vertical and Horizontal Steel Reinforcement for Above-grade Walls[1]

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)			Max. Spacing for Horizontal Reinforcement (mm)		
	150-mm wall	200-mm wall	250-mm wall	150-mm wall	200-mm wall	250-mm wall
Single-storey concrete construction supporting a wood-frame roof structure						
2.44	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.05	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.66	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
Ground floor concrete construction supporting a second storey wood frame and wood-frame roof structure						
2.44	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.05	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.66	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure						
2.44	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.05	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400
3.66	10M @ 450	10M @ 300	10M @ 150	15M @ 400	15M @ 400	15M @ 400

Note to Table 4.2.1.2:

1 Table 4.2.1.2 is based on the following assumptions:

- The design is applicable to seismic zones up to $S_a(0.2) = 1.2$ for Site Class C.
- Applicable to a maximum wind pressure of 3.18 kPa.
- For allowable building dimensions and floor and roof clear spans, see Note 1 to Table 4.2.1.1.
- For assumed loads, see Note 1 to Table 4.2.1.1.
- For concrete and steel material properties, see Note 1 to Table 4.2.1.1.
- Minimum concrete cover for vertical reinforcement is 38 mm from the inside face (tension face) of concrete.
- Minimum concrete cover for horizontal reinforcement is 28 mm from the inside face of concrete.
- A minimum of two 10M bars should be placed around all openings and must extend at least 600 mm beyond each corner of the opening.

Table 4.2.1.3(a) Minimum Steel Reinforcement of Lintels with a 250-mm Core[1,2]

Opening Width (mm)	Factored Uniformly Distributed Load (kN/m)													
	2.0		5.0		10.0		15.0		20.0		25.0		30.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
1 000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0
1 500	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	55
2 000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	167	1-15M	305
2 500	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	208	1-15M	417	1-20M	555
3 000	1-15M	0	1-15M	0	1-15M	0	1-15M	111	1-15M	458	1-20M	667	1-20M	805
3 500	1-15M	0	1-15M	0	1-15M	0	1-15M	361	1-20M	708	2-15M	917	1-25M	1055
4 000	1-15M	0	1-15M	0	1-15M	0	1-20M	611	2-15M	958	1-25M	1167	2-20M	1305
4 500	1-15M	0	1-15M	0	1-20M	166	2-15M	861	1-25M	1208	2-20M	1417	2-25M	1555
5 000	1-15M	0	1-15M	0	1-20M	416	1-25M	1111	2-20M	1458	2-25M	1667	2-25M	1805

Table 4.2.1.3(b) Minimum Steel Reinforcement of Lintels with a 200-mm Core[1,2]

Opening Width (mm)	Factored Uniformly Distributed Load (kN/m)													
	2.0		5.0		10.0		15.0		20.0		25.0		30.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
1 000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0
1 500	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	83	1-15M	194
2 000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	167	1-15M	333	1-15M	444
2 500	1-15M	0	1-15M	0	1-15M	0	1-15M	139	1-15M	417	1-15M	583	1-20M	694
3 000	1-15M	0	1-15M	0	1-15M	0	1-15M	389	1-15M	667	1-20M	83	2-15M	944
3 500	1-15M	0	1-15M	0	1-15M	83	1-15M	639	1-20M	917	2-15M	1083	1-25M	1194
4 000	1-15M	0	1-15M	0	1-15M	333	1-20M	889	2-15M	1167	1-25M	1333	2-20M	1444
4 500	1-15M	0	1-15M	0	1-20M	583	2-15M	1139	1-25M	1417	1-30M	1583	2-25M	1694
5 000	1-15M	0	1-15M	0	1-20M	833	1-25M	1389	1-30M	1667	2-25M	1833	–	–

Table 4.2.1.3(c) Minimum Steel Reinforcement of Lintels with a 150-mm Core[1,2]

Opening Width (mm)	Factored Uniformly Distributed Load (kN/m)													
	2.0		5.0		10.0		15.0		20.0		25.0		30.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
1 000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	83
1 500	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	125	1-15M	250	1-15M	333
2 000	1-15M	0	1-15M	0	1-15M	0	1-15M	167	1-15M	375	1-15M	500	1-15M	583
2 500	1-15M	0	1-15M	0	1-15M	0	1-15M	417	1-15M	625	1-15M	750	1-20M	833
3 000	1-15M	0	1-15M	0	1-15M	250	1-15M	667	1-15M	875	1-20M	1 000	2-15M	1 083
3 500	1-15M	0	1-15M	0	1-15M	500	1-20M	917	1-20M	1125	2-15M	1 250	1-25M	1 333
4 000	1-15M	0	1-15M	0	1-15M	750	1-20M	1 167	2-15M	1375	1-25M	1 500	–	–
4 500	1-15M	0	1-15M	0	1-20M	1 000	2-15M	1 417	1-25M	1625	–	–	–	–
5 000	1-15M	0	1-15M	0	1-20M	1 250	1-25M	1 667	–	–	–	–	–	–

Notes to Tables 4.2.1.3(a) to 4.2.1.3(c):

1 Tables 4.2.1.3(a) to 4.2.1.3(c) are based on the following assumptions:

- The factored uniformly distributed load includes live and dead loads, not including the weight of the lintel.
- The minimum height of the lintel is 200 mm for Table 4.2.1.3(a); 419 mm for Table 4.2.1.3(b); and 629 mm for Table 4.2.1.3(c).
- Stirrups are single leg fabricated from 10M bars spaced at 100 mm on centre (o.c) for Table 4.2.1.3(a); 200 mm o.c for Table 4.2.1.3(b); and 300 mm o.c for Table 4.2.1.3(c).
- Lintel reinforcing is located at the bottom of the lintel and projects 600 mm into the lintel support on each side.
- Specified compressive strength of concrete, @ 28 days f'_c, is 20 MPa.
- Specified yield strength of reinforcement, f_y, is 400 MPa.
- A minimum of two 10M bars should be placed around all openings and must extend at least 600 mm beyond each corner of the opening.

2 Table cells without a value indicate that the load is not feasible. Engineering input is required.

Table 4.2.1.4(a) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.35 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
18	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.83	1.94	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83

Table 4.2.1.4(b) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.45 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	1.87	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	1.87	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.83	2.18	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
18	6	1.83	1.83	1.83	2.49	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.87	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	1.87	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.87	1.87	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.87	2.18	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.87	2.49	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83

Table 4.2.1.4(c) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.55 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	1.90	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	2.29	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	2.67	1.83	1.83	1.83	1.91	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.83	3.05	1.83	1.83	1.83	2.18	1.83	1.83	1.83	1.83
18	6	1.83	1.83	1.83	2.29	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	2.29	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.90	2.29	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	2.29	2.29	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	2.29	2.67	1.83	1.83	1.83	1.91	1.83	1.83	1.83	1.83
	24	1.83	1.83	2.29	3.05	1.83	1.83	1.83	2.18	1.83	1.83	1.83	1.83

Table 4.2.1.4(d) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.65 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	2.25	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	2.70	1.83	1.83	1.83	1.93	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	3.15	1.83	1.83	1.83	2.26	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.83	3.60	1.83	1.83	1.83	2.58	1.83	1.83	1.83	1.83
18	6	1.83	1.83	1.83	2.70	1.83	1.83	1.83	1.93	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	2.70	1.83	1.83	1.83	1.93	1.83	1.83	1.83	1.83
	15	1.83	1.83	2.25	2.70	1.83	1.83	1.83	1.93	1.83	1.83	1.83	1.83
	18	1.83	1.83	2.70	2.70	1.83	1.83	1.93	1.93	1.83	1.83	1.83	1.83
	21	1.83	1.83	2.70	3.15	1.83	1.83	1.93	2.26	1.83	1.83	1.83	1.83
	24	1.83	1.83	2.70	3.60	1.83	1.83	1.93	2.58	1.83	1.83	1.83	1.93

Table 4.2.1.4(e) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.75 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	2.08	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	2.60	1.83	1.83	1.83	1.86	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	3.12	1.83	1.83	1.83	2.23	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	3.64	1.83	1.83	1.83	2.60	1.83	1.83	1.83	1.95
	24	1.83	2.08	1.83	4.15	1.83	1.83	1.83	2.98	1.83	1.83	1.83	2.23
18	6	1.83	1.83	1.83	3.12	1.83	1.83	1.83	2.23	1.83	1.83	1.83	1.83
	12	1.83	1.83	2.08	3.12	1.83	1.83	1.83	2.23	1.83	1.83	1.83	1.83
	15	1.83	1.83	2.60	3.12	1.83	1.83	1.86	2.23	1.83	1.83	1.83	1.83
	18	1.83	1.83	3.12	3.12	1.83	1.83	2.23	2.23	1.83	1.83	1.83	1.83
	21	1.83	1.83	3.12	3.64	1.83	1.83	2.23	2.60	1.83	1.83	1.83	1.95
	24	1.83	2.08	3.12	4.15	1.83	1.83	2.23	2.98	1.83	1.83	1.83	2.23

Table 4.2.1.4(f) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.85 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	2.08	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	2.60	1.83	1.83	1.83	2.11	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	3.12	1.83	1.83	1.83	2.53	1.83	1.83	1.83	1.90
	21	1.83	2.06	1.83	3.64	1.83	1.83	1.83	2.95	1.83	1.83	1.83	2.21
	24	1.83	2.35	1.83	4.15	1.83	1.83	1.83	3.37	1.83	1.83	1.83	2.53
18	6	1.83	1.83	1.83	3.12	1.83	1.83	1.83	2.53	1.83	1.83	1.83	1.90
	12	1.83	1.83	2.35	3.12	1.83	1.83	1.83	2.53	1.83	1.83	1.83	1.90
	15	1.83	1.83	2.94	3.12	1.83	1.83	2.11	2.53	1.83	1.83	1.83	1.90
	18	1.83	1.83	3.53	3.12	1.83	1.83	2.53	2.53	1.83	1.83	1.90	1.90
	21	1.83	2.06	3.53	3.64	1.83	1.83	2.53	2.95	1.83	1.83	1.90	2.21
	24	1.47	2.35	3.53	4.15	1.83	1.83	2.53	3.37	1.83	1.83	1.90	2.53

Table 4.2.1.4(g) Minimum Solid Shear Wall Length for Wind Pressure Equal to 0.95 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.97	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.97	2.63	1.83	1.83	1.83	1.88	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.97	3.29	1.83	1.83	1.83	2.36	1.83	1.83	1.83	1.83
	18	1.83	1.97	1.97	3.95	1.83	1.83	1.83	2.83	1.83	1.83	1.83	2.12
	21	1.83	2.30	1.97	4.60	1.83	1.83	1.83	3.30	1.83	1.83	1.83	2.47
	24	1.83	2.63	1.97	5.26	1.83	1.88	1.83	3.77	1.83	1.83	1.83	2.82
18	6	1.83	1.97	1.83	3.95	1.83	1.83	1.83	2.83	1.83	1.83	1.83	2.12
	12	1.83	1.97	2.63	3.95	1.83	1.83	1.88	2.83	1.83	1.83	1.83	2.12
	15	1.83	1.97	3.29	3.95	1.83	1.83	2.36	2.83	1.83	1.83	1.83	2.12
	18	1.97	1.97	3.95	3.95	1.83	1.83	2.83	2.83	1.83	1.83	2.12	2.12
	21	1.97	2.30	3.95	4.60	1.83	1.83	2.83	3.30	1.83	1.83	2.12	2.47
	24	1.97	2.63	3.95	5.26	1.83	1.88	2.83	3.77	1.83	1.83	2.12	2.82

Table 4.2.1.4(h) Minimum Solid Shear Wall Length for Wind Pressure Equal to 1.05 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	2.18	2.91	1.83	1.83	1.83	2.08	1.83	1.83	1.83	1.83
	15	1.83	1.83	2.18	3.64	1.83	1.83	1.83	2.60	1.83	1.83	1.83	1.95
	18	1.83	2.18	2.18	4.36	1.83	1.83	1.83	3.12	1.83	1.83	1.83	2.34
	21	1.83	2.54	2.18	5.09	1.83	1.83	1.83	3.65	1.83	1.83	1.83	2.73
	24	1.83	2.91	2.18	5.82	1.83	2.08	1.83	4.17	1.83	1.83	1.83	3.12
18	6	1.83	2.18	1.83	4.36	1.83	1.83	1.83	3.12	1.83	1.83	1.83	2.34
	12	1.83	2.18	2.91	4.36	1.83	1.83	2.08	3.12	1.83	1.83	1.83	2.34
	15	1.83	2.18	3.64	4.36	1.83	1.83	2.60	3.12	1.83	1.83	1.95	2.34
	18	2.18	2.18	4.36	4.36	1.83	1.83	3.12	3.12	1.83	1.83	2.34	2.34
	21	2.18	2.54	4.36	5.09	1.83	1.83	3.12	3.65	1.83	1.83	2.34	2.73
	24	2.18	2.91	4.36	5.82	1.83	2.08	3.12	4.17	1.83	1.83	2.34	3.12

Table 4.2.1.4(i) Minimum Solid Shear Wall Length for Wind Pressure Equal to 1.25 kPa[1]

Length (m)	Width (m)	150-mm-thick Wall (mm)				200-mm-thick Wall (mm)				250-mm-thick Wall (mm)			
		2nd floor		1st floor		2nd floor		1st floor		2nd floor		1st floor	
		Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.	Short dir.	Long dir.
9	6	1.83	1.83	1.83	2.60	1.83	1.83	1.83	1.86	1.83	1.83	1.83	1.83
	12	1.83	1.83	2.60	3.46	1.83	1.83	1.86	2.48	1.83	1.83	1.83	1.86
	15	1.83	2.16	2.60	4.33	1.83	1.83	1.86	3.10	1.83	1.83	1.83	2.32
	18	1.83	2.60	2.60	5.19	1.83	1.86	1.86	3.72	1.83	1.83	1.83	2.79
	21	1.83	3.03	2.60	6.06	1.83	2.17	1.86	4.34	1.83	1.83	1.83	3.25
	24	1.83	3.46	2.60	6.92	1.83	2.48	1.86	4.96	1.83	1.86	1.83	3.72
18	6	1.83	2.60	1.83	5.19	1.83	1.86	1.83	3.72	1.83	1.83	1.83	2.79
	12	1.83	2.60	3.46	5.19	1.83	1.86	2.48	3.72	1.83	1.83	1.86	2.79
	15	2.16	2.60	4.33	5.19	1.83	1.86	3.10	3.72	1.83	1.83	2.32	2.79
	18	2.60	2.60	5.19	5.19	1.86	1.86	3.72	3.72	1.83	1.83	2.79	2.79
	21	2.60	3.03	5.19	6.06	1.86	2.17	3.72	4.34	1.83	1.83	2.79	3.25
	24	2.60	3.46	5.19	6.92	1.86	2.48	3.72	4.96	1.83	1.86	2.79	3.72

Notes to Tables 4.2.1.4(a) to 4.2.1.4(i):

1 Tables 4.2.1.4(a) to 4.2.1.4(i) are based on the following assumptions:

- Linear interpolation is permitted between hourly wind pressure and building lengths.
- Design applicable to Type A soil.
- The minimum shear wall length is the maximum of either 1.2 m or height/2 or 6 × wall thickness.
- Specified compressive strength of concrete, @ 28 days f'_c, is 20 MPa.
- Specified yield strength of reinforcement, f_y, is 400 MPa.

Table 4.2.1.5(a) Minimum Solid Wall Length for $S_a(0.2) \leq 0.2$[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.83	1.83	1.83	1.83	1.83
	18	1.83	1.83	1.83	1.83	1.83	1.83
	21	1.83	1.83	1.83	1.83	1.83	1.83
	24	1.83	1.83	1.83	1.83	1.83	1.83
18	6	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.93	1.83	1.83	1.83	1.83
	18	1.83	2.18	1.83	1.83	1.83	1.83
	21	1.83	2.43	1.83	2.00	1.83	1.83
	24	1.83	2.68	1.83	2.20	1.83	1.86

Table 4.2.1.5(b) Minimum Solid Wall Length for $S_a(0.2) = 0.3$[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	1.83	1.83	1.83	1.83	1.83
	15	1.83	1.84	1.83	1.83	1.83	1.83
	18	1.83	2.11	1.83	1.83	1.83	1.83
	21	1.83	2.38	1.83	2.00	1.83	1.83
	24	1.83	2.64	1.83	2.22	1.83	1.91
18	6	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	2.48	1.83	2.07	1.83	1.83
	15	1.83	2.85	1.83	2.37	1.83	2.02
	18	1.83	3.22	1.83	2.66	1.83	2.26
	21	2.01	3.59	1.83	2.96	1.83	2.51
	24	2.22	3.96	1.83	3.25	1.83	2.75

Table 4.2.1.5(c) Minimum Solid Wall Length for $S_a(0.2)$ = 0.45[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	1.83	1.83	1.83	1.83	1.83
	12	1.83	2.25	1.83	1.91	1.83	1.83
	15	1.83	2.63	1.83	2.22	1.83	1.92
	18	1.83	3.01	1.83	2.54	1.83	2.19
	21	1.83	3.40	1.83	2.86	1.83	2.46
	24	2.04	3.78	1.83	3.17	1.83	2.73
18	6	1.83	2.48	1.83	2.12	1.83	1.84
	12	1.93	3.54	1.83	2.96	1.83	2.54
	15	2.24	4.07	1.83	3.38	1.83	2.89
	18	2.55	4.60	2.07	3.81	1.83	3.23
	21	2.87	5.13	2.32	4.23	1.93	3.58
	24	3.18	5.66	2.56	4.65	2.13	3.93

Table 4.2.1.5(d) Minimum Solid Wall Length for $S_a(0.2)$ = 0.66[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	2.07	1.83	1.83	1.83	1.83
	12	1.83	3.14	1.83	2.67	1.83	2.31
	15	1.96	3.68	1.83	3.11	1.83	2.69
	18	2.26	4.21	1.87	3.55	1.83	3.06
	21	2.56	4.75	2.11	4.00	1.83	3.44
	24	2.86	5.29	2.36	4.44	2.00	3.82
18	6	1.83	3.47	1.83	2.96	1.93	2.58
	12	2.70	4.96	2.22	4.14	1.87	3.55
	15	3.14	5.70	2.56	4.73	2.15	4.04
	18	3.58	6.44	2.90	5.33	2.43	4.52
	21	4.01	7.18	3.24	5.92	2.71	5.01
	24	4.45	7.92	3.59	6.51	2.98	5.50

Table 4.2.1.5(e) Minimum Solid Wall Length for $S_a(0.2)$ = 0.75[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	2.22	1.83	1.91	1.83	1.83
	12	1.83	3.37	1.83	2.86	1.83	2.48
	15	2.11	3.95	1.83	3.34	1.83	2.89
	18	2.43	4.53	2.01	3.82	1.83	3.29
	21	2.75	5.10	2.27	4.29	1.93	3.69
	24	3.07	5.68	2.53	4.77	2.15	4.10
18	6	1.96	3.73	1.83	3.18	1.83	2.77
	12	2.90	5.32	2.38	4.45	2.01	3.81
	15	3.37	6.12	2.75	5.08	2.31	3.34
	18	3.84	6.92	3.11	5.72	2.61	4.86
	21	4.31	7.71	3.48	6.35	2.91	5.38
	24	4.78	8.51	3.85	6.99	3.20	5.91

Table 4.2.1.5(f) Minimum Solid Wall Length for $S_a(0.2)$ = 0.94[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	2.78	1.83	2.39	1.83	2.09
	12	2.24	4.23	1.87	3.59	1.83	3.11
	15	2.64	4.95	2.19	4.19	1.87	3.62
	18	3.04	5.67	2.52	4.78	2.14	4.12
	21	3.44	6.40	2.85	5.38	2.42	4.63
	24	3.84	7.12	3.17	5.98	2.69	5.14
18	6	2.45	4.68	2.06	3.99	1.83	3.47
	12	3.63	6.67	2.98	5.58	2.52	4.78
	15	4.22	7.67	3.44	6.37	2.89	5.43
	18	4.81	8.76	3.90	7.17	3.27	6.09
	21	5.40	9.67	4.36	7.96	3.64	6.75
	24	5.99	10.66	4.83	8.76	4.02	7.40

Table 4.2.1.5(g) Minimum Solid Wall Length for $S_a(0.2)$ = 1.2[1] and Type D Soil

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	1.83	3.49	1.83	3.00	1.83	2.62
	12	2.81	5.30	2.34	4.50	2.00	3.90
	15	3.31	6.21	2.75	5.25	2.35	4.53
	18	3.8	7.11	3.16	6.00	2.69	5.17
	21	4.31	8.02	3.57	6.47	3.03	5.80
	24	4.82	8.92	3.97	7.49	3.37	6.44
18	6	3.07	5.86	2.58	5.00	2.22	4.35
	12	4.55	8.36	3.74	6.99	3.16	5.99
	15	5.29	9.61	4.32	7.99	3.63	6.81
	18	6.03	10.86	4.89	8.98	4.10	7.63
	21	6.77	12.11	5.47	9.98	4.56	8.45
	24	7.51	13.36	6.05	10.98	5.03	9.28

Table 4.2.1.5(h) Minimum Solid Wall Length for $S_a(0.2)$ = 2.3[1] and Type D Soil[2]

Width (m)	Length (m)	Wall Thickness (mm)					
		150 mm		200 mm		250 mm	
		2nd floor	1st floor	2nd floor	1st floor	2nd floor	1st floor
12	6	–	–	2.71	5.32	2.35	4.66
	12	–	–	4.16	7.98	3.56	6.91
	15	–	–	–	–	4.16	8.04
	18	–	–	–	–	–	–
	21	–	–	–	–	–	–
	24	–	–	–	–	–	–
18	6	–	–	–	–	–	–
	12	–	–	–	–	5.60	10.63
	15	–	–	7.66	14.18	6.44	12.09
	18	–	–	8.68	15.94	7.27	13.55
	21	–	–	9.71	17.71	8.10	15.00
	24	–	–	–	–	8.93	16.46

Notes to Table 4.2.1.5(a) to 4.2.1.5(h):

1 Tables 4.2.1.5(a) to 4.2.1.5(h) are based on the following assumptions:
- Linear interpolation is permitted between hourly wind pressures and building lengths.
- The design is applicable to Type D soil.
- The maximum wall height is 3.66 m for each floor.
- Specified compressive strength of concrete, @ 28 days, f'_c, is 20 MPa.
- Specified yield strength of reinforcement, f_y, is 400 MPa.

2 Table cells without a value indicate that the design is not feasible.

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