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EVALUATION
REPORT

DIVISION 03131

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NUDURA™ Integrated Building Technology

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1. Purpose of Evaluation

The manufacturer sought confirmation from the Canadian Construction Materials Centre (CCMC) that “NUDURA™ Integrated Building Technology” can serve as a wall forming system, resulting in a monolithic concrete wall in compliance with the intent of the National Building Code of Canada (NBC) 1995.

2. Opinion

Test results and a design analysis provided by the manufacturer show that “NUDURA™ Integrated Building Technology” complies with CCMC’s Technical Guide for Modular, Expanded-polystyrene Concrete Forms, Masterformat number 03131, dated 2000-09-16, subject to the limitations and conditions stated in this report, “NUDURA™ Integrated Building Technology” and provides a level of performance equivalent to that required by:

- NBC 1995, Article 4.3.3.1., Subsection 9.3.1., Section 9.4., and Subsection 9.15.4., with respect to wall construction.

Canada Mortgage and Housing Corporation permits the use of this product in construction financed or insured under the National Housing Act.

Note: The attachment of exterior cladding and interior finishing materials has not been assessed by the present evaluation.

3. Description

“NUDURA™ Integrated Building Technology” units are modular, interlocking, concrete forms consisting of two expanded-polystyrene panels, Type II, having a density of 20.50 kg/m³. The two polystyrene panels are connected through polypropylene webs that are molded into the polystyrene panels, and equally spaced at 203 mm. The extremities of the polypropylene connectors are flush with the exterior surface of the molds. The forms are dry-laid and stacked in a running (staggered) configuration. The laid-up units form a rectangular space that, after being filled with concrete, forms 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 2440 mm in length and 457 mm in height. The polystyrene panels are 64 mm thick, resulting in an overall wall thickness of 235 mm, 286 mm and 336 mm that, in turn, encloses a 100 mm, 152 mm and a 203 mm concrete wall.

The polystyrene face panels have a preformed interlocking mechanism along their top and bottom edges to facilitate stacking and to prevent the leakage of freshly placed concrete.

The unit is illustrated in Figure 1.

Typical details for residential and small building construction conforming to the requirements of Part 9 of the NBC are shown in Figures 2 to 6.

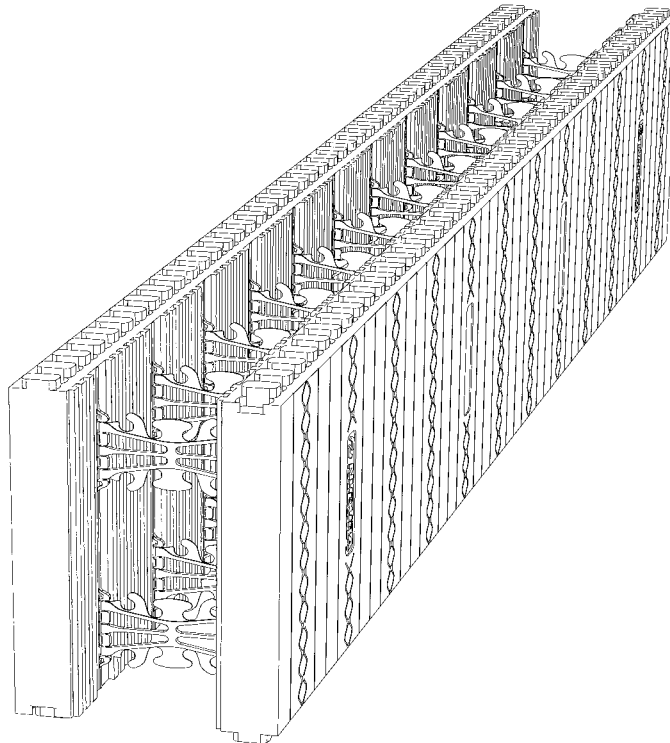


Figure 1. “NUDURA™ Integrated Building Technology” standard unit

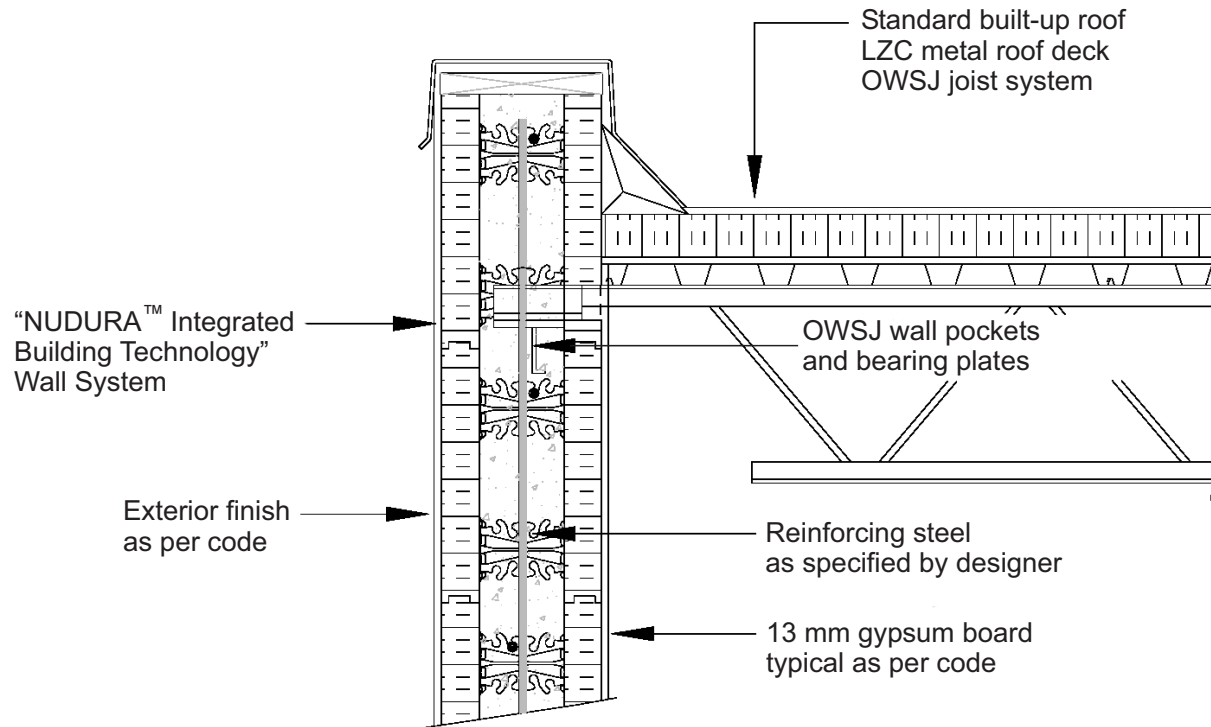


Figure 2. Typical flat roof detail (steel joist)

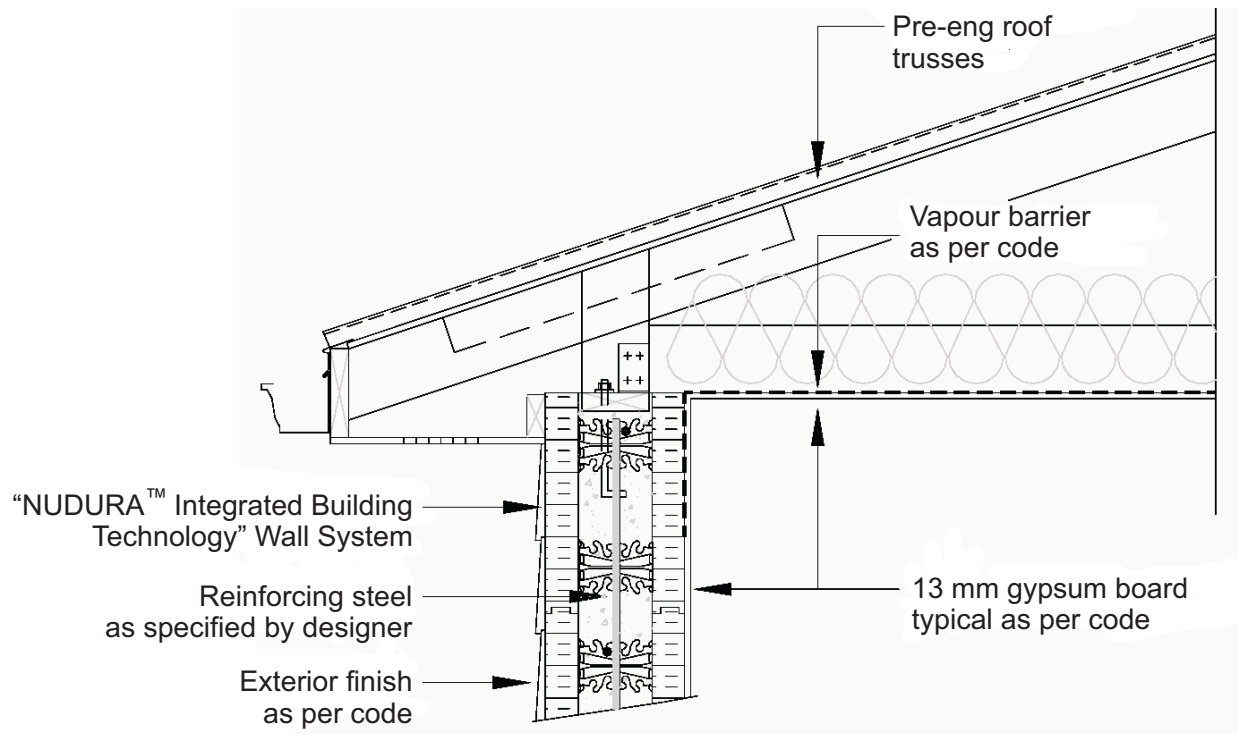


Figure 3. Typical sloped roof detail (wood truss)

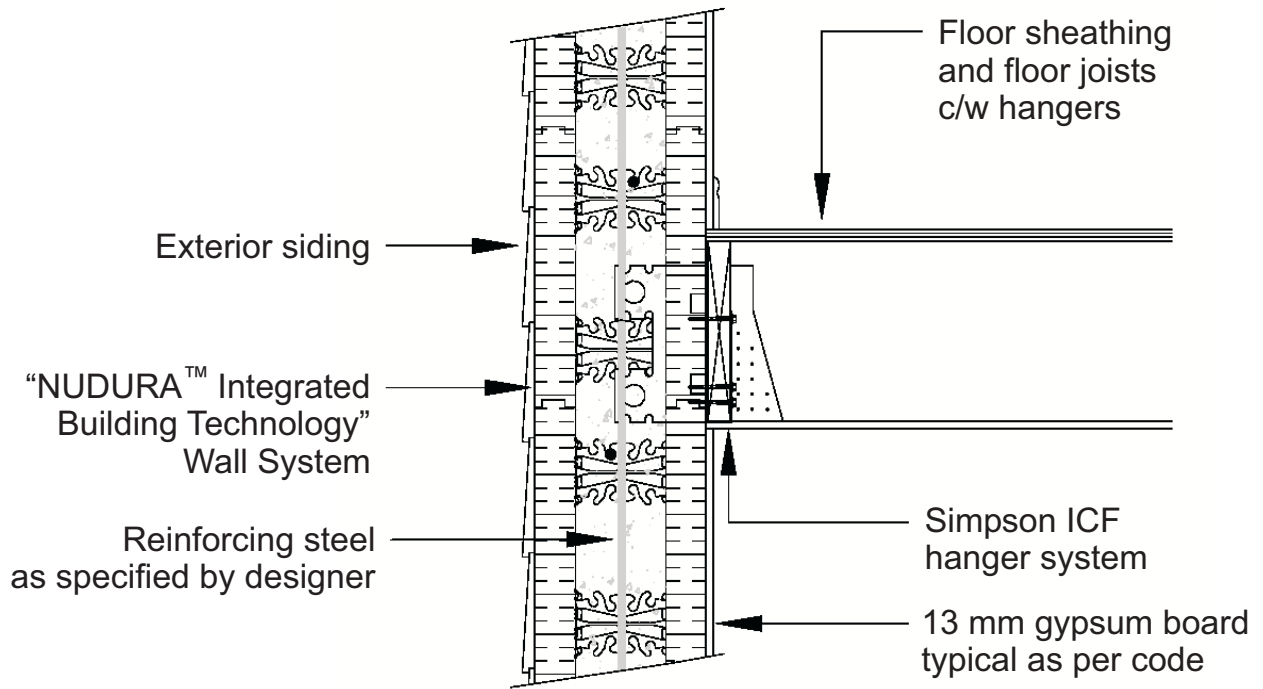


Figure 4. Typical detail for wood floor joist support

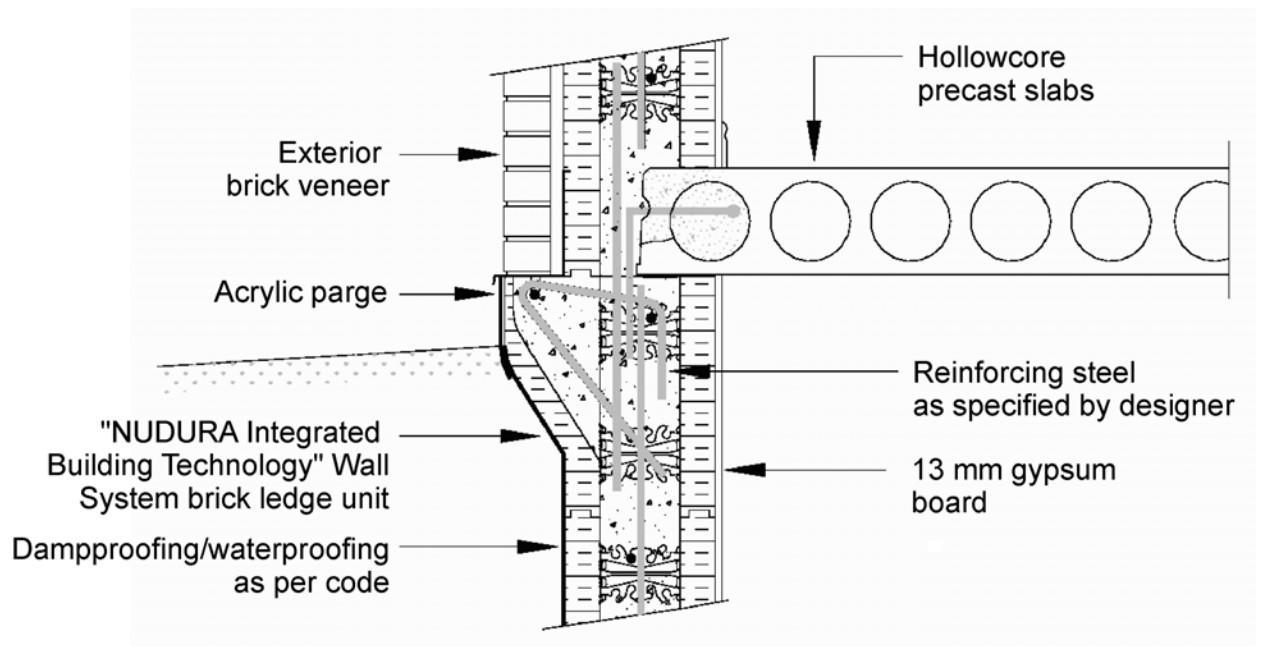


Figure 5. Typical detail for support of brick veneer

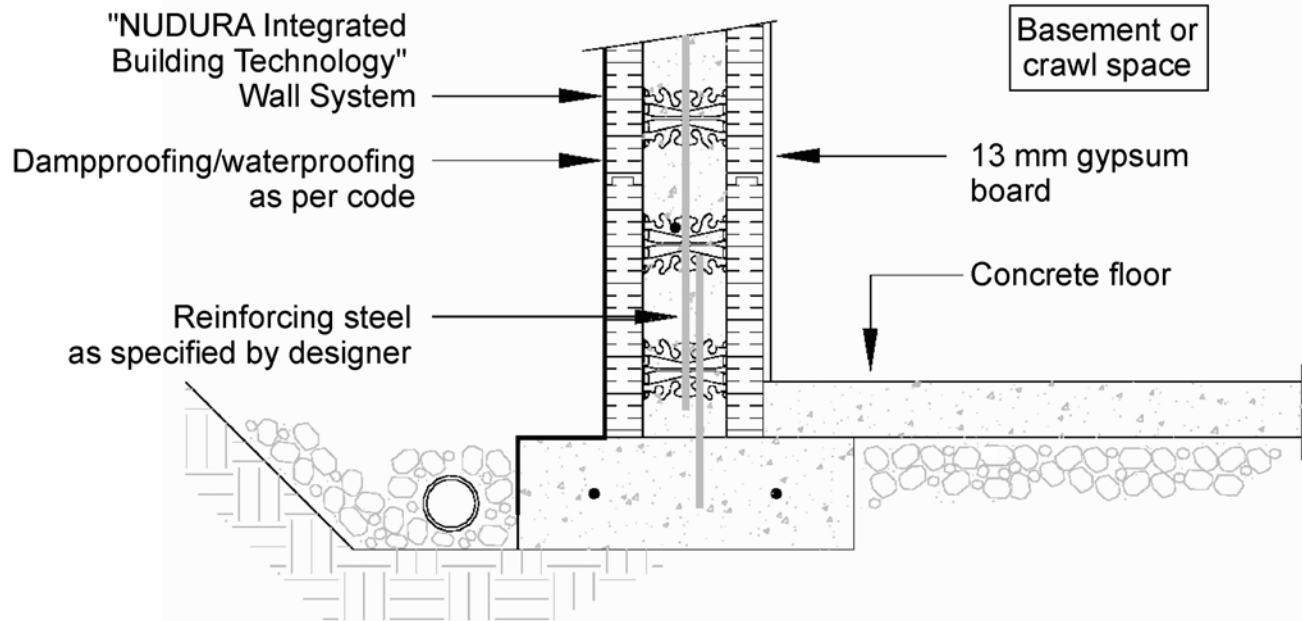


Figure 6. Typical detail at foundation

4. Usage and Limitations

The use of "NUDURA™ Integrated Building Technology" is permitted in construction of houses and small buildings up to two storeys high, that fall under the provisions of Part 9 of NBC 1995, subject to the following conditions:

- The structural applications of "NUDURA™ Integrated Building Technology" must be in strict accordance with the design analysis as prepared for NUDURA Corporation by "Trow Associates Inc., Report No. 01-1142, dated 17 August 2001, revised July 25, 2003, and from which Tables 1(a), 1(b), 1(c), 2(a), 2(b), and 2(c) have been reproduced.
- The concrete used "NUDURA™ Integrated Building Technology" units must be Type 10 or Type 30, having a minimum compressive strength of 20 MPa, and a maximum slump of 140 mm±25 mm.
The maximum aggregate size to be used in conjunction with "NUDURA™ Integrated Building Technology" shall not be greater than 14 mm.
- For the wall heights indicated in Table 2(a), and 2(b), the pouring of concrete must be made at a rate of 1.2 m per hour in consecutive lifts; each lift is limited to a maximum height of 1.2 m.
- The EPS insulation used in this system must comply with CAN/ULC-S701-97," Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering," Type 2.
- The aging of "NUDURA™ Integrated Building Technology" EPS insulation panels must be not less than 4 weeks from the date of manufacturing.
- The interior face of "NUDURA™ Integrated Building Technology" panels shall be protected from the inside of the building in accordance with Sentence 9.10.16.10.(1) of NBC 1995.
- For above-grade installations, the exterior face of "NUDURA™ Integrated Building Technology" forms shall be protected with materials conforming to NBC 1995, Sections 9.20., 9.27. and/or 9.28.
- The attachment of exterior cladding and interior finishing materials has not been assessed by the present evaluation.

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- For foundation wall installations, the backfill shall be placed in such a way as to avoid damaging the wall, the exterior insulation panel and the waterproofing and dampproofing protection.
 - The concrete must be cured a minimum of 7 days before backfilling. The top of the foundation wall must be supported by the first floor prior to backfilling.
 - For below-grade installations, dampproofing material compatible with the EPS insulation must be provided in accordance with NBC 1995, Article 9.13.1.1.

Where hydrostatic pressure exists, waterproofing compatible with the EPS insulation must be provided in accordance with NBC 1995, Article 9.13.1.2.

- The backfill material must be well drained and a drainage system must be installed around the footing as per NBC 1995 requirements.
- Installation of “NUDURA™ Integrated Building Technology” shall be in strict compliance with “NUDURA™ Integrated Building Technology” Installation Manual, dated November 2001.

Only installers trained and authorized by NUDURA Corporation shall be contracted to set up the wall system.

5. Performance

Compliance of the expanded polystyrene thermal insulation with the requirements of CAN/ULC-S701-97 was conducted at laboratories recognized by CCMC and is covered by Intertek Testing Services Report No. 3023287, revised March 13, 2002.

The design analysis of walls using “NUDURA™ Integrated Building Technology” as prepared for “NUDURA Corporation,” is summarized in Tables 1(a), 1(b), 1(c), 2(a), 2(b), and 2(c).

The tables provide steel reinforcement designs for a number of different wall and lintel applications, based on the structural loads, and the design assumptions indicated below each table. When “NUDURA™ Integrated Building Technology” forms are used in structural applications outside the scope of the referenced design analysis, a registered professional engineer skilled in concrete design must certify the design analysis and the design drawings for such buildings. The engineer shall certify that the construction provides a level of performance equivalent to that required by Part 4, and/or Part 9 of NBC 1995.

Table 1(a) - Vertical & Horizontal Steel Reinforcement for Below Grade Walls built with “NUDURA™ Integrated Building Technology” in all Seismic Zones

Wall Height	Backfill Height	Vertical Reinforcement						Horizontal Reinforcement
		Free Draining Backfill Soil Type (Maximum Equivalent Fluid Density)						All Scenarios
		Sand & Gravel 480 kg/m ³		Sand, Gravel with Silt or Clay 720 kg/m ³		Inorganic Silt or Clay 960 kg/m ³		
m	m	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall	All Wall Thickness
2.44	1.220	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.525	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.830	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 600	15M @ 600	15M @ 457
	2.135	15M @ 600	15M @ 600	15M @ 600	15M @ 600	15M @ 400	15M @ 600	15M @ 457
2.75	1.220	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.525	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.830	10M @ 400	15M @ 600	15M @ 600	15M @ 600	15M @ 600	15M @ 600	15M @ 457
	2.135	15M @ 600	15M @ 600	15M @ 400	15M @ 600	15M @ 400	15M @ 600	15M @ 457
	2.440	15M @ 400	15M @ 600	15M @ 400	15M @ 600	20M @ 400	15M @ 400	15M @ 457
3.05	1.220	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.525	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.830	10M @ 400	15M @ 600	15M @ 600	15M @ 600	15M @ 400	15M @ 600	15M @ 457
	2.135	15M @ 600	15M @ 600	15M @ 400	15M @ 600	15M @ 400	15M @ 600	15M @ 457
	2.440	15M @ 400	15M @ 600	15M @ 400	15M @ 600	20M @ 400	15M @ 400	15M @ 457
	2.745	15M @ 400	15M @ 600	20M @ 400	15M @ 400	15M @ 200	15M @ 400	15M @ 457
3.66	1.220	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.525	10M @ 400	15M @ 600	10M @ 400	15M @ 600	10M @ 400	15M @ 600	15M @ 457
	1.830	10M @ 400	15M @ 600	15M @ 600	15M @ 600	15M @ 400	15M @ 600	15M @ 457
	2.135	15M @ 600	15M @ 600	15M @ 400	15M @ 600	20M @ 400	15M @ 600	15M @ 457
	2.440	15M @ 400	15M @ 600	20M @ 400	15M @ 400	20M @ 400	15M @ 400	15M @ 457
	2.745	15M @ 400	15M @ 600	20M @ 400	15M @ 400	15M @ 200	20M @ 400	15M @ 457
	3.050	20M @ 400	15M @ 400	15M @ 200	20M @ 400	20M @ 200	20M @ 400	15M @ 457
	3.355	20M @ 400	15M @ 400	20M @ 200	20M @ 400	-	15M @ 200	15M @ 457

Table 1(a), 1(b) and 1(c) are based on the following assumptions:

1. Applicable to construction falling under the provisions of Part 9 of NBC 1995.
2. Maximum building width is 12.2 m.
3. Maximum building length is 24.4 m.
4. Maximum floor clear span is 10.0 m.
5. Maximum roof clear span is 12.2 m.
6. Roof Slope is 20°.
7. Roof dead load is 0.70 kPa.
8. Floor dead load is 0.70 kPa.
9. Snow load is 4.0 kPa.
10. Use and occupancy live load is 1.9 kPa for the first floor and 1.4 kPa for the second floor.
11. Maximum of 2 storeys of ICF walls above-grade of equal thickness as the foundation wall.
12. Maximum storey wall height of 3.0 m.
13. All materials and workmanship shall conform to the requirements of the NBC 1995 and amendments as of the issue date of these tables.
12. Wall design shall be in accordance with CSA A23.3-94.
13. Two 15M bars shall be placed around all openings and extend 600 mm (24") beyond each side of openings.
14. Reinforcing bars shall be hard grade deformed bars conforming to CSA-G30.12, Grade 400.
15. Conform to CAN/CSA-A23.1-M90, Concrete Materials and Methods of Concrete Construction, CAN/CSA-A23.2-M90, Methods of Test for Concrete, and CAN3-A23.3-M84, Design of Concrete Structures for Buildings, in detailing bends, placement, spacing, splicing and protection of reinforcing.
16. Minimum 28 day concrete yield strength is 20 MPa. Mix design in accordance with manufacturers recommendations.
17. Vertical reinforcement placed near the interior face of the form.
18. Minimum length of solid wall on each side of building is 8.1 m.

Table 1(b) – Vertical Steel Reinforcement for Above-Grade Walls (all Seismic Zones) built with “NUDURA™ Integrated Building Technology” Insulated Forms

Wall Height	Vertical Steel						Horizontal Steel
	Wind Load ≤ 1.0 kPa						All Scenarios
	Seismic Zone Classification						
	Za or Zv ≤ 4			Za or Zv ≥ 5			
Ground Floor Concrete Structure or Top Floor of 2 Storey Concrete Structure Supporting Wood Frame Roof							
m	100-mm Wall	150-mm Wall	200-mm Wall	100-mm Wall	150-mm Wall	200-mm Wall	
2.44	15M @ 400	10M @ 400	15M @ 600	15M @ 400	10M @ 400	15M @ 600	15M @ 457
2.75	15M @ 400	10M @ 400	15M @ 600	15M @ 400	10M @ 400	15M @ 600	15M @ 457
3.05	15M @ 400	10M @ 400	15M @ 600	15M @ 400	10M @ 400	15M @ 600	15M @ 457
3.66	-	15M @ 600	15M @ 600	-	15M @ 600	15M @ 600	15M @ 457
4.27	-	15M @ 400	15M @ 600	-	15M @ 400	15M @ 400	15M @ 457
4.88	-	15M @ 400	15M @ 600	-	15M @ 400	20M @ 400	15M @ 457
Ground Floor Concrete Structure Supporting 2nd Storey Wood Frame Walls and Wood Frame Roof							
2.44	15M @ 400	10M @ 400	15M @ 600	15M @ 400	15M @ 400	15M @ 400	15M @ 457
2.75	15M @ 400	10M @ 400	15M @ 600	15M @ 400	15M @ 400	15M @ 400	15M @ 457
3.05	-	15M @ 600	15M @ 600	-	20M @ 400	20M @ 400	15M @ 457
3.66	-	15M @ 400	15M @ 400	-	-	15M @ 200	15M @ 457
4.27	-	15M @ 400	15M @ 400	-	-	-	15M @ 457
4.88	-	-	20M @ 400	-	-	-	15M @ 457
Ground Floor Concrete Structure Supporting 2nd Storey Concrete Walls & Wood Frame Roof							
2.44	15M @ 400	15M @ 600	15M @ 600	15M @ 400	20M @ 400	20M @ 400	15M @ 457
2.75	15M @ 400	15M @ 600	15M @ 600	-	20M @ 400	20M @ 400	15M @ 457
3.05	-	15M @ 400	15M @ 400	-	-	15M @ 200	15M @ 457
3.66	-	15M @ 400	20M @ 400	-	-	-	15M @ 457
4.27	-	20M @ 400	20M @ 400	-	-	-	15M @ 457
4.88	-	-	15M @ 200	-	-	-	15M @ 457

Table 1(c) – Vertical Steel Reinforcement for Above-Grade Walls (all Seismic Zones) built with “NUDURA™ Integrated Building Technology” Insulated Forms

Wall Height	Vertical Steel						Horizontal Steel
	Wind Load > 1.0 kPa or ≤ 3.0 kPa						All Scenarios
	Seismic Zone Classification						
	Z _a or Z _v ≤ 4			Z _a or Z _v ≥ 5			
Ground Floor Concrete Structure or Top Floor of 2 Storey Concrete Structure Supporting Wood Frame Roof							
m	100-mm Wall	150-mm Wall	200-mm Wall	100-mm Wall	150-mm Wall	200-mm Wall	
2.44	15M @ 200	15M @ 600	15M @ 600	15M @ 200	15M @ 600	15M @ 600	15M @ 457
2.75	-	15M @ 400	15M @ 600	-	15M @ 400	15M @ 600	15M @ 457
3.05	-	15M @ 400	15M @ 600	-	15M @ 400	15M @ 600	15M @ 457
3.66	-	20M @ 400	15M @ 400	-	20M @ 400	15M @ 400	15M @ 457
4.27	-	-	15M @ 400	-	-	15M @ 400	15M @ 457
4.88	-	-	20M @ 400	-	-	20M @ 400	15M @ 457
Ground Floor Concrete Structure Supporting 2nd Storey Wood Frame Walls and Wood Frame Roof							
2.44	15M @ 200	15M @ 600	15M @ 600	15M @ 200	15M @ 400	15M @ 400	15M @ 457
2.75	-	15M @ 400	15M @ 600	-	15M @ 400	15M @ 400	15M @ 457
3.05	-	15M @ 400	15M @ 600	-	20M @ 400	20M @ 400	15M @ 457
3.66	-	20M @ 400	15M @ 400	-	-	15M @ 200	15M @ 457
4.27	-	-	15M @ 400	-	-	-	15M @ 457
4.88	-	-	20M @ 400	-	-	-	15M @ 457
Ground Floor Concrete Structure Supporting 2nd Storey Concrete Walls & Wood Frame Roof							
2.44	15M @ 200	15M @ 600	15M @ 600	15M @ 200	20M @ 400	20M @ 400	15M @ 457
2.75	-	15M @ 400	15M @ 600	-	20M @ 400	20M @ 400	15M @ 457
3.05	-	15M @ 400	15M @ 400	-	-	15M @ 200	15M @ 457
3.66	-	15M @ 400	20M @ 400	-	-	-	15M @ 457
4.27	-	20M @ 400	20M @ 400	-	-	-	15M @ 457
4.88	-	-	15M @ 200	-	-	-	15M @ 457

Table 2(c) – Minimum Steel Reinforcement of Lintels for “NUDURA™ Integrated Building Technology” 203-mm Core Insulated Concrete Forms

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.	Bottom Steel	Stirrup End Dist.	Bottom Steel	Stirrup End Dist.	Bottom Steel	Stirrup End Dist.	Bottom Steel	Stirrup End Dist.	Bottom Steel	Stirrup End Dist.	Bottom Steel	Stirrup End Dist.
1000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0
1500	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	360
2000	1-15M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	402	1-15M	597	1-15M	726
2500	1-15M	0	1-15M	0	1-15M	0	1-15M	446	1-20M	769	1-20M	956	2-15M	1075
3000	1-15M	0	1-15M	0	1-15M	0	1-20M	810	1-25M	1125	2-15M	1293	2-20M	1423
3500	1-15M	0	1-15M	0	1-15M	533	2-15M	1144	1-25M	1468	2-20M	1641	-	-
4000	1-15M	0	1-15M	0	1-20M	898	1-25M	1510	-	-	-	-	-	-
4500	1-15M	0	1-15M	0	2-15M	1224	2-20M	1839	-	-	-	-	-	-
5000	1-15M	0	1-20M	0	1-25M	1600	-	-	-	-	-	-	-	-

Tables 2(a), 2(b) and 2(c) are based on the following assumptions:

1. All materials and workmanship shall conform to the requirements of the NBC 1995 and amendments as of the issue of these tables.
2. Lintel design shall be in accordance with CSA A23.3-94.
3. Lintel height is 300 mm.
4. Stirrups are single leg fabricated from 10M bars spaced at max. 170 mm o.c.
5. Lintel reinforcing is located in the bottom of lintel and projects 600 mm into lintel support on each side of openings.
6. The factored uniformly distributed load includes dead and live loads.
7. Lintels supporting point loads from beams or girder trusses shall be designed by a professional engineer.
8. Reinforcing bars shall be hard grade deformed bars conforming to CSA-G30.12, Grade 400.
9. Conform to CAN/CSA-A23.1-M90, Concrete Materials and Methods of Concrete Construction, CAN/CSA-A23.2-M90, Methods of Test for Concrete, and CAN3-A23.3-M84, Design of Concrete Structure for Buildings, in detailing bends, placement, spacing, splicing and protection of reinforcing.
10. Minimum 28 day concrete yield strength is 20 MPa. Mix design in accordance with manufacturers recommendations.

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