NRC·CNRC
Institute for Research in Construction

Evaluation Report
CCMC 13063-R

MASTERFORMAT:	03 11 19.01
Issued:	2003-09-02
Re-evaluated:	2010-11-02
Re-evaluation due:	2012-09-02

NUDURA® Integrated Building Technology

1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "NUDURA® Integrated Building Technology" 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 2005:

- Clause 1.2.1.1.(1)(a), Division A, using the following acceptable solutions from Division B:
  - Article 3.1.5.12. Combustible Insulation and its Protection
  - 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
  - Article 9.10.17.10. Protection of Foamed Plastics
  - 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 of 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)
  - Clause 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 4.1 provided by the Report Holder.

Ruling No. 04-13-117 (13063-R) authorizing the use of this product in Ontario, subject to the terms and conditions contained in the Ruling, was made by the Minister of Municipal Affairs and Housing on 2004-06-15 pursuant to s.29 of the Building Code Act, 1992 (see Ruling for terms and conditions). This Ruling is subject to periodic revisions and updates.

2. Description

"NUDURA® Integrated Building Technology" units are modular, interlocking concrete forms consisting of two expanded-polystyrene (EPS) Type 2 panels. The two polystyrene panels are connected by polypropylene webs which are molded into the polystyrene panels and equally spaced at 203 mm. The webs lock the two EPS panes together. The extremities of the polypropylene connectors are flush with the exterior surface of the molds. The webs also contain a hinge mechanism that enables the forms to fold and open for storage and shipping purposes.

The polystyrene 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 forms are dry-laid and stacked in a running (staggered) configuration. The stacked units form a rectangular space which, after being filled with concrete, forms an insulated, monolithic concrete wall of uniform thickness.

Reinforcement is placed as required to satisfy strength requirements for above- or below-grade loadbearing walls, beams, lintels and shear walls.

The units have external dimensions of 2438 mm in length and 457 mm in height. The polystyrene panels are 67 mm thick and the concrete walls are either 100 mm, 152 mm, 203 mm, or 254 mm thick, resulting in an overall wall thickness of 234 mm, 286 mm, 337 mm, or 388 mm. A standard unit is illustrated in Figure 1.

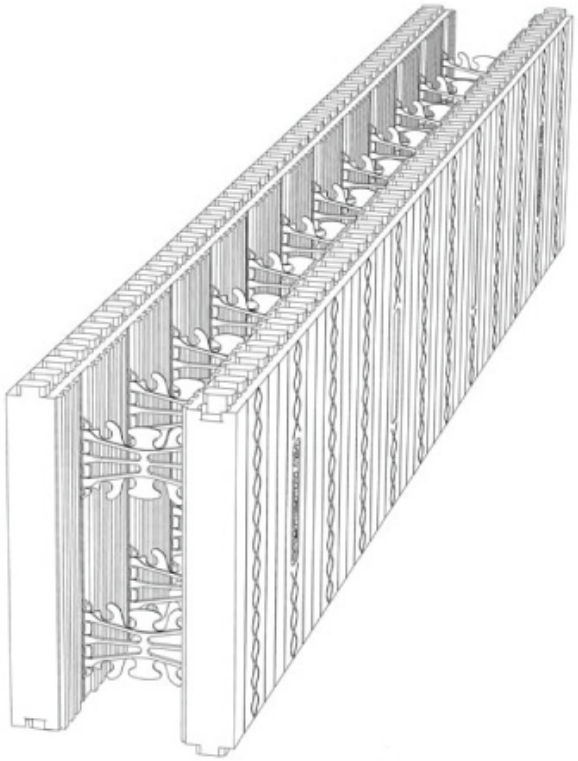

Figure 1. "NUDURA® Integrated Building Technology" standard unit

3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "NUDURA® Integrated Building Technology" being used in accordance with the conditions and limitations set out below.

- The use of the product is permitted in the construction of houses and small buildings up to two storeys above grade and one storey below grade that fall under the provisions of Part 9 of Division B of the NBC 2005, subject to all of the conditions listed below.

- The structural applications of the product must be in strict accordance with the design analysis as prepared for NUDURA Corporation by Tacoma Engineers, and included in the Engineering Analysis Report, dated February 1, 2010, from which Tables 4.1.2.1.1 to 4.1.2.1.8 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 structural 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 2005.

- The maximum permitted building length is 24.4 m and the maximum permitted building width is 12.0 m. For buildings with a dimension that exceeds any of the above dimensions engineering is required on a case-by-case basis.

- For load-bearing and shear wall applications, the core thickness of the product must be equal to or greater than 150 mm.

- For non-load-bearing wall applications, the core thickness of the product must be equal to or greater than 100 mm.

- The concrete used in the product must be Type 10 or Type 30 with a minimum compressive strength of 20 MPa, a slump between 100 mm and 150 mm, and an air content between 4% and 7%.

- The maximum aggregate size to be used in conjunction with the 100-mm- and 150-mm-thick concrete walls is 12.7-mm crushed aggregate and with the 200-mm- and 250-mm-thick concrete walls is 19-mm crushed aggregate.

- For the wall heights indicated in Tables 4.1.2.1.1 and 4.1.2.1.2, 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.

- 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, “Standard For 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 product's 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 2005.

- The attachment of exterior cladding and interior finishing materials has not been assessed by the present evaluation. The exterior cladding attachment must be as per Part 5 of Division B of the NBC 2005 as stated in Sentence 9.27.1.1.(5).

- The interior face of the product's panels must be protected from the inside of the building in accordance with Sentence 9.10.17.10.(1) of Division B of the NBC 2005.

- 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 2005.

- For below-grade installations, dampproofing must be provided in accordance with Article 9.13.2., Dampproofing, of Division B of the NBC 2005.

- Where hydrostatic pressure exists, waterproofing must be provided in accordance with Article 9.13.3., Waterproofing, of Division B of the NBC 2005.

- 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 2005.

- The installation of the product must be in strict compliance with NUDURA Corporation installation instructions, without conflicting with the requirements stated in the NBC 2005 or in this report. Only installers trained and authorized by NUDURA Corporation shall be contracted to set up the wall system.

4. Technical Evidence

CCMC's Technical Guide for "NUDURA® Integrated Building Technology" sets out the nature of the technical evidence required by CCMC to enable it to evaluate a product as an acceptable or alternative solution in compliance with the NBC 2005. The Report Holder has submitted test results and engineering design analyses for CCMC's evaluation. Testing was conducted at independent laboratories recognized by CCMC. The corresponding test results for "NUDURA® Integrated Building Technology" are summarized below.

4.1 NBC 2005 Compliance Data for "NUDURA® Integrated Building Technology" on which CCMC Based its Opinion in Section 1

4.1.1 Material Requirements

4.1.1.1 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. certification program.

4.1.2 Design Requirements

4.1.2.1 Conformance of Structural Capacity (Steel Reinforcement Designs)

The design analysis in the Engineering Analysis Report provided to CCMC of walls using "NUDURA® Integrated Building Technology" 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 2005. The corresponding design analysis is summarized in Tables 4.1.2.1.1 to 4.1.2.1.8. 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 4.1.2.1.1(a) Vertical and horizontal steel reinforcement for below-grade walls (Sa(0.2) ≤ 0.12)[1]

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 @ 400	10M @ 300	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.53	10M @ 250	10M @ 300	15M @ 500	10M @ 457	15M @ 457	15M @ 457
	1.83	–	15M @ 500	15M @ 500	–	15M @ 457	15M @ 457
	2.13	–	15M @ 400	15M @ 500	–	15M @ 457	15M @ 457
3.05	1.22	10M @ 350	10M @ 300	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.53	15M @ 400	10M @ 300	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.83	–	15M @ 450	15M @ 500	–	15M @ 457	15M @ 457
	2.13	–	15M @ 350	15M @ 450	–	15M @ 457	15M @ 457
	2.44	–	–	15M @ 350	–	–	15M @ 457
	2.74	–	–	15M @ 300	–	–	15M @ 457
3.66	1.22	10M @ 300	10M @ 300	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.53	15M @ 400	10M @ 300	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.83	–	15M @ 400	15M @ 500	–	15M @ 457	15M @ 457
	2.13	–	–	15M @ 400	–	–	15M @ 457
	2.44	–	–	15M @ 300	–	–	15M @ 457
	2.74	–	–	–	–	–	–
	3.05	–	–	–	–	–	–
	3.35	–	–	–	–	–	–

Table 4.1.2.1.1(b) Vertical and horizontal steel reinforcement for below-grade walls (Sa(0.2) > 0.12)(1)

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 Walls	200-mm Wall	250-mm Wall
2.44	1.22	15M @ 400	10M @ 300	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.53	15M @ 200	10M @ 200	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.83	–	15M @ 250	15M @ 350	–	15M @ 457	15M @ 457
	2.13	–	15M @ 200	15M @ 250	–	15M @ 457	15M @ 457
3.05	1.22	15M @ 200	10M @ 250	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.53	15M @ 150	15M @ 300	15M @ 450	15M @ 457	15M @ 457	15M @ 457
	1.83	–	15M @ 200	15M @ 250	–	15M @ 457	15M @ 457
	2.13	–	20M @ 200	15M @ 200	–	15M @ 457	15M @ 457
	2.44	–	–	20M @ 200	–	–	15M @ 457
	2.74	–	–	–	–	–	–
3.66	1.22	15M @ 200	10M @ 250	15M @ 500	15M @ 457	15M @ 457	15M @ 457
	1.53	15M @ 150	15M @ 250	15M @ 400	15M @ 457	15M @ 457	15M @ 457
	1.83	–	20M @ 250	15M @ 250	–	15M @ 457	15M @ 457
	2.13	–	–	20M @ 250	–	–	15M @ 457
	2.44	–	–	20M @ 150	–	–	15M @ 457
	2.74	–	–	–	–	–	–
	3.05	–	–	–	–	–	–
	3.35	–	–	–	–	–	–

Note to Tables 4.1.2.1.1(a) and (b): Table cells without a value indicate that the spacing is not feasible with respect to the proposed backfill height.

(1) Tables 4.1.2.1.1(a) and (b) are based on the following assumptions:

- The design is applicable to structures that are to be constructed on soil Types A, B, C and D.
- Wall height is the distance from the top of the basement floor slab to the point of bearing for the floor system.
- Backfill height is the distance from the top of the basement floor slab to the finished exterior grade level.
- All walls shall be proportionally distributed in both the transverse and logitudinal directions of the building.
- Maximum building width is 12.0 m.
- Maximum building length is 24.4 m.
- Maximum clear floor span is 6.0 m.
- Maximum clear roof span is 12.0 m.
- Maximum number of storeys above grade is two (2).
- Maximum number of storeys below grade is one (1).
- Maximum height of above grade first floor walls is 3.66 m.
- Maximum height of above grade second floor walls is 3.05 m.
- Maximum height of foundation walls is 3.66 m.
- Roof unfactored dead load is 0.70 kPa.
- Floor unfactored dead load is 0.70 kPa.
- Roof unfactored snow live load is 4.0 kPa.
- Main floor unfactored live load (occupancy load) is 1.9 kPa.
- Second floor unfactored live load (occupancy load) is 1.4 kPa.
- Unfactored soil surcharge live load is 2.4 kPa with a horizontal soil coefficient of $k_o = 0.5$.
- Concrete density is 23.6 kN/m^3.

- Drained earth density is 1800 kg/m^3.
- Loads include earth pressure and surcharge loads, plus gravity load. Gravity load assumes two concrete storeys and wood-frame roof.
- The exterior walls are assumed to be clad with clay bricks and a density of 20.0 kN/m^3.
- The length of the solid wall between two openings should be equal to the average width of the openings and shall be no less than a minimum of 1.22 m. Openings in a foundation wall shall not exceed a maximum width of 1.83 m, and the foundation wall shall have a total length for openings of less than 25% of its total length.
- Reinforcing bars shall be hard-grade deformed bars conforming to CAN/CSA G30.18, "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 shall be in accordance with CAN/CSA A23.3 (R2000), "Design of Concrete Structures."
- Vertical reinforcement shall be placed at 38 mm from the interior face of the forms, i.e. 38 mm from the inside of the form on the tension side of the wall.
- In addition to the horizontal reinforcement required, as indicated in these tables, one 10M continuous bar shall be placed at 150 mm from the top of the wall and at floor levels.
- Two full height vertical bars, equal to the vertical reinforcing within the wall system, are to be installed at all corners.
- The minimum horizontal length of solid walls without openings directly below a concentrated load, such as loads created by girder trusses, columns and beams, shall be 1.83 m.
- In addition to the wall reinforcing required, as indicated in these tables, two 15M vertical bars shall be installed directly below the concentrated load.
- Two 15M bars shall be placed around all openings and extend 600 mm beyond each side of the openings.
- Specified 28-day compressive strength of concrete, f'_c at 28 days, is 20 MPa.
- Concrete shall be allowed to cure for a minimum of seven days prior to backfilling.
- Basement walls are considered to be supported by an adequately designed floor system at the top.
- Floor and roof connections to ICF walls shall be designed to accommodate diaphragm action in seismic zones and zones of high wind pressure.
- All materials and workmanship shall conform to the requirements of the NBC 2005 including any Revisions and Errata that have been released as of the issue date of this table.

Table 4.1.2.1.2(a) Vertical and horizontal steel reinforcement for above-grade walls ($Q_{50} \leq 0.75$ kPa, Sa(0.2) ≤ 0.32)[(2)]

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)		Max. Spacing for Horizontal Reinforcement (mm)	
	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall
Single-storey concrete construction supporting a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	**10M @ 400**	**10M @ 300**	**15M @ 457**	**15M @ 457**
Ground floor concrete construction supporting a second storey wood-frame construction and wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	10M @ 400	10M @ 300	15M @ 457	15M @ 457
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	10M @ 400	10M @ 300	15M @ 457	15M @ 457

Table 4.1.2.1.2(b) Vertical and horizontal steel reinforcement for above-grade walls ($Q_{50} \leq 0.75$ kPa, $0.32 < Sa(0.2) \leq 0.67$)[(2)]

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)		Max. Spacing for Horizontal Reinforcement (mm)	
	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall
Single-storey concrete construction supporting a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	**10M @ 400**	**10M @ 300**	**15M @ 457**	**15M @ 457**
Ground floor concrete construction supporting a second storey wood-frame construction and wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	10M @ 400	10M @ 300	15M @ 457	15M @ 457
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	15M @ 500	15M @ 457	15M @ 457

Table 4.1.2.1.2(c) Vertical and horizontal steel reinforcement for above-grade walls ($Q_{50} \leq 0.75$ kPa, $0.67 < Sa(0.2) \leq 2.3$)[(2)]

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)		Max. Spacing for Horizontal Reinforcement (mm)	
	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall
Single-storey concrete construction supporting a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	**15M @ 450**	**15M @ 500**	**15M @ 457**	**15M @ 457**
Ground floor concrete construction supporting a second storey wood-frame construction and wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	15M @ 500	15M @ 457	15M @ 457
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure				
2.44	15M @ 450	10M @ 300	15M @ 457	15M @ 457
3.05	15M @ 450	15M @ 400	15M @ 457	15M @ 457
3.66		15M @ 300	15M @ 457	15M @ 457

Table 4.1.2.1.2(d) Vertical and horizontal steel reinforcement for above-grade walls (Q_{50} ≤ 0.59 kPa, Sa(0.2) ≤ 0.32)(2)

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)		Max. Spacing for Horizontal Reinforcement (mm)	
	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall
Single-storey concrete construction supporting a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	**15M @ 450**	**10M @ 300**	**15M @ 457**	**15M @ 457**
Ground floor concrete construction supporting a second storey wood-frame construction and wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	10M @ 300	15M @ 457	15M @ 457
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	10M @ 300	15M @ 457	15M @ 457

Table 4.1.2.1.2(e) Vertical and horizontal steel reinforcement for above-grade walls (Q_{50} ≤ 0.59 kPa, 0.32 < Sa(0.2) ≤ 0.67)(2)

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)		Max. Spacing for Horizontal Reinforcement (mm)	
	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall
Single-storey concrete construction supporting a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	**15M @ 450**	**10M @ 300**	**15M @ 457**	**15M @ 457**
Ground floor concrete construction supporting a second storey wood frame construction and wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	10M @ 300	15M @ 457	15M @ 457
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	15M @ 500	15M @ 457	15M @ 457

Table 4.1.2.1.2(f) Vertical and horizontal steel reinforcement for above-grade walls (Q_{50} ≤ 0.59 kPa, 0.67 < Sa(0.2) ≤ 2.3)(2)

Wall Height (m)	Max. Spacing for Vertical Reinforcement (mm)		Max. Spacing for Horizontal Reinforcement (mm)	
	150-mm Wall	200-mm Wall	150-mm Wall	200-mm Wall
Single-storey concrete construction supporting a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	**15M @ 450**	**15M @ 500**	**15M @ 457**	**15M @ 457**
Ground floor concrete construction supporting a second storey wood-frame construction and wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.66	15M @ 450	15M @ 500	15M @ 457	15M @ 457
Ground floor concrete construction supporting a second storey concrete construction and a wood-frame roof structure				
2.44	10M @ 400	10M @ 300	15M @ 457	15M @ 457
3.05	15M @ 450	15M @ 400	15M @ 457	15M @ 457
3.66	–	15M @ 300	15M @ 457	15M @ 457

Note:

- *The bolded data indicates reinforcing for ground floor concrete walls only. Second floor concrete walls are to be limited to a height of 3.05 m.*

Note to Tables 4.1.2.1.2(a) to 4.1.2.1.2(f):

(2) Tables 4.1.2.1.2(a) to (f) are based on the following assumptions:

- The design is applicable to seismic zones up to $S_a(0.2) = 2.3$ for soil Types A, B, C and D.
- The design is applicable to a maximum factored wind pressure of 0.59 kPa.
- Loads include all applicable gravity loads and wind loads.
- For allowable building dimensions, see Note (1) to Tables 4.1.2.1.1(a) and (b).
- For assumed loads and densities of materials, see Note (1) to Tables 4.1.2.1.1(a) and (b).
- For concrete and steel material properties, see Note (1) to Tables 4.1.2.1.1(a) and (b).
- For 150-mm- and 200-mm-thick walls the vertical reinforcement shall be placed at the center of the wall.
- The minimum horizontal length of solid walls without openings directly below a concentrated load, such as loads created by girder trusses, columns and beams, shall be 1.83 m.
- In addition to the wall reinforcing required as indicated in these tables, two 15M vertical bars shall be installed directly below the concentrated load.
- In addition to the horizontal reinforcement required as indicated in these tables, one 10M continuous bar shall be placed at 150 mm from the top of the wall and at floor levels.
- Two 15M bars should be placed around all openings and shall extend at least 600 mm beyond each corner of the opening.
- Floor and roof connections to ICF walls shall be designed to accommodate diaphragm action in seismic zones and zones of high wind pressure.
- All materials and workmanship shall conform to the requirements of the NBC 2005 including any Revisions and Errata that have been released as of the issue date of this table.

Table 4.1.2.1.3(a) Minimum steel reinforcement of 300-mm deep lintels with a 150-mm concrete core[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)									
	7.0		10.5		14.0		17.5		21.0	
	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)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	380
1200	1-10M	0	1-10M	0	1-10M	380	1-10M	380	1-10M	535
1500	1-10M	0	1-10M	380	1-10M	535	1-15M	535	1-15M	685
1800	1-10M	380	1-10M	535	1-15M	685	1-15M	685	1-15M	840
2400	1-15M	685	1-15M	840	1-20M	990	1-20M	990	2-15M	1143
3000	1-20M	990	1-20M	1143	2-15M	1295	2-20M	1295	–	–
3600	2-15M	1295	1-15M 1-20M	1445	–	–	–	–	–	–
4200	1-15M 1-20M	1600	–	–	–	–	–	–	–	–
4800	–	–	–	–	–	–	–	–	–	–
5400	–	–	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–	–	–

Table 4.1.2.1.3(b) Minimum steel reinforcement of 300-mm deep lintels with a 150-mm concrete core (continued)[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)							
	24.5		28.0		31.5		35.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
900	1-10M	380	1-10M	380	1-10M	380	1-10M	380
1200	1-10M	535	1-10M	535	1-15M	535	1-15M	535
1500	1-15M	685	1-15M	685	1-15M	685	1-20M	685
1800	1-20M	840	1-20M	840	1-20M	840	2-15M	840
2400	1-15M 1-20M	1143	1-15M 1-20M	1143	–	–	–	–
3000	–	–	–	–	–	–	–	–
3600	–	–	–	–	–	–	–	–
4200	–	–	–	–	–	–	–	–
4800	–	–	–	–	–	–	–	–
5400	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–

Table 4.1.2.1.4(a) Minimum steel reinforcement of 600-mm deep lintels with a 150-mm concrete core[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)									
	7.0		10.5		14.0		17.5		21.0	
	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)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1500	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1800	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-15M	0
2400	1-10M	0	1-15M	0	1-15M	0	1-15M	965	1-15M	965
3000	1-15M	0	1-15M	965	1-15M	965	1-15M	1345	1-20M	1345
3600	1-15M	0	1-15M	965	1-20M	1345	1-20M	1345	2-15M	1725
4200	1-15M	965	1-20M	1345	2-15M	1725	2-15M	1725	1-15M 1-20M	1725
4800	1-20M	1345	2-15M	1725	1-15M 1-20M	2110	2-20M	2110	1-10M 2-20M	2110
5400	2-15M	1725	1-15M 1-20M	2110	2-20M	2110	1-15M 2-20M	2490	3-20M	2490
6000	1-15M 1-20M	2110	2-20M	2490	1-15M 2-20M	2490	1-10M 3-20M	2870	–	–

Table 4.1.2.1.4(b) Minimum steel reinforcement of 600-mm deep lintels with a 150-mm concrete core (con[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)							
	24.5		28.0		31.5		35.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1500	1-10M	0	1-10M	0	1-15M	0	1-15M	0
1800	1-15M	0	1-15M	965	1-15M	965	1-15M	965
2400	1-15M	965	1-15M	965	1-20M	1345	1-20M	1345
3000	1-20M	1345	1-20M	1345	2-15M	1345	2-15M	1345
3600	2-15M	1725	1-15M 1-20M	1725	1-15M 1-20M	1725	2-20M	1725
4200	2-20M	2110	1-10M 2-20M	2110	1-15M 2-20M	2110	1-15M 2-20M	2110
4800	1-15M 2-20M	2110	3-20M	2490	–	–	–	–
5400	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–

Table 4.1.2.1.5(a) Minimum steel reinforcement of 300-mm deep lintels with a 200-mm concrete core[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)									
	7.0		10.5		14.0		17.5		21.0	
	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)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-15M	380
1500	1-10M	0	1-10M	0	1-15M	380	1-15M	380	1-15M	535
1800	1-10M	0	1-15M	380	1-15M	535	1-15M	535	1-15M	685
2400	1-15M	380	1-15M	685	1-20M	840	1-20M	840	2-15M	990
3000	1-20M	685	1-20M	990	2-15M	1143	1-15M 1-20M	1143	2-20M	1295
3600	2-15M	990	1-15M 1-20M	1295	2-20M	1445	1-15M 2-20M	1445	–	–
4200	1-15M 1-20M	1295	1-10M 2-20M	1600	–	–	–	–	–	–
4800	1-10M 2-20M	1600	–	–	–	–	–	–	–	–
5400	–	–	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–	–	–

Table 4.1.2.1.5(b) Minimum steel reinforcement of 300-mm deep lintels with a 200-mm concrete core (cont'd)[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)							
	24.5		28.0		31.5		35.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
900	1-10M	0	1-10M	0	1-10M	380	1-10M	380
1200	1-15M	380	1-15M	380	1-15M	535	1-15M	535
1500	1-15M	535	1-15M	535	1-15M	685	1-15M	685
1800	1-20M	685	1-20M	685	1-20M	840	1-20M	840
2400	2-15M	990	1-15M 1-20M	990	2-20M	1143	2-20M	1143
3000	1-10M 2-20M	1295	–	–	–	–	–	–
3600	–	–	–	–	–	–	–	–
4200	–	–	–	–	–	–	–	–
4800	–	–	–	–	–	–	–	–
5400	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–

Table 4.1.2.1.6(a) Minimum steel reinforcement of 600-mm deep lintels with a 200-mm concrete core[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)									
	7.0		10.5		14.0		17.5		21.0	
	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)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1500	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1800	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-15M	0
2400	1-10M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	965
3000	1-15M	0	1-15M	0	1-20M	0	1-20M	965	1-20M	965
3600	1-20M	0	1-20M	965	1-20M	965	1-20M	1345	2-15M	1345
4200	1-20M	0	1-20M	1345	2-15M	1345	1-15M 1-20M	1725	1-15M 1-20M	1725
4800	1-20M	965	2-15M	1725	1-15M 1-20M	1725	2-20M	1725	1-10M 2-20M	2110
5400	2-15M	1345	1-15M 1-20M	1725	2-20M	2110	1-10M 2-20M	2110	3-20M	2490
6000	1-15M 1-20M	1725	2-20M	2110	1-15M 2-20M	2110	3-20M	2490	–	–

Table 4.1.2.1.6(b) Minimum steel reinforcement of 600-mm deep lintels with a 200-mm concrete core (continued)[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)							
	24.5		28.0		31.5		35.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1500	1-10M	0	1-10M	0	1-15M	0	1-15M	0
1800	1-15M	0	1-15M	0	1-15M	0	1-15M	0
2400	1-20M	965	1-20M	965	1-20M	965	1-20M	965
3000	1-20M	1345	1-20M	1345	2-15M	1345	2-15M	1345
3600	2-15M	1345	1-15M 1-20M	1725	1-15M 1-20M	1725	2-20M	1725
4200	2-20M	1725	1-10M 2-20M	1725	1-10M 2-20M	2110	1-15M 2-20M	2110
4800	1-15M 2-20M	2110	3-20M	2110	1-10M 3-20M	2110	–	–
5400	1-10M 3-20M	2490	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–

Table 4.1.2.1.7(a) Minimum steel reinforcement of 300-mm deep lintels with a 250-mm concrete core[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)									
	7.0		10.5		14.0		17.5		21.0	
	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)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-15M	0
1500	1-10M	0	1-10M	0	1-15M	0	1-15M	380	1-15M	380
1800	1-15M	0	1-15M	0	1-15M	380	1-15M	535	1-15M	535
2400	1-15M	0	1-15M	535	1-20M	685	1-20M	840	2-15M	840
3000	1-20M	535	1-20M	840	2-15M	990	1-15M 1-20M	1143	2-20M	1143
3600	2-15M	840	1-15M 1-20M	1143	2-20M	1295	1-15M 2-20M	1445	3-20M	1445
4200	1-15M 1-20M	1143	1-10M 2-20M	1445	3-20M	1600	–	–	–	–
4800	1-10M 2-20M	1445	–	–	–	–	–	–	–	–
5400	–	–	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–	–	–

Table 4.1.2.1.7(b) Minimum steel reinforcement of 300-mm deep lintels with a 250-mm concrete core (continued)[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)							
	24.5		28.0		31.5		35.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-15M	380	1-15M	380	1-15M	380	1-15M	380
1500	1-15M	535	1-15M	535	1-15M	535	1-15M	535
1800	1-20M	685	1-20M	685	1-20M	685	1-20M	685
2400	2-15M	990	1-15M 1-20M	990	1-15M 1-20M	990	2-20M	990
3000	1-10M 2-20M	1295	1-15M 2-20M	1295	3-20M	1295	–	–
3600	–	–	–	–	–	–	–	–
4200	–	–	–	–	–	–	–	–
4800	–	–	–	–	–	–	–	–
5400	–	–	–	–	–	–	–	–
6000	–	–	–	–	–	–	–	–

Table 4.1.2.1.8(a) Minimum steel reinforcement of 600-mm deep lintels with a 250-mm concrete core[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)									
	7.0		10.5		14.0		17.5		21.0	
	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)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1500	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1800	1-10M	0	1-10M	0	1-10M	0	1-10M	0	1-15M	0
2400	1-10M	0	1-15M	0	1-15M	0	1-15M	0	1-15M	
3000	1-15M	0	1-15M	0	1-20M	0	1-20M	0	1-20M	965
3600	1-20M	0	1-20M	0	1-20M	965	1-20M	965	2-15M	1345
4200	1-20M	0	1-20M	965	2-15M	965	1-15M 1-20M	1345	1-15M 1-20M	1345
4800	1-20M	0	2-15M	965	1-15M 1-20M	1345	2-20M	1725	1-10M 2-20M	1725
5400	2-15M	965	1-15M 1-20M	1345	2-20M	1725	1-15M 2-20M	2110	3-20M	2110
6000	1-15M 1-20M	1345	2-20M	1725	1-15M 2-20M	2110	3-20M	2110	4-20M	2490

Table 4.1.2.1.8(b) Minimum steel reinforcement of 600-mm deep lintels with a 250-mm concrete core (continued)[3]

Opening Width (mm)	Unfactored Uniformly Distributed Load (kN/m)							
	24.5		28.0		31.5		35.0	
	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)	Bottom Steel	Stirrup End Dist. (mm)
900	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1200	1-10M	0	1-10M	0	1-10M	0	1-10M	0
1500	1-10M	0	1-10M	0	1-15M	0	1-15M	0
1800	1-15M	0	1-15M	0	1-15M	0	1-15M	0
2400	1-20M	0	1-20M	965	1-20M	965	1-20M	965
3000	1-20M	965	2-15M	965	2-15M	1345	2-15M	1345
3600	2-15M	1345	1-10M 2-20M	1345	1-15M 1-20M	1345	2-20M	1725
4200	2-20M	1725	1-10M 2-20M	1725	1-10M 2-20M	1725	1-15M 2-20M	1725
4800	1-15M 2-20M	2110	3-20M	2110	1-10M 3-20M	2110	4-20M	2110
5400	1-10M 3-20M	2110	4-20M	2490	–	–	–	–
6000	–	–	–	–	–	–	–	–

Note to Tables 4.1.2.1.3 to 4.1.2.1.8: Table cells without a value indicate that the load is not feasible with respect

to the proposed core thickness.

(3) Tables 4.1.2.1.3 to 4.1.2.1.8 are based on the following assumptions:

- Unfactored uniformly distributed loads include all applicable gravity loads and wind loads.
- For allowable building dimensions, see Note (1) to Table 4.1.2.1.1(a) and (b).
- For assumed loads and densities of materials, see Note (1) to Table 4.1.2.1.1(a) and (b).
- For concrete and steel material properties, see Note (1) to Table 4.1.2.1.1(a) and (b).
- Lintels are designed for uniformly distributed gravity line loads only. A local design professional shall prepare the design of the lintels to resist lateral loads or point loads.
- Stirrups are single leg fabricated from 10M bars spaced at 170 mm on centre.
- Lintel reinforcing is located at the bottom of the lintel and projects 200 mm into the lintel support on each side.
- Specified compressive strength of concrete, f'_c at 28 days, is 20 MPa.
- Specified yield strength of reinforcement, f_y, is 400 MPa.
- A minimum of one 10M top bar should be placed 38 mm from the top of the lintel and shall extend at least 610 mm beyond each corner of the opening.
- As indicated in the tables, bottom bars are required to have a concrete cover of 38 mm and shall extend at least 610 mm beyond each corner of the opening.
- Where there is less than 305 mm of solid concrete wall between two openings, the lintel shall be reinforced to span over both openings.
- Where there is less than 610 mm of solid concrete wall between two openings, and where either opening is greater than 1.53 m in length, the lintel shall be reinforced to span over both openings.
- Construction joints shall not be installed within 610 mm on either side of any wall opening.

Report Holder: NUDURA Corporation
27 Hooper Road, Unit 10
Barrie, ON L4N 9S3
Tel: 705-726-9499
Fax: 705-726-2110

Plant(s): Granby, QC