OPENINGS WITHIN 4FT FROM CORNERS

Unlike the International Residential Code in the USA, The National Building Code of Canada 2015 does not permit ICF walls to have window or door openings within 4ft from a corner. This section of the NBCC, 9.20.17.3, unfairly targets ICF construction, and is currently being addressed at industry level to amend the code in future editions. Nevertheless, currently in Canada where openings are within 4ft from corners, engineering is required. However, this engineering is now readily available on a prescriptive basis. It's contained in the first edition "ICFMA Prescriptive ICF Design For Part 9 Structures" (or the ICFMA design guide) which is published by the Insulating Concrete Forms Manufacturers Association. This document can be downloaded from LogixICF.com at any time.

Section 5.2.4 of the ICFMA design guide addresses openings within 4ft from corners by ensuring adequate shear walls are provided.

> 5.2.4 A minimum number and length of shear walls is required in all four sides of the building on all levels in the building as specified in shear wall tables (A.3. to A.11.) for above grade walls. This is to replace the requirements for 1200mm long wall segments at each corner in exterior walls specified in NBCC 9.20.17.3.(1) and 9.20.17.4.(1).

This document provides working examples on how to use the ICFMA design guide when openings are within 4ft from corners. Examples include

1. one story Logix above-grade plus basement WITHOUT walkout,
2. one story Logix above-grade plus basement WITH walkout.

NOTE: The above examples demonstrate the use of shear walls to address openings within 4ft from corners, as prescribed in the ICFMA design guide. It is the user's responsibility to ensure the building is within the scope of the ICFMA design guide.

In addition to shear walls, the ICFMA design guide also covers the design of

- strip footings,
- footing dowels,
- brick Ledge load ratings,
- wood Ledgers,
- stair openings,
- concentrated loads,
- lintels,
- laterally unsupported and supported foundation walls,
- walkout basements and
- below- and above-grade walls.

EXAMPLE 1: ONE STORY LOGIX ABOVE-GRADE PLUS BASEMENT WITHOUT WALKOUT

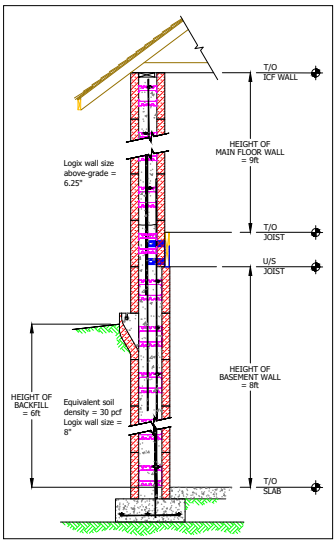

FIGURE 1: Wall Section

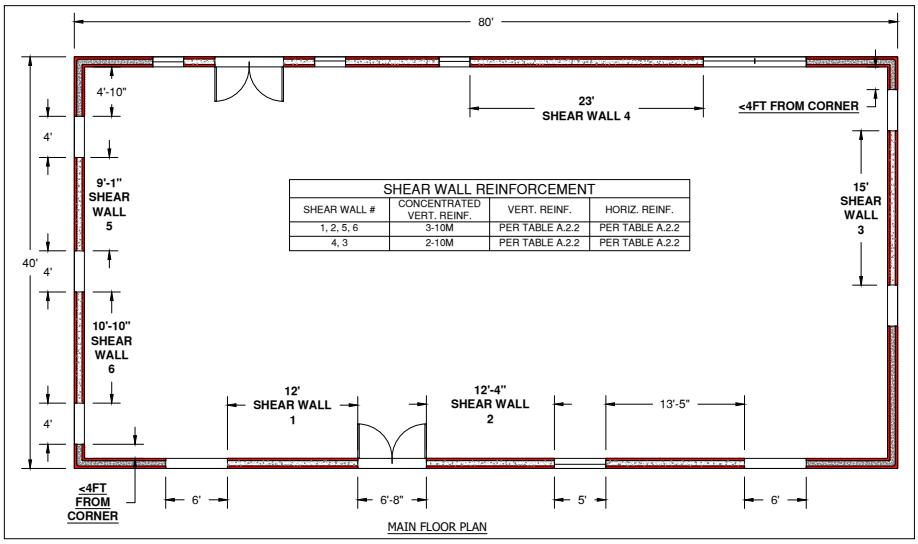

FIGURE 2: Floor Plan

STEP 1: Does the building have a walkout basement? NO

STEP 2: Does the main floor have openings within 4ft from corners? YES (see Figure 2)
If "YES" then either Tables A.3, A.4, A.5 or A.6 will apply

STEP 3: Where is the project located? OTTAWA
What is the "equivalent spectral response acceleration," Sa_{ICF} (from Appendix A)? 0.213
What is the "hourly wind pressure," $q_{1/50}$ (from Appendix B)? 0.48

STEP 4: Select the appropriate Table.
From Sa_{ICF} and $q_{1/50}$ determined in STEP 3 which table applies? TABLE A.6 (see Figure 3)

If the answer is "YES" in STEP 2 then either shear wall Tables A.3, A.4, A.5 or A.6 will apply.

6.0 - CANADIAN PRESCRIPTIVE ENGINEERING

Table A.6 – Above Grade Shear Wall Concentrated Vertical Reinforcement for Seismic Zone Classification, $S_{a,ICF} > 0.2$ and Hourly Wind Pressure, $q_{1/50} \leq 1.05kPa$ (in a Building Without Walkout Basement)

FIGURE 3: Table A.6 requirements.

STEP 5: From the table determined in STEP 4 select the following information (refer to Figure 6):
Select the type of structure: Main flr walls of one story structure... (in green highlight)
Select wall height under type of structure: 9ft (in blue highlight)
Select appropriate Sa_{ICF} determined in STEP 3: Sa_{ICF} <= 0.4 (in red highlight)

STEP 6: Select shear wall design options (refer to Figure 6).
The shear wall options are the values where the wall height and Sa_{ICF} intersect (outlined in red. See Figure 4).
These values (outlined in red) represent the number and length of shear walls, and the number of 10M concentrated vertical bars required the ends of the shear walls, as shown in Detail A.10 (see Figure 5).

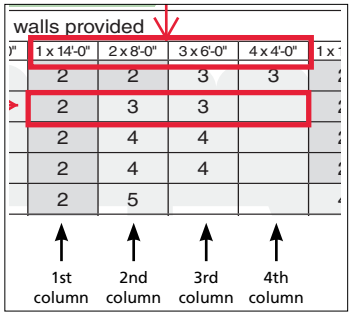

Figure 4

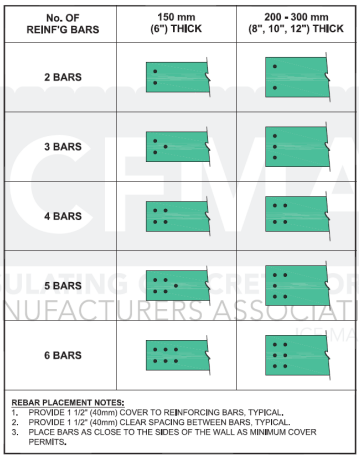

Figure 5

From Figure 4, the shear wall options are:
- One minimum 14 ft long shear wall with 2-10M concentrated vertical bars
- Two minimum 8 ft long shear walls with 3-10M concentrated vertical bars
- Three minimum 6 ft long shear walls with 3-10M concentrated vertical bars

STEP 7: Select appropriate shear walls and concentrated vertical reinforcement.
Shear walls must be used on all four sides of the building.
The most economical shear wall is the first column followed by the 2nd column, etc.

In this example, the north wall has a solid 23ft long wall. Since this is longer than 14ft, the first column can be used with a 23ft long shear wall and two 10M concentrated vertical bars. The vertical bars are installed at the ends of the shear wall (next to the windows).

NOTE: Because the value, "2," is shaded grey this means the vertical bars already required for window/door openings can also be used as the concentrated vertical bars. So no additional concentrated vertical bars are required.

The east wall has a 15ft solid wall. This meets the first column - 15ft shear wall with two 10M vertical bars at the ends.

The south wall has three wall lengths less than 14ft but are longer than 8ft. So the 2nd shear wall option can be used - two shear walls greater than 8ft each with three 10M vertical bars at the ends. (Any two of the walls can be used as a shear wall).

The west has two wall lengths less than 14ft but more than 8ft. So the 2nd shear wall option can be used - two shear walls greater than 8ft each with three 10M vertical bars at the ends.

STEP 8: Select appropriate horizontal reinforcement and vertical reinforcement.
The concentrated vertical reinforcement determined in STEP 7 is only applied at the ends of the shear walls. Specific vertical and horizontal reinforcement will be required for the remaining length of the shear walls. The additional reinforcement can be found at the bottom of the table determined in STEP 4. See Figure 6.

For this example, the vertical and horizontal reinforcement are:
Vertical reinf: for 8" tie spacing use Table A.2.2
Horizontal reinf: for 16" tall blocks use Table A.2.2

STEP 9: Below-grade walls shall have the same number and length of shears walls as the walls immediately above it.
In this, example, the shear walls on the main floor will be the same shear walls required for the foundation walls.

As a design aid, a spreadsheet has been developed to easily help design Logix ICF walls, based on the ICFMA design guide. Contact your local Logix representative for more information.

Table A.6 – Above Grade Shear Wall Concentrated Vertical Reinforcement for Seismic Zone Classification, $S_{a,ICF} > 0.2$ and Hourly Wind Pressure, $q_{1/50} \leq 1.05$kPa (in a Building Without Walkout Basement)

Wall Height		Number of Concentrated Vertical 10M Reinforcing Bars at End of Each Shear Wall															
		Seismic Zone Classification															
m	(ft)	$S_{a,ICF} \leq 0.2$				$S_{a,ICF} \leq 0.4$				$S_{a,ICF} \leq 0.7$				$S_{a,ICF} \leq 1.05$			
Second Floor Walls of Two Story ICF Structure Supporting Wood Frame Roof																	
		Number and length of shear walls provided															
		1 x 10'-0"	2 x 5'-0"	3 x 4'-0"	4 x 3'-0"	1 x 13'-0"	2 x 7'-6"	3 x 5'-6"	4 x 4'-0"	1 x 16'-0"	2 x 9'-0"	3 x 7'-0"	4 x 5'-0"	1 x 18'-0"	2 x 12'-0"	3 x 9'-0"	4 x 7'-0"
2.44	(8)	2	2	3	3	2	2	3	3	2	3	3	4	2	2	3	4
2.75	(9)	2	3	3	4	2	3	4	4	2	3	3	5	2	2	4	4
3.05	(10)	2	4	3	4	3	4	4		2	4	4		3	3	4	6
Main Floor Walls of One Story ICF Structure Supporting Wood Frame Roof																	
		Number and length of shear walls provided															
		1 x 10'-0"	2 x 5'-0"	3 x 4'-0"	4 x 3'-0"	1 x 14'-0"	2 x 8'-0"	3 x 6'-0"	4 x 4'-0"	1 x 17'-0"	2 x 11'-0"	3 x 7'-0"	4 x 5'-0"	1 x 20'-0"	2 x 12'-0"	3 x 9'-0"	4 x 7'-0"
2.44	(8)	2	2	3	3	2	2	3	3	2	2	2	3	2	2	3	4
2.75	(9)	2	3	3	4	2	3	3		2	2	3	4	2	2	4	4
3.05	(10)	2	4	3	4	2	4	4		2	3	4	5	3	3	4	6
3.66	(12)	2	4	4	5	2	4	4		2	4	5		3	3	6	6
4.27	(14)	2	6	5		2	5			4	5			5			
4.88	(16)	2	6			2	5			4	6			6			
Main Floor Walls of Two Story Structure Supporting 2nd Story Wood Framed Walls, Floor and Roof																	
		Number and length of shear walls provided															
		1 x 14'-0"	2 x 8'-0"	3 x 6'-0"	4 x 4'-0"	1 x 16'-0"	2 x 11'-0"	3 x 8'-0"	4 x 6'-0"	1 x 24'-0"	2 x 14'-0"	3 x 10'-0"	4 x 8'-0"	1 x 28'-0"	2 x 16'-0"	3 x 12'-0"	4 x 9'-0"
2.44	(8)	2	2	2	4	2	2	4	4	2	2	3	4	2	2	4	5
2.75	(9)	2	2	3	4	3	3	5	5	2	2	4	5	2	3	4	6
3.05	(10)	2	3	3		3	3	5	5	2	3	4	5	2	4	5	
3.66	(12)	2	3	4		4	4	5		2	4	6		2	6		
4.27	(14)	2	4			6	5			2				4			
4.88	(16)	2	4			6	5			2				4			
Main Floor Walls of Two Story ICF Structure Supporting Wood Frame Floors and Roof																	
		Number and length of shear walls provided															
		1 x 16'-0"	2 x 10'-0"	3 x 7'-0"	4 x 6'-0"	1 x 22'-0"	2 x 14'-0"	3 x 11'-0"	4 x 8'-0"	1 x 28'-0"	2 x 16'-0"	3 x 12'-0"	4 x 9'-4"	1 x 34'-0"	2 x 20'-0"	3 x 15'-0"	4 x 12'-0"
2.44	(8)	2	3	3	3	2	3	3	4	2	2	4	5	2	2	4	5
2.75	(9)	2	3	4	3	2	3	3	5	2	3	4	6	2	3	5	6
3.05	(10)	2	3	4	4	2	4	4	6	2	4	5		2	4	6	
3.66	(12)	2	3	5	5	2	4	4	6	2	6			2	6		
4.27	(14)	2	4	6		3	5	5		5				5			
4.88	(16)	2	4			3	5	5		5				5			
Vertical Reinforcement	6" ICF Tie Spacing	As per table A.2.1.				As per table A.2.1.				As per table A.2.1.				As per table A.2.1.			
	8" ICF Tie Spacing	As per table A.2.2.				As per table A.2.2.				As per table A.2.2.				As per table A.2.2.			
Horizontal Reinforcement	Block Height of 12" and 18"	As per table A.2.1.				As per table A.2.1.				As per table A.2.1.				As per table A.2.1.			
	Block Height of 16"	As per table A.2.2.				As per table A.2.2.				As per table A.2.2.				As per table A.2.2.			

NOTES

1. $S_{a,ICF}$ is equivalent spectral response acceleration for ICF walls as provided in Appendix A.
2. This table is to be used in conjunction with the "Design Limitations".
3. Provide two layers of the indicated horizontal and vertical distributed steel specified for 300mm (12") walls. Place each layer as shown in the rebar placement drawing.
4. All four sides of the building are to have a minimum number and length of shear walls that conforms to this table.
5. Use the left-most column that meets the minimum number and length of shear walls to determine the minimum required concentrated reinforcement
6. Shaded cells indicate that the minimum bars required beside all windows and openings, as per the "Design Limitations", are adequate.
7. All required number of 10M bars may be replaced by an equivalent number of 15M bars as given in the "Design Limitations"
8. All concentrated reinforcement is to be continues to the bottom of the foundation wall. Provide lap splices as required.
9. Concentrated reinforcement is to be placed in accordance with Bar Placement Detail.
10. Horizontal reinforcement in shear walls where $S_{a,ICF} > 0.2$ must be anchored using a standard 180° hook around vertical end bars.
11. When using this table for $S_{a,ICF} \leq 0.2$, use the vertical and horizontal distributed steel in Tables A.2.1. or A.2.2. for $S_{a,ICF} \leq 0.4$.

FIGURE 6: Table A.6
Source: The ICFMA Prescriptive ICF Design for Part 9 Structures in Canada

EXAMPLE 2: ONE STORY LOGIX ABOVE-GRADE PLUS BASEMENT WITH WALKOUT

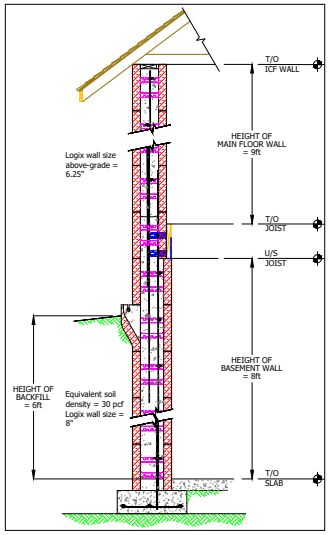

FIGURE 1: Wall Section

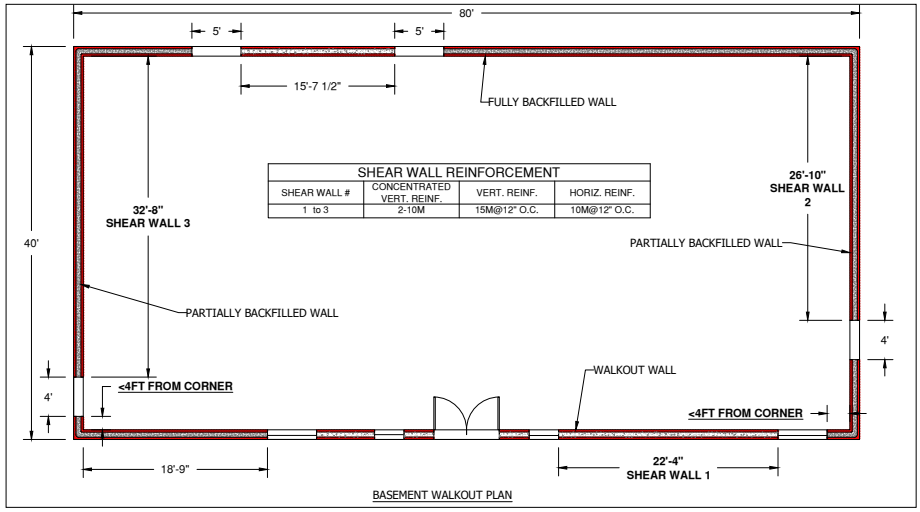

FIGURE 2: Basement Walkout Plan

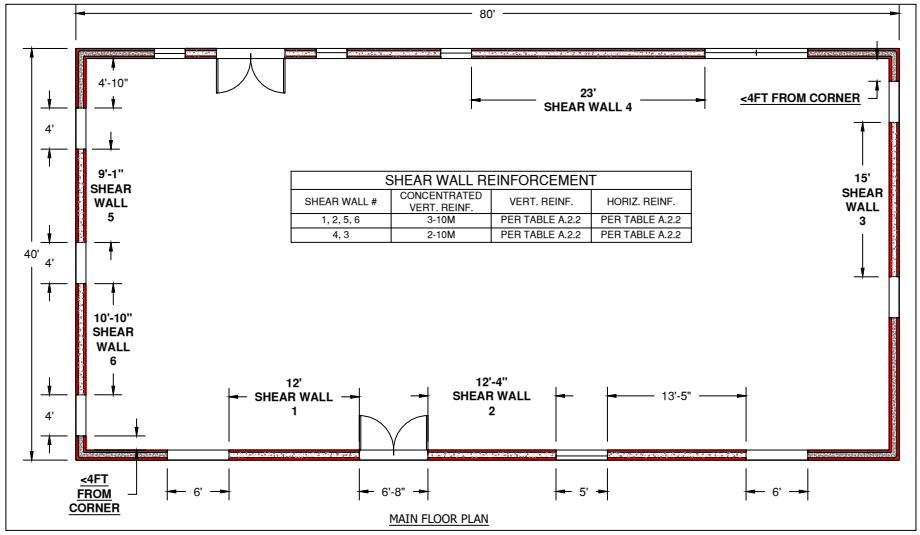

FIGURE 3: Main Floor Plan

STEP 1: Does the building have a walkout basement? YES (see Figure 2)

STEP 2: Does the walkout wall or partially backfilled walls of the basement have openings within 4ft from corners? YES (see Figure 2)
If "YES" then use Table A.11 to determine shear wall requirements for the walkout basement (see Figure 6).

STEP 3: Where is the project located? OTTAWA
What is the "equivalent spectral response acceleration," Sa_{ICF} (from Appendix A)? 0.213
What is the "hourly wind pressure," $q_{1/50}$ (from Appendix B)? 0.48

STEP 4: From Table A.11 select the following information (refer to Figure 6):
Select the type of structure: Main flr walls of one story structure... (in green highlight)
Select wall height under type of structure: 9ft (in blue highlight)
Select appropriate Sa_{ICF} determined in STEP 3: Sa_{ICF} <= 0.4 (in red highlight)

STEP 5: Select shear wall design options (refer to Figure 6).
The shear wall options are the values where the wall height and Sa_{ICF} intersect (outline in red. See Figure 4).
These values (outlined in red) represent the number and length of shear walls, and the number of 10M concentrated vertical bars required for ends of the shear walls, as shown in Detail A.10 (see Figure 5).

'-0"	1 x 19'-0"	2 x 13'-0"	3 x 10'-0"
	2	2	4
	2	3	5
	4	4	5
	6	6	
	1st column	2nd column	3rd column

FIGURE 4

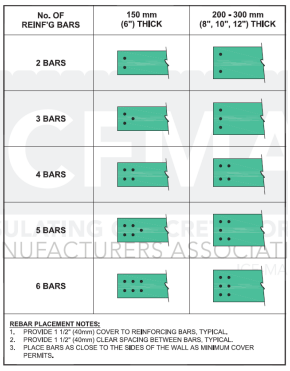

FIGURE 5

From Figure 4, the shear wall options are:
- One minimum 19 ft long shear wall with 2-10M concentrated vertical bars
- Two minimum 13 ft long shear walls with 2-10M concentrated vertical bars
- Three minimum 10 ft long shear walls with 3-10M concentrated vertical bars

STEP 6: Select appropriate shear walls and concentrated vertical reinforcement.
Shear walls must be used on the walkout wall and adjacent partially backfilled walls (see basement walkout plan).
The most economical shear wall is the first column followed by the 2nd column, etc.

In this example, the walkout wall has a solid 22'-4" long wall section. Since this is longer than 19 ft, the first column can be used with a 22'-4" long shear wall and two 10M concentrated vertical bars. The vertical bars are installed at the ends of the shear wall (next to the window and at the corner).

NOTE: Because the value, "2," is shaded grey, this means the vertical bars already required for window/door openings can also be used as the concentrated vertical bars. So no additional concentrated vertical bars are required at the window end.

The partially backfilled walls have solid wall sections greater than 19 ft. This meets the first column - shear walls greater than 19 ft with two 10M vertical bars at the ends.

The fully backfilled wall (north wall) will only require shear walls if the walls immediately above it has openings within 4 ft from corners, and will be the same shear walls as the wall immediately above it.

STEP 7: Select appropriate horizontal reinforcement and vertical reinforcement.
The concentrated vertical reinforcement determined in STEP 7 is only applied at the ends of the shear walls. Specific vertical and horizontal reinforcement will be required for the remaining length of the shear walls. The additional reinforcement can be found at the bottom of Table A.11 (see Figure 6).

For this example, the vertical and horizontal reinforcement are:
Vertical reinf: for 8" thick ICF use 15M@12" o.c.
Horizontal reinf: for 16" tall blocks use 10M@12" o.c.

STEP 8: Check main floor for openings within 4 ft from corners.
In this example, there are openings within 4 ft from corners (see main floor plan). Follow the steps in Example 1. However, Tables A.7 to A.10 will apply in Step 4.

As a design aid, a spreadsheet has been developed to easily help design Logix ICF walls, based on the ICFMA design guide. Contact your local Logix representative for more information.

Table A.11 – Above Grade Walkout Basement Shear Wall Concentrated Vertical Reinforcement for Seismic Zone Classification, $S_{a,ICF} \leq 0.4$ and Hourly Wind Pressure, $q_{1/50} \leq 1.05$kPa

Wall Height		Seismic Zone Classification											
m	(ft)	$S_{a,ICF} \leq 0.085$			$S_{a,ICF} \leq 0.145$			$S_{a,ICF} \leq 0.2$			$S_{a,ICF} \leq 0.4$		
Walkout Basement Wall of a Single Story ICF Structure Supporting Wood Framed Roof													
		Number and length of shear walls provided											
		1 x 10'-0"	2 x 6'-0"	3 x 4'-0"	1 x 12'-0"	2 x 8'-0"	3 x 6'-0"	1 x 14'-0"	2 x 9'-0"	3 x 7'-0"	1 x 19'-0"	2 x 13'-0"	3 x 10'-0"
2.44	(8)	2	3	5	2	3	3	2	3	4	2	2	4
2.75	(9)	2	3	6	2	3	4	2	4	4	2	3	5
3.05	(10)	2	3	6	2	3	4	2	5	5	4	4	5
3.66	(12)	2	4		3	4	5	3	6	6	6	6	
Walkout Basement Walls of a Two Story Wood Framed Structure Supporting Wood Frame Floors and Roof													
		Number and length of shear walls provided											
		1 x 10'-0"	2 x 6'-6"	3 x 5'-0"	1 x 12'-0"	2 x 8'-0"	3 x 6'-0"	1 x 14'-0"	2 x 9'-0"	3 x 7'-0"	1 x 19'-0"	2 x 13'-0"	3 x 10'-0"
2.44	(8)	2	4	4	2	3	4	2	3	4	2	3	4
2.75	(9)	3	4	5	2	4	4	2	4	4	3	4	5
3.05	(10)	4	5	5	2	4	4	2	4	5	4	5	6
3.66	(12)	5	6	6	3	4	5	3	5	6	5	6	6
Walkout Basement Wall of a Two Story Building with Main Floor ICF Walls Supporting 2nd Story Wood Framed Walls, Floor and Roof													
		Number and length of shear walls provided											
		1 x 12'-0"	2 x 7'-0"	3 x 5'-6"	1 x 14'-0"	2 x 9'-0"	3 x 7'-0"	1 x 16'-0"	2 x 11'-0"	3 x 8'-6"	1 x 22'-0"	2 x 15'-0"	3 x 12'-0"
2.44	(8)	2	3	3	2	4	4	2	3	4	2	4	4
2.75	(9)	2	3	4	2	4	5	2	3	4	4	4	5
3.05	(10)	2	4	4	2	4	5	2	3	4	4	5	5
3.66	(12)	2	4	5	3	5	6	4	4	6	6	6	6
Walkout Basement Wall of Two Story ICF Structure Supporting Wood Frame Floors and Roof													
		Number and length of shear walls provided											
		1 x 12'-0"	2 x 8'-0"	3 x 6'-0"	1 x 16'-0"	2 x 10'-6"	3 x 8'-0"	1 x 20'-0"	2 x 13'-0"	3 x 9'-6"	1 x 26'-0"	2 x 18'-0"	3 x 14'-0"
2.44	(8)	2	3	4	2	4	5	2	2	4	2	3	4
2.75	(9)	2	4	5	2	4	5	2	3	5	2	3	5
3.05	(10)	2	4	5	2	4	5	2	3	5	3	4	6
3.66	(12)	3	5	6	3	5	6	2	4		6	6	6
Vertical Reinforcement	6", 8", 10" Thick Wall	15 M @	300	(12)	15 M @	300	(12)	15 M @	300	(12)	15 M @	300	(12)
	12" Thick Wall	10 M @	300	(12)	10 M @	300	(12)	10 M @	300	(12)	10 M @	300	(12)
Horizontal Reinforcement	Block Height of 12" and 18"	10 M @	450	(18)	10 M @	450	(18)	10 M @	450	(18)	10 M @	450	(18)
	Block Height of 16"	10 M @	400	(16)	10 M @	400	(16)	10 M @	400	(16)	10 M @	400	(16)

NOTES

1. $S_{a,ICF}$ is equivalent spectral response acceleration for ICF walls as provided in Appendix A.
2. This table is to be used in conjunction with the "Design Limitations".
3. Provide two layers of the indicated horizontal and vertical distributed steel specified for 300mm (12") walls. Place each layer as shown in the rebar placement drawing.
4. Use the left-most column that meets the minimum number and length of shear walls to determine the minimum required concentrated reinforcement
5. Shaded cells indicate that the minimum bars required beside all windows and openings, as per the "Design Limitations", are adequate.
6. All required number of 10M bars may be replaced by an equivalent number of 15M bars as given in the "Design Limitations"
7. All concentrated reinforcement is to be continues to the bottom of the foundation wall. Provide lap splices as required.
8. Concentrated reinforcement is to be placed in accordance with Bar Placement Detail.
9. Horizontal reinforcement in shear walls where $S_{a,ICF} > 0.2$ must be anchored using a standard 180° hook around vertical end bars.
10. Walkout basement shear walls are to be reviewed and designed by a structural engineer where $S_{a,ICF} > 0.4$.

FIGURE 6: Table A.11
Source: The ICFMA Prescriptive ICF Design for Part 9 Structures in Canada