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Scope of Engineering Analysis, Design Parameters

Construction Methods

Foundation wall	Ground Storey	Second Storey
IntegraSpec® ICF	Wood-framed	Wood-framed
IntegraSpec® ICF	IntegraSpec® ICF	Wood-framed
IntegraSpec® ICF	IntegraSpec® ICF	IntegraSpec® ICF

Building Dimensions

Maximum plan dimension	18.0 m		
Maximum roof clear span	12.0 m		
Maximum floor clear span	6.0 m		
Storey Heights (all storeys)	2.44 m	3.05 m	3.66 m
Foundation wall backfill depths	1.22 m to 2.12 m	1.22 m to 2.74 m	1.22 m to 3.35 m

Load Combinations

NBC 4.1.3.2.

	Vertical Loads			Lateral Loads above grade		Lateral Loads below grade		
Case	Dead	Live	Snow	Wind	Seismic	Soil	Live	Seismic
1	1.4					1.5		
2 & 3	1.25	1.5	1.5	0.4		1.5	1.5	
4	1.25	(0.5)	(0.5)	1.4		1.5		
5	1.0	(0.5)	(0.25)		1.0	1.0		1.0

Materials

Concrete	CSA	A23.1 or A438
	f'_c	20 MPa @ 28 days
	Aggregate	14 mm max
	Slump	150 mm ± 25 mm
Reinforcement	CSA	G30.18
	f_y	400 MPa
	Laps	40 dia
Backfill		Free-draining non-frost-susceptible

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Analysis Output

The structural analysis was undertaken in conformance with the requirements of NBC Part 4 and CSA A23.3-04. The analyses are detailed in the attached appendices and tables:

1.1 Vertical Loads
1.2 Lateral Loads
1.3 Seismic Loads – Out-of-Plane Bending
1.4 Design Loads
2 Brick Veneer
3 Slenderness
4.1 Above-Grade Walls - Design Moments & Reinforcement
4.2 Load and Moment Capacity - Reinforcement at Centre of Wall
4.3 Load and Moment Capacity - Reinforcement at Centre of Wall - Interaction Diagram
5.1 Foundation Walls - Design Moments - Example 1
5.2 Foundation Walls - Design Moments - Example 2
5.3.1 Foundation Walls - No Brick Veneer - Design Moments - Summary by Locations
5.3.2 Foundation Walls - No Brick Veneer - Design Moments - Summary by PGA values
5.4.1 Foundation Walls - With Brick Veneer - Design Moments - Summary by Locations
5.4.2 Foundation Walls - With Brick Veneer - Design Moments - Summary by PGA values
5.5 Load and Moment Capacity - Reinforcement Offset towards Inside Face
5.6 Load and Moment Capacity - Reinforcement Offset towards Inside Face - Interaction Diagram
6 Lateral Deflection
7.1 Lintels - Capacity
8.1 Seismic Loads - Building as a Whole
8.2 Seismic Design - Building as a Whole

A1 Foundation Walls - No Brick Veneer - Vertical Reinforcement - Summary by Locations
A2 Foundation Walls - No Brick Veneer - Vertical Reinforcement - Summary by PGA values
B1 Foundation Walls - With Brick Veneer - Vertical Reinforcement - Summary by Locations
B2 Foundation Walls - With Brick Veneer - Vertical Reinforcement - Summary by PGA values
C Lintels - Reinforcement

Analysis Comments

The following factors influence the analysis, and, where applicable, they are incorporated into the design tables:

- Load Case 1 - Dead load only - is not a governing load case by inspection. This load case was not considered.

- Load Cases 2 & 3 were combined to generate a worst-case combination of live and snow loads.

- The worst case for lateral loads above grade is either Case 4 or Case 5, depending on the relative magnitudes of wind loads vs seismic loads at the building location. For all locations in Canada the design moments do not exceed the design capacity of a wall reinforced with

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the minimum Code-compliant vertical reinforcement. Accordingly the same reinforcement may be used for all above-grade walls.

- The worst case for lateral loads below grade is either Case 2/3 or Case 5, depending on the relative magnitudes of lateral soil pressure from surcharge vs lateral soil pressure from seismic effects at the building location.

- Seismic loads vary considerably across Canada, and seismic load effects are significant for taller foundation walls with deep backfill. The maximum Peak Ground Acceleration (PGA) in Canada is 0.61 (Victoria, BC) - this value was used to check the extreme condition. There are potential savings available for buildings at locations with lower seismic loads, and for buildings with shorter walls / lesser depths of backfill.

- Because the vertical loads are relatively small (when compared to the capacity of the wall) the interaction diagrams for moment resistance and vertical load resistance are typically governed by the design moment. Accordingly, increasing the vertical load has a "beneficial effect", so the governing design combination is generally the combination with maximum lateral load and least vertical load.

- Some of the tall walls are relatively slender. Under the condition of maximum vertical load and most slender wall, the walls do not exceed the maximum slenderness permitted by CSA A23.3 – and thus the design process for “non-slender” walls is valid.

- ICF foundation walls without ICF walls at upper storeys would have larger design moments than multi-storey ICF walls because there would be no redistribution of the foundation wall moments to the upper storey walls. On this basis, all walls were analyzed as single-span simply-supported members. For the case of multi-storey ICF walls, extending the wall reinforcement into adjacent storeys would provide adequate capacity for any moments that would be redistributed by continuity effects.

- Exterior brick veneer supported on “Brick Ledge Units” or steel angles will impose eccentric loads on the ICF walls, creating additional moments in the walls. In most cases the brick veneer would be supported below the ground floor, on the foundation wall. At this location the additional moments would act in the same direction as the moments generated by lateral soil pressure. In some instances, particularly for a building with two storeys of brick veneer, this combination will be the governing design condition. Separate design tables have been prepared for foundation walls without brick veneer, and for foundation walls with brick veneer.

- Floor joists supported on ledgers also impose eccentric loads on the ICF walls. At the ground floor, the resulting moments act in the opposite direction to the moments generated by lateral soil pressure - and thus they reduce the moments in the walls. At the upper floor - depending on the direction of the wind or seismic loads - the resulting moments are potentially additive to the moments from wind or seismic loads. These eccentricity moments, which are relatively small, were included in the design review.

- Walls must be restrained at each storey, including the roof. Gable walls must be restrained at ceiling level, or alternatively they must be constructed in accordance with the design

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- Walls must be restrained at each storey, including the roof. Gable walls must be restrained at ceiling level, or alternatively they must be constructed in accordance with the design tables using their full unsupported height to determine the required spacing of reinforcement.

Analysis Report

IntegraSpec® ICF Wall capacities were determined for 6" thick walls with vertical reinforcement at selected spacings. CSA A23.3 requirements for minimum reinforcement (vertical & horizontal), maximum spacing, and maximum reinforcement were checked.

Governing load cases were determined for each configuration of wall height and backfill height, using the stated load combinations, to determine the required wall capacity.

The attached design tables show the reinforcement required to provide adequate design capacity for each wall configuration.

Reinforced concrete lintels were designed for a range of opening lengths and factored loads, as shown in the attached design tables.

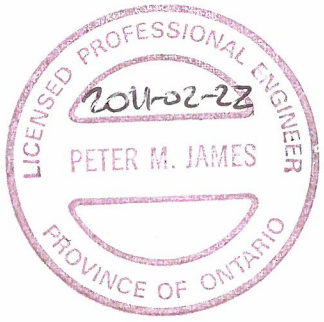
Conclusions

The IntegraSpec® ICF System when constructed in accordance with the attached tables and standard details conforms to the structural design requirements of the National Building Code as modified by the CCMC requirements listed above.

Yours truly,

NOVATECH ENGINEERING CONSULTANTS LTD.

Peter James, P.Eng
Senior Structural Engineer



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IntegraSpec® ICF Walls **110197**
Vertical Loads **2011-02-22**
Appendix 1.1
NBC 2010

Dead & Live		Dead	Live	
Roof		0.50 kPa	1.0 kPa	(min – see snow loads)
Line load - width of ½ x	12.0 m	3.0 kN/m		
Floors		0.70 kPa	1.9 kPa	
Line load - width of ½ x	6.0 m	2.1 kN/m	5.7 kN/m	

Walls		Line loads for storey heights of		
Storey Heights		2.44 m	3.05 m	3.66 m
Wood-framed	0.3 kN/m²	0.7 kN/m	0.9 kN/m	1.1 kN/m
6” IntegraSpec® ICF	3.6 kN/m²	8.8 kN/m	11.0 kN/m	13.2 kN/m
3½” Brick Veneer	1.8 kN/m²	4.4 kN/m	5.5 kN/m	6.6 kN/m
Wood-framed with Veneer	2.1 kN/m²	5.1 kN/m	6.4 kN/m	7.7 kN/m
6" IntegraSpec® ICF with Veneer	5.4 kN/m²	13.2 kN/m	16.5 kN/m	19.8 kN/m

Snow **NBC 9.4.2.2.(1)**

C_b 0.55

NBC Table C-2

		Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
$S_{s\ 1/50}$		0.9 kPa	2.4 kPa	2.6 kPa	1.9 kPa	1.1 kPa	1.8 kPa
S_r		0.4 kPa	0.4 kPa	0.4 kPa	0.6 kPa	0.1 kPa	0.2 kPa
$S = C_b S_s + S_r$ (min 1.0 kPa)		1.00 kPa	1.72 kPa	1.83 kPa	1.65 kPa	1.00 kPa	1.19 kPa
Line load - width of ½ x	12.0 m	6.0 kN/m	10.3 kN/m	11.0 kN/m	9.9 kN/m	6.0 kN/m	7.1 kN/m

IntegraSpec® ICF Walls **110197**
Lateral Loads **2011-02-22**
Appendix 1.2
NBC 2010

Wind

NBC 4.1.7.1.

I_w	1	
C_e	1	
$C_{pe}C_g$	1.5	NBC Commentary Figure I7, zone 1E, 20° roof
$p_e/q = I_wC_eC_gC_{pe}$	1.5	
C_{gi}	2	NCB 4.1.7.1.(6)(c)
C_{pi}	-0.45	NBC Commentary I, Para 31, category 2
$p_i/q = I_wC_eC_{gi}C_{pi}$	-0.9	

NBC Table C-2

	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
$q_{1/50}$	0.44 kPa	0.41 kPa	0.42 kPa	0.58 kPa	0.48 kPa	0.45 kPa
$p = q(p_e/q - p_i/q)$	1.06 kPa	0.98 kPa	1.01 kPa	1.39 kPa	1.15 kPa	1.08 kPa

Soil - Self-weight

	γ	18	kN/m³	
	Φ	32	°	free-draining granular
	k_o	0.47		
Lateral pressure	$k_o \gamma H$	0	kN/m²	Top of soil
Lateral pressure	$k_o \gamma H$	8.46	kN/m²	Base of wall per metre of soil height

Soil - Vehicle surcharge

	V_s	2.4	kN/m²	
Lateral pressure	$k_o V_s$	1.13	kN/m²	Uniform full-height of wall

Soil - Seismic

See "Earthquake-Induced Soil Pressures on Structures" (JH Wood, 1973)

Lateral force F_s	$F_p \gamma H^2 a_h$		
Force Factor	F_p	Varies 0.95 to 1.05 for Poisson's Ratio 0.3 to 0.4 -	use 1.0
Peak acceleration	a_h	Use PGA for location	
Centroid	0.6 H	Above base of wall	

NBC Table C-2

	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
PGA	0.12	0.32	0.33	0.086	0.088	0.46
F_s/H^2	2.16	5.76	5.94	1.55	1.58	8.28

IntegraSpec® ICF Walls **110197**
Seismic Loads - Elements - Walls Above Grade - out-of-plane bending **2011-02-22**
Appendix 1.3
NBC 4.1.8.17. **NBC 2010**

$V_p = 0.3\ F_a\ S_a(0.2)\ I_E\ S_p\ W_p$ I_E 1

$S_p = C_p\ A_r\ A_x / R_p$ Assume Site Class E

C_p	1	Category 1
A_r	1	Category 1
A_x	3	Max value for uppermost storey – used for all storeys
R_p	2.5	Category 1
S_p	1.2	Category 1

F_a from Table 4.1.8.4.B plus City-specific $S_a(0.2)$ from Appendix C Table C-2

F_a	Calgary	Toronto	Halifax	**NBC**	**NBC**	Ottawa	Montréal	**NBC**	Vancouver	**NBC**
Sa(0.2)	0.15	0.22	0.23	**0.25**	**0.5**	0.64	0.64	**0.75**	0.94	**1.0**
Site Class										
A	0.7	0.7	0.7	**0.7**	**0.7**	0.76	0.76	**0.8**	0.80	**0.8**
B	0.8	0.8	0.8	**0.8**	**0.8**	0.86	0.86	**0.9**	0.98	**1**
C	1	1.0	1	**1**	**1**	1	1	**1**	1	**1**
D	1.3	1.3	1.3	**1.3**	**1.2**	1.14	1.14	**1.1**	1.10	**1.1**
E	2.1	2.1	2.1	**2.1**	**1.4**	1.23	1.23	**1.1**	0.95	**0.9**
F										

	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
$S_a(0.2)$	0.22	0.64	0.64	0.23	0.15	0.94
F_a (Class E)	2.10	1.23	1.23	2.1	2.1	0.95
V_p =	0.17 Wp	0.28 Wp	0.28 Wp	0.17 Wp	0.11 Wp	0.32 Wp

IntegraSpec® ICF Walls **110197**
Design Loads **2011-02-22**
Appendix 1.4
NBC 2010

Load Combinations	Vertical Loads			Lateral Loads		
Case	Dead	Live	Snow	Wind	Seismic	
1	1.4					
2 & 3	**1.25**	**1.5**	**1.5**	0.4		**Max vertical load**
4	1.25	0.5	0.5	1.4		
5	1	0.5	0.25		1.0	

Design Loads - Foundation Walls

Consider 12 m span roof with max snow load
Two - 6 m span floors
Two storeys 3.66 m high ICF walls above grade with brick veneer
3.66 m high basement ICF wall

		thickness mm	γ kN/m³	Unit load kPa	Span/ height m	Service Line load kN/m	ICF wall above grade α	ICF wall above grade Line load kN/m	Wood-framed wall above grade α	Wood-framed wall above grade Line load kN/m
Roof	Dead			0.5	12.0	3.0	1.25	3.8	1.25	3.8
	Snow (max - Montréal)			1.83	12.0	11.0	1.5	16.5	1.5	16.5
ICF Wall 2-R	Dead	150	24	3.6	3.66	13.2	1.25	16.5		
Wood-framed 2-R				0.3	3.66	1.1			1.25	1.4
Second floor	Dead			0.7	6.0	2.1	1.25	2.6	1.25	2.6
	Live			1.9	6.0	5.7	1.5	8.6	1.5	8.6
ICF Wall G-2	Dead	150	24	3.6	3.66	13.2	1.25	16.5		
Wood-framed G-2				0.3	3.66	1.1			1.25	1.4
Veneer G - R	Dead	90	20	1.8	7.32	13.2	1.25	16.5		
Ground floor	Dead			0.7	6.0	2.1	1.25	2.6	1.25	2.6
	Live			1.9	6.0	5.7	1.5	8.6	1.5	8.6
ICF Fdn Wall (weight at mid-height)	Dead	150	24	3.6	1.83	6.6	1.25	8.2		

Total load **max for ICF Fdn Wall** **100.2 kN/m**
max for ICF lintels over basement windows **45.3 kN/m**

Design Loads - Lintels (Buildings with full-height ICF Walls)

The stiffness of uninterrupted full height ICF walls will span across openings
Lintels at openings below other openings will only be required to support the panel of wall between the openings

} Use max height of: 1.0 m ICF wall at roof, 2.5 m ICF wall at floors

Roof	Dead			0.5	12.0	3.0	1.25	3.8	
	Snow			1.83	12.0	11.0	1.5	16.5	
1 m ICF wall	Dead	150	24	3.6	1.0	3.6	1.25	4.5	
								24.7 kN/m	**max**
Floor	Dead			0.7	6.0	2.1	1.25	2.6	
	Live			1.9	6.0	5.7	1.5	8.6	
2.5 m ICF wall	Dead	150	24	3.6	2.5	9.0	1.25	11.3	
								22.4 kN/m	

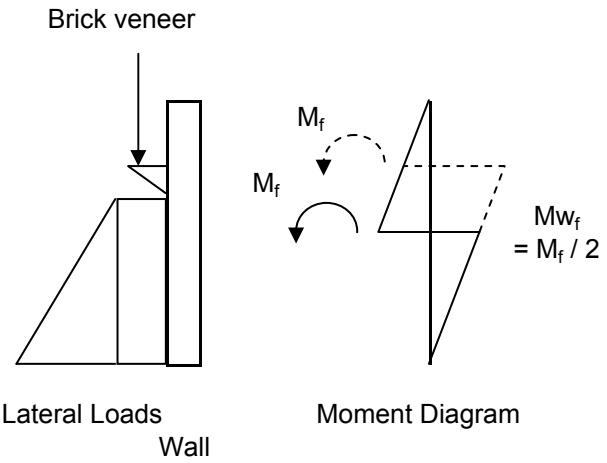
γ_b	20	kN/m³
t_b	90	mm
αD	1.25	
w_{bf}	2.25	kN/m/m height of veneer
ecc	225	mm
M_f	0.51	kNm/m/m height of veneer

h	M_f
4	2.03 kNm/m
8	4.05 kNm/m
12	6.08 kNm/m

The maximum moment in the foundation wall from soil and surcharge loads will always occur below the mid-height of the wall

Accordingly, it is conservative to add the brick veneer moment at mid-height of the wall to the maximum moment from soil and lateral loads

The moment at the mid-height of the wall is the same irrespective of the height that the brick veneer is attached to the wall = M_f / 2



For a 12-metre height of brick veneer, M_{wf} = 3.04 kNm/m

CSA A23.3 10.15.2 Can ignore slenderness effects if:

$$\frac{k\,l_u}{r} \le \sqrt{\frac{25 - 10\,(M_1/M_2)}{(\,P_f / f'_c\,A_g\,)}}$$

Consider 12 m span roof with max snow load } max
Two - 6 m span floors } load
Two storeys 3.66 m high ICF walls above grade with brick veneer max load
3.66 m high basement ICF wall max height

Max design load at Retaining Wall (Appendix 1, Case 2 & 3) **100.2 kN/m**

k		1.0	
l_u		3.66	m
t		150	mm
r	0.3 h	45	mm
M_1/M_2	single curvature	1.0	
P_f		100.2	kN/m
f'_c		20	MPa
A_g		150000	mm²/m

Check:

$$\sqrt{\frac{25 - 10\,(M_1/M_2)}{(\,P_f / f'_c\,A_g\,)}} = \sqrt{\frac{(\,25 - (\,10 * 1\,)\,)}{(\,100200 / 20 * 150000\,)}} = \mathbf{82.08}$$

OK

$$\frac{k\,l_u}{r} = \frac{1 * 3660}{45} = \mathbf{81.33}$$

IntegraSpec® ICF Walls **110197**
Above-Grade Walls - Design Moments & Reinforcement **2011-02-22**
Appendix 4.1
NBC 2010

Load Combinations	Vertical Loads			Lateral Loads above grade	
Case	Dead	Live	Snow	Wind	Seismic
1	1.4				
2 & 3	1.25	1.5	1.5	0.4	
4	1.25	0.5	0.5	**1.4**	
5	1	0.5	0.25		**1.0**

Floor Load (for eccentricity)	Unit load kPa	Span/ height m	Service Line load kN/m	α	Case 2 & 3 Line load kN/m	α	Case 4 Line load kN/m	α	Case 5 Line load kN/m
Dead	0.7	6.0	2.1	1.25	2.6	1.25	2.6	1.00	2.6
Live	1.9	6.0	5.7	1.5	8.6	0.5	2.9	0.0	0.0
					11.2		5.5		2.6
Eccentricity	100 mm								
Moment (at floor - would be less at mid-height)					1.12 kNm/m		0.55 kNm/m		0.26 kNm/m

By inspection, moment from eccentricity for Case 2 & 3 is less than moments from wind or seismic loads (below). For design, use Case 4 or Case 5 as principal load, add eccentricity effects as companion load.

Unit Weight of Wall (for seismic)	t mm	γ kN/m³	kPa
ICF Wall	150	24	3.6
Veneer	90	20	1.8
Total (W_p)			5.4

Wind (Case 4)			Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver	
$q(p_e/q - p_i/q)$		p	1.06	0.98	1.01	1.39	1.15	1.08	kPa
αW	1.4	p_f	1.48	1.38	1.41	1.95	1.61	1.51	kPa

Seismic (Case 5)			Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver	
(Appendix 1.2)		V_p	0.17 Wp	0.28 Wp	0.28 Wp	0.17 Wp	0.11 Wp	0.32 Wp	
αE	1.0		0.90	1.53	1.53	0.94	0.61	1.73	kPa

Wall Height		Design Moments						
2.44	Wind (Case 4)	**1.65**	**1.57**	**1.60**	**2.00**	**1.75**	**1.67**	**kNm/m**
	Seismic (Case 5)	0.93	1.40	1.40	0.96	0.72	1.55	**kNm/m**
3.05	Wind (Case 4)	**2.27**	**2.15**	**2.19**	**2.81**	**2.42**	**2.31**	**kNm/m**
	Seismic (Case 5)	1.31	2.04	2.04	1.35	0.97	2.28	**kNm/m**
3.66	Wind (Case 4)	**3.02**	**2.85**	**2.91**	**3.81**	**3.25**	3.08	**kNm/m**
	Seismic (Case 5)	1.77	2.83	2.83	1.83	1.29	**3.16**	**kNm/m**

Min Vertical Reinforcement (Appendix 4.2) **10M @ 400** **} Use 10M @ 400 V**
M_r (P = 0) = 6.04 kNm/m (Adequate for all design moments) **} & 10M @ 325 H**
Min Horizontal Reinforcement (Appendix 4.2) **10M @ 325** **} in all above-grade walls**

IntegraSpec® ICF Walls **110197**
Load and Moment Capacity **2011-02-22**
Reinforcement at Centre of Wall **Appendix 4.2**

t	150 mm	f_y	400 MPa	Minimum Reinforcement				
d	75 mm	φ_s	0.85	Vertical	$0.0015A_g$	225 mm²/m	10M @ 400	
b	1000 mm	f'_c	20 MPa	Horizontal	$0.002A_g$	300 mm²/m	10M @ 325	
α_1	0.82	φ_c	0.65					
β_1	0.92	c/d max	0.636					

Max P P_{max} $0.8\varphi_c f'_c b t \alpha_1$ 1279 kN Compressive capacity of vertical rebar excluded

Balanced	x_b		47.7 mm	50.0	60.0	90.0	120.0	
	a_b		43.9 mm	46.0	55.2	82.8	110.4	
	C	$\alpha_1 \varphi_c f'_c a b$	468.1 kN	490.4	588.4	882.6	1176.9	
	M_b	C (d-a/2)	24.83 kNm	25.50	27.89	29.66	23.30	

Max M

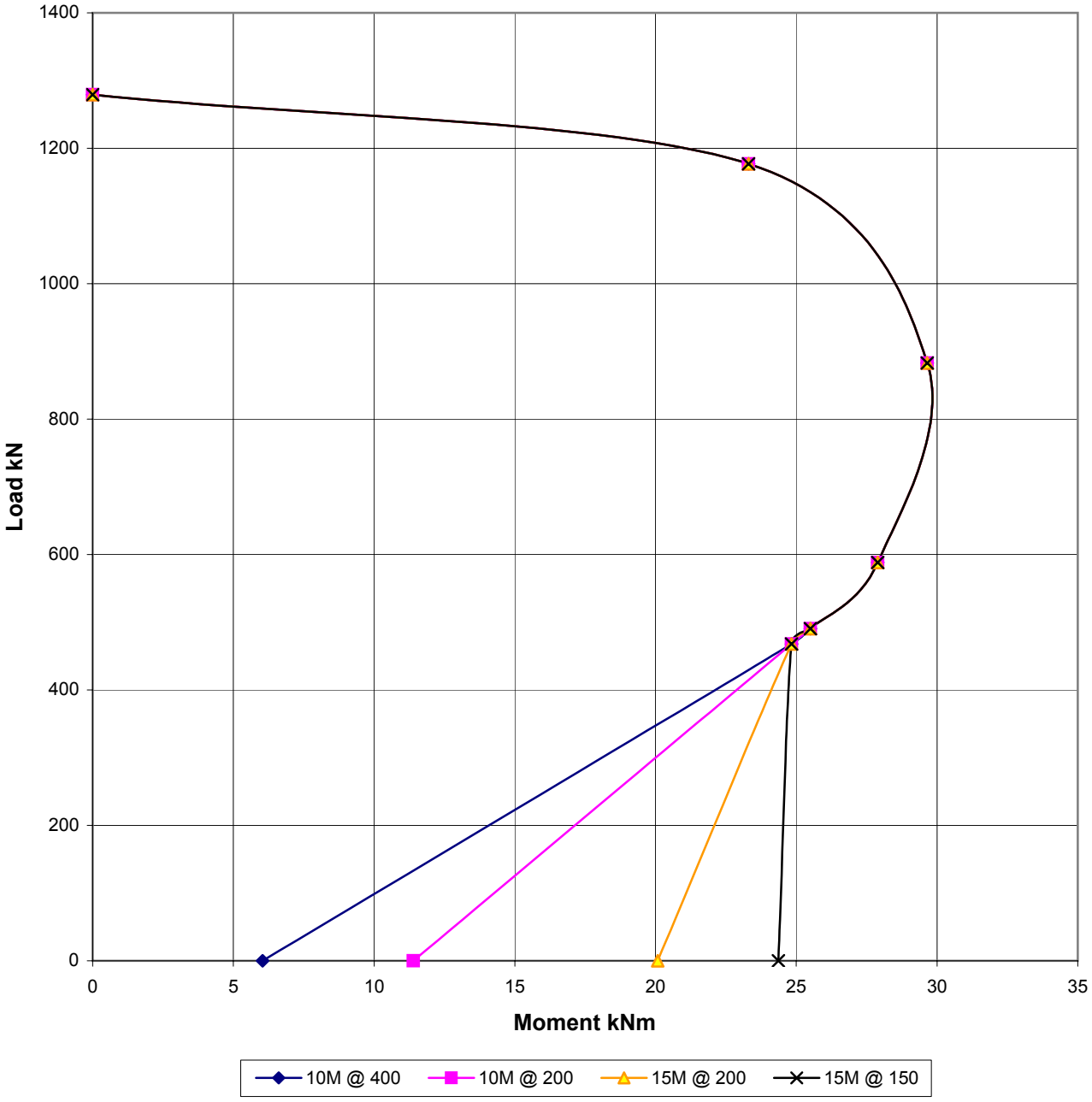
Rebar 10M
A_s 100 mm²

Rebar spacing mm		450	400	300	250	200	150	100
T	$\varphi_s A_s f_y$	75.6	85.0	113.3	136.0	170.0	226.7	340.0
ρ_g		*0.148%*	0.167%	0.222%	0.267%	0.333%	0.444%	0.667%
ρ		0.296%	0.333%	0.444%	0.533%	0.667%	0.889%	1.333%
a_{min}		7.088	7.974	10.632	12.758	15.947	21.263	31.895
c		7.704	8.667	11.556	13.867	17.334	23.112	34.668
c/d	limit 0.636	0.103	0.116	0.154	0.185	0.231	0.308	0.462
K_r		0.960	1.073	1.404	1.659	2.026	2.594	3.569
M_r	kNm/m	5.40	6.04	7.90	9.33	11.39	14.59	20.08
M_r (P = 0)		**INVALID**	**6.04**	**7.90**	**9.33**	**11.39**	**14.59**	**20.08**

Rebar 15M
A_s 200 mm²

Rebar spacing mm		450	400	300	250	200	150	145.5
T	$\varphi_s A_s f_y$	151.1	170.0	226.7	272.0	340.0	453.3	467.4
ρ_g		0.296%	0.333%	0.444%	0.533%	0.667%	0.889%	0.916%
ρ		0.593%	0.667%	0.889%	1.067%	1.333%	1.778%	1.833%
a_{min}		14.176	15.947	21.263	25.516	31.895	42.527	43.842
c		15.408	17.334	23.112	27.735	34.668	46.225	47.654
c/d	limit 0.636	0.205	0.231	0.308	0.370	0.462	0.616	0.635
K_r		1.824	2.026	2.594	3.010	3.569	4.331	4.410
M_r	kNm/m	10.26	11.39	14.59	16.93	20.08	24.36	24.81
M_r (P = 0)		**10.26**	**11.39**	**14.59**	**16.93**	**20.08**	**24.36**	**24.81**

Interaction Diagram



IntegraSpec® ICF Walls **110197**
Foundation Walls - Design Moments **2011-02-22**
Example 1 **Appendix 5.1**
NBC 2010

Wall, Backfill			Seismic	X				
Hw	**2.44**	m	PGA	**0.32**	Ottawa			
Hb	**1.22**	m	αE	1.0				
γsoil	18	kN/m³	Fs	8.57	kN/m			
Φsoil	32	°	Hs	0.6	x Hb	=	0.73	m
k_o	0.47		Pxtb	11.24	kN/m²		y1	0.4
Surcharge	2.4	kN/m²	Pxb	2.81	kN/m²		y2	1.2
αH soil lateral	1.5		Rxtw	2.57	kN/m			
αL	1.5		Rxb	6.00	kN/m			

Uniform loads

	Surcharge	Seismic	
Putb	1.69	2.81	kN/m²
Pub	1.69	2.81	kN/m²
Fu	2.06	3.43	kN/m
Rutw	0.52	0.86	kN/m
Rub	1.55	2.57	kN/m

Triangular loads			**Inverted triangular loads**	
	Backfill	Backfill	Seismic	
Pttb	0.00	0.00	8.43	kN/m²
Ptb	15.48	15.48	0.00	kN/m²
Ft	9.45	9.45	5.14	kN/m
Rttw	1.57	1.57	1.71	kN/m
Rtb	7.87	7.87	3.43	kN/m

Reactions at base of wall				
Rub		1.55	2.57	kN/m
Rtb	7.87	7.87	3.43	kN/m
ΣR = Vf	7.87	9.42	6.00	kN/m

Quadratic for POZS				
a	6.346	6.346	3.456	
b	-15.484	-17.177	2.811	
c	7.871	9.420	-6.001	
x1	1.718	1.943	0.972	
x2	0.722	0.764	-1.786	
POZS	0.722	0.764	0.972	m

Mf

Backfill (1.5)	2.44		kNm/m
Backfill + Surcharge (1.5)	**3.13**		**kNm/m**
Backfill (1.0)	1.63		kNm/m
Seismic only (1.0)		2.39	kNm/m
Backfill + Seismic (1.0) (approx)		**4.02**	**kNm/m**

IntegraSpec® ICF Walls **110197**
Foundation Walls - Design Moments **2011-02-22**
Example 2 **Appendix 5.2**
NBC 2010

Wall, Backfill			Seismic	X				
Hw	**3.05**	m	PGA	**0.32**	Ottawa			
Hb	**2.75**	m	αE	1.0				
γsoil	18	kN/m³	Fs	43.56	kN/m			
Φsoil	32	°	Hs	0.6	x Hb	=	1.65	m
k_o	0.47		Pxtb	25.34	kN/m²	y1	0.4	
Surcharge	2.4	kN/m²	Pxb	6.34	kN/m²	y2	1.2	
αH soil lateral	1.5		Rxtw	23.57	kN/m			
αL	1.5		Rxb	19.99	kN/m			

Uniform loads

	Surcharge	Seismic	
Putb	1.69	6.34	kN/m²
Pub	1.69	6.34	kN/m²
Fu	4.65	17.42	kN/m
Rutw	2.10	7.86	kN/m
Rub	2.56	9.57	kN/m

Triangular loads			**Inverted triangular loads**	
	Backfill	Backfill	Seismic	
Pttb	0.00	0.00	19.01	kN/m²
Ptb	34.90	34.90	0.00	kN/m²
Ft	47.99	47.99	26.14	kN/m
Rttw	14.42	14.42	15.71	kN/m
Rtb	33.57	33.57	10.43	kN/m

Reactions at base of wall				
Rub		2.56	9.57	kN/m
Rtb	33.57	33.57	10.43	kN/m
ΣR = Vf	33.57	36.12	19.99	kN/m

Quadratic for POZS				
a	6.346	6.346	3.456	
b	-34.903	-36.596	6.336	
c	33.568	36.124	-19.995	
x1	4.258	4.502	1.657	
x2	1.242	1.264	-3.491	
POZS	1.242	1.264	1.657	m

Mf

Backfill (1.5)	18.82			kNm/m
Backfill + Surcharge (1.5)		**20.70**		**kNm/m**
Backfill (1.0)	12.55			kNm/m
Seismic only (1.0)			13.95	kNm/m
Backfill + Seismic (1.0) (approx)			**26.50**	**kNm/m**

IntegraSpec® ICF Walls — **110197**
Foundation Walls - No Brick Veneer — **2011-02-22**
Design Moments — **Appendix 5.3.1**
Summary - All Locations — **NBC 2010**

γsoil	18	kN/m³	Seismic	
Φsoil	32	°	Fs	$\gamma s H_b^2$ PGA
k_o	0.47		Hs	0.6 Hb
Surcharge	2.4	kN/m²		

Location	N/A	All	N/A	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
αD		1.25		1.0	1.0	1.0	1.0	1.0	1.0
αH soil lateral	1.0	1.5		1.0	1.0	1.0	1.0	1.0	1.0
αL		1.5							
αE				1.0	1.0	1.0	1.0	1.0	1.0
PGA				0.12	0.32	0.33	0.086	0.088	0.46

Design Moment (kNm/m)

Height of Wall	Height of Backfill	Backfill only αH=1.0	Backfill + Surcharge	Seismic only PGA=1.0	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic
2.44	**1.22**	1.63	**3.13**	7.46	2.52	**4.02**	**4.09**	2.27	2.29	**5.06**
2.44	**1.53**	2.85	**5.17**	12.26	4.32	**6.77**	**6.90**	3.90	3.93	**8.49**
2.44	**1.83**	4.32	**7.55**	17.17	6.38	**9.81**	**9.99**	5.80	5.83	**12.22**
2.44	**2.14**	6.07	**10.29**	21.61	8.66	**12.98**	**13.20**	7.93	7.97	**16.01**
3.05	**1.22**	1.79	**3.46**	8.50	2.81	**4.51**	**4.59**	2.52	2.53	**5.70**
3.05	**1.53**	3.21	**5.88**	14.69	4.97	**7.91**	**8.05**	4.47	4.50	**9.96**
3.05	**1.83**	5.00	**8.84**	21.85	7.63	**12.00**	**12.21**	6.88	6.93	**15.06**
3.05	**2.14**	7.25	**12.45**	29.80	10.83	**16.79**	**17.08**	9.81	9.87	**20.96**
3.05	**2.44**	9.74	**16.36**	37.20	14.20	**21.64**	**22.02**	12.94	13.01	**26.85**
3.05	**2.75**	12.55	**20.70**	43.58	17.78	**26.50**	**26.93**	16.30	16.38	**32.60**
3.66	**1.22**	1.90	**3.69**	9.21	3.00	**4.85**	**4.94**	2.69	2.71	**6.14**
3.66	**1.53**	3.46	**6.39**	16.39	5.43	**8.71**	**8.87**	4.87	4.91	**11.00**
3.66	**1.83**	5.50	**9.78**	25.19	8.52	**13.56**	**13.81**	7.66	7.71	**17.08**
3.66	**2.14**	8.12	**14.04**	35.75	12.41	**19.56**	**19.91**	11.19	11.26	**24.56**
3.66	**2.44**	11.12	**18.83**	46.75	16.73	**26.08**	**26.55**	15.14	15.23	**32.63**
3.66	**2.75**	14.64	**24.37**	58.12	21.62	**33.24**	**33.82**	19.64	19.76	**41.38**
3.66	**3.05**	18.38	**30.17**	68.23	26.57	**40.22**	**40.90**	24.25	24.39	**49.77**
3.66	**3.36**	22.50	**36.46**	76.77	31.71	**47.06**	**47.83**	29.10	29.25	**57.81**

Location	N/A	All	N/A	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver

NOVATECH ENGINEERING CONSULTANTS LTD.

IntegraSpec® ICF Walls **110197**
Foundation Walls - No Brick Veneer **2011-02-22**
Design Moments **Appendix 5.3.2**
Summary - By PGA values **NBC 2010**

γsoil	18	kN/m³	Seismic	
Φsoil	32	°	Fs	$\gamma s H_b^2$ PGA
k_o	0.47		Hs	0.6 Hb
Surcharge	2.4	kN/m²		

PGA			0.036	0.15	0.25	0.40	0.50	0.61
αD		1.25	1.0	1.0	1.0	1.0	1.0	1.0
αH soil lateral	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0
αL		1.5						
αE			1.0	1.0	1.0	1.0	1.0	1.0

Design Moment (kNm/m)

Height of Wall	Height of Backfill	Backfill only αH=1.0	Backfill + Surcharge	Seismic only PGA=1.0	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic
2.44	**1.22**	1.63	**3.13**	7.46	1.90	2.75	**3.49**	**4.61**	**5.36**	**6.18**
2.44	**1.53**	2.85	**5.17**	12.26	3.29	4.69	**5.91**	**7.75**	**8.98**	**10.33**
2.44	**1.83**	4.32	**7.55**	17.17	4.94	6.90	**8.61**	**11.19**	**12.90**	**14.79**
2.44	**2.14**	6.07	**10.29**	21.61	6.85	9.31	**11.47**	**14.71**	**16.87**	**19.25**
3.05	**1.22**	1.79	**3.46**	8.50	2.09	3.06	**3.91**	**5.19**	**6.04**	**6.97**
3.05	**1.53**	3.21	**5.88**	14.69	3.74	5.41	**6.88**	**9.08**	**10.55**	**12.17**
3.05	**1.83**	5.00	**8.84**	21.85	5.79	8.28	**10.47**	**13.74**	**15.93**	**18.33**
3.05	**2.14**	7.25	**12.45**	29.80	8.32	11.72	**14.70**	**19.17**	**22.15**	**25.43**
3.05	**2.44**	9.74	**16.36**	37.20	11.08	15.32	**19.04**	**24.62**	**28.34**	**32.43**
3.05	**2.75**	12.55	**20.70**	43.58	14.12	19.09	**23.45**	**29.98**	**34.34**	**39.14**
3.66	**1.22**	1.90	**3.69**	9.21	2.23	3.28	**4.20**	**5.58**	**6.50**	**7.52**
3.66	**1.53**	3.46	**6.39**	16.39	4.05	5.92	**7.56**	**10.02**	**11.66**	**13.46**
3.66	**1.83**	5.50	**9.78**	25.19	6.40	9.28	**11.79**	**15.57**	**18.09**	**20.86**
3.66	**2.14**	8.12	**14.04**	35.75	9.41	13.48	**17.05**	**22.42**	**25.99**	**29.92**
3.66	**2.44**	11.12	**18.83**	46.75	12.80	18.13	**22.81**	**29.82**	**34.50**	**39.64**
3.66	**2.75**	14.64	**24.37**	58.12	16.74	23.36	**29.17**	**37.89**	**43.70**	**50.10**
3.66	**3.05**	18.38	**30.17**	68.23	20.84	28.62	**35.44**	**45.68**	**52.50**	**60.00**
3.66	**3.36**	22.50	**36.46**	76.77	25.26	34.01	**41.69**	**53.20**	**60.88**	**69.33**
	PGA				**0.036**	**0.15**	**0.25**	**0.40**	**0.50**	**0.61**

IntegraSpec® ICF Walls **110197**
Foundation Walls - With Brick Veneer **2011-02-22**
Design Moments **Appendix 5.4.1**
Summary - All Locations **NBC 2010**

γsoil	18	kN/m³	Seismic	
Φsoil	32	°	Fs	$\gamma s H_b^2$ PGA
k_o	0.47		Hs	0.6 Hb
Surcharge	2.4	kN/m²		
Brick Veneer	add 3.0	kNm/m of wall at mid-height of foundation wall		

Location	N/A	All	N/A	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
αD		1.25		1.0	1.0	1.0	1.0	1.0	1.0
αH soil lateral	1.0	1.5		1.0	1.0	1.0	1.0	1.0	1.0
αL		1.5							
αE				1.0	1.0	1.0	1.0	1.0	1.0
PGA				0.12	0.32	0.33	0.086	0.088	0.46

Design Moment (kNm/m)

Height of Wall	Height of Backfill	Backfill only αH=1.0	Backfill + Surcharge	Seismic only PGA=1.0	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic
2.44	**1.22**	1.63	**6.92**	7.46	5.56	**7.05**	**7.13**	5.31	5.32	**8.10**
2.44	**1.53**	2.85	**8.97**	12.26	7.36	**9.81**	**9.93**	6.94	6.97	**11.53**
2.44	**1.83**	4.32	**11.35**	17.17	9.42	**12.85**	**13.02**	8.84	8.87	**15.26**
2.44	**2.14**	6.07	**14.09**	21.61	11.70	**16.02**	**16.24**	10.96	11.01	**19.05**
3.05	**1.22**	1.79	**7.26**	8.50	5.84	**7.54**	**7.63**	5.55	5.57	**8.73**
3.05	**1.53**	3.21	**9.68**	14.69	8.01	**10.95**	**11.09**	7.51	7.54	**13.00**
3.05	**1.83**	5.00	**12.64**	21.85	10.66	**15.03**	**15.25**	9.92	9.96	**18.09**
3.05	**2.14**	7.25	**16.24**	29.80	13.86	**19.82**	**20.12**	12.85	12.91	**24.00**
3.05	**2.44**	9.74	**20.16**	37.20	17.24	**24.68**	**25.05**	15.98	16.05	**29.89**
3.05	**2.75**	12.55	**24.50**	43.58	20.82	**29.53**	**29.97**	19.34	19.42	**35.64**
3.66	**1.22**	1.90	**7.49**	9.21	6.04	**7.88**	**7.97**	5.73	5.75	**9.17**
3.66	**1.53**	3.46	**10.19**	16.39	8.47	**11.75**	**11.91**	7.91	7.94	**14.04**
3.66	**1.83**	5.50	**13.58**	25.19	11.56	**16.60**	**16.85**	10.70	10.75	**20.12**
3.66	**2.14**	8.12	**17.84**	35.75	15.45	**22.59**	**22.95**	14.23	14.30	**27.60**
3.66	**2.44**	11.12	**22.63**	46.75	19.77	**29.12**	**29.59**	18.18	18.27	**35.66**
3.66	**2.75**	14.64	**28.17**	58.12	24.66	**36.28**	**36.86**	22.68	22.80	**44.42**
3.66	**3.05**	18.38	**33.96**	68.23	29.61	**43.25**	**43.94**	27.29	27.43	**52.81**
3.66	**3.36**	22.50	**40.26**	76.77	34.75	**50.10**	**50.87**	32.14	32.29	**60.85**

Location	N/A	All	N/A	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver

IntegraSpec® ICF Walls — **110197**
Foundation Walls - With Brick Veneer — **2011-02-22**
Design Moments — **Appendix 5.4.2**
Summary - By PGA values — **NBC 2010**

γsoil	18	kN/m³	Seismic	
Φsoil	32	°	Fs	$\gamma s H_b^2$ PGA
k_o	0.47		Hs	0.6 Hb
Surcharge	2.4	kN/m²		
Brick Veneer	add 3.0	kNm/m of wall at mid-height of foundation wall		

PGA			**0.036**	**0.15**	**0.25**	**0.40**	**0.50**	**0.61**
αD		**1.25**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
αH soil lateral	**1.0**	**1.5**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**
αL		**1.5**						
αE			**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

Design Moment (kNm/m)

Height of Wall	Height of Backfill	Backfill only αH=1.0	Backfill + Surcharge	Seismic only PGA=1.0	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic	Backfill + Seismic
2.44	**1.22**	1.63	**6.92**	7.46	4.94	5.79	6.53	**7.65**	**8.40**	**9.22**
2.44	**1.53**	2.85	**8.97**	12.26	6.33	7.73	8.95	**10.79**	**12.02**	**13.37**
2.44	**1.83**	4.32	**11.35**	17.17	7.98	9.93	**11.65**	**14.23**	**15.94**	**17.83**
2.44	**2.14**	6.07	**14.09**	21.61	9.88	12.35	**14.51**	**17.75**	**19.91**	**22.29**
3.05	**1.22**	1.79	**7.26**	8.50	5.13	6.10	6.95	**8.22**	**9.07**	**10.01**
3.05	**1.53**	3.21	**9.68**	14.69	6.77	8.45	**9.92**	**12.12**	**13.59**	**15.20**
3.05	**1.83**	5.00	**12.64**	21.85	8.83	11.32	**13.50**	**16.78**	**18.97**	**21.37**
3.05	**2.14**	7.25	**16.24**	29.80	11.36	14.76	**17.74**	**22.21**	**25.19**	**28.47**
3.05	**2.44**	9.74	**20.16**	37.20	14.12	18.36	**22.08**	**27.66**	**31.38**	**35.47**
3.05	**2.75**	12.55	**24.50**	43.58	17.16	22.12	**26.48**	**33.02**	**37.38**	**42.17**
3.66	**1.22**	1.90	**7.49**	9.21	5.27	6.32	7.24	**8.62**	**9.54**	**10.55**
3.66	**1.53**	3.46	**10.19**	16.39	7.09	8.96	**10.60**	**13.06**	**14.70**	**16.50**
3.66	**1.83**	5.50	**13.58**	25.19	9.44	12.31	**14.83**	**18.61**	**21.13**	**23.90**
3.66	**2.14**	8.12	**17.84**	35.75	12.44	16.52	**20.09**	**25.45**	**29.03**	**32.96**
3.66	**2.44**	11.12	**22.63**	46.75	15.84	21.17	**25.85**	**32.86**	**37.53**	**42.68**
3.66	**2.75**	14.64	**28.17**	58.12	19.77	26.40	**32.21**	**40.93**	**46.74**	**53.13**
3.66	**3.05**	18.38	**33.96**	68.23	23.88	31.66	**38.48**	**48.71**	**55.54**	**63.04**
3.66	**3.36**	22.50	**40.26**	76.77	28.30	37.05	**44.73**	**56.24**	**63.92**	**72.36**
	PGA			**0.036**	**0.15**	**0.25**	**0.40**	**0.50**	**0.61**	

IntegraSpec® ICF Walls **110197**
Load and Moment Capacity **2011-02-22**
Reinforcement Offset towards Inside Face of Wall **Appendix 5.5**

t	150	mm	f_y	400	MPa
d	110	mm	φ_s	0.85	
b	1000	mm	f'_c	20	MPa
α_1	0.82		φ_c	0.65	
β_1	0.92		c/d max	0.636	

Max P P_{max} $0.8\varphi_c f'_c b t \alpha_1$ 1279 kN Compressive capacity of vertical rebar excluded

Balanced	x_b		70.0	mm	75.0	80.0	90.0	120.0
	a_b		64.4	mm	69.0	73.6	82.8	110.4
	C	$\alpha_1 \varphi_c f'_c a b$	686.5	kN	735.5	784.6	882.6	1176.9
	M_b	C (d-a/2)	53.41	kNm	55.53	57.43	60.55	64.49

Max M

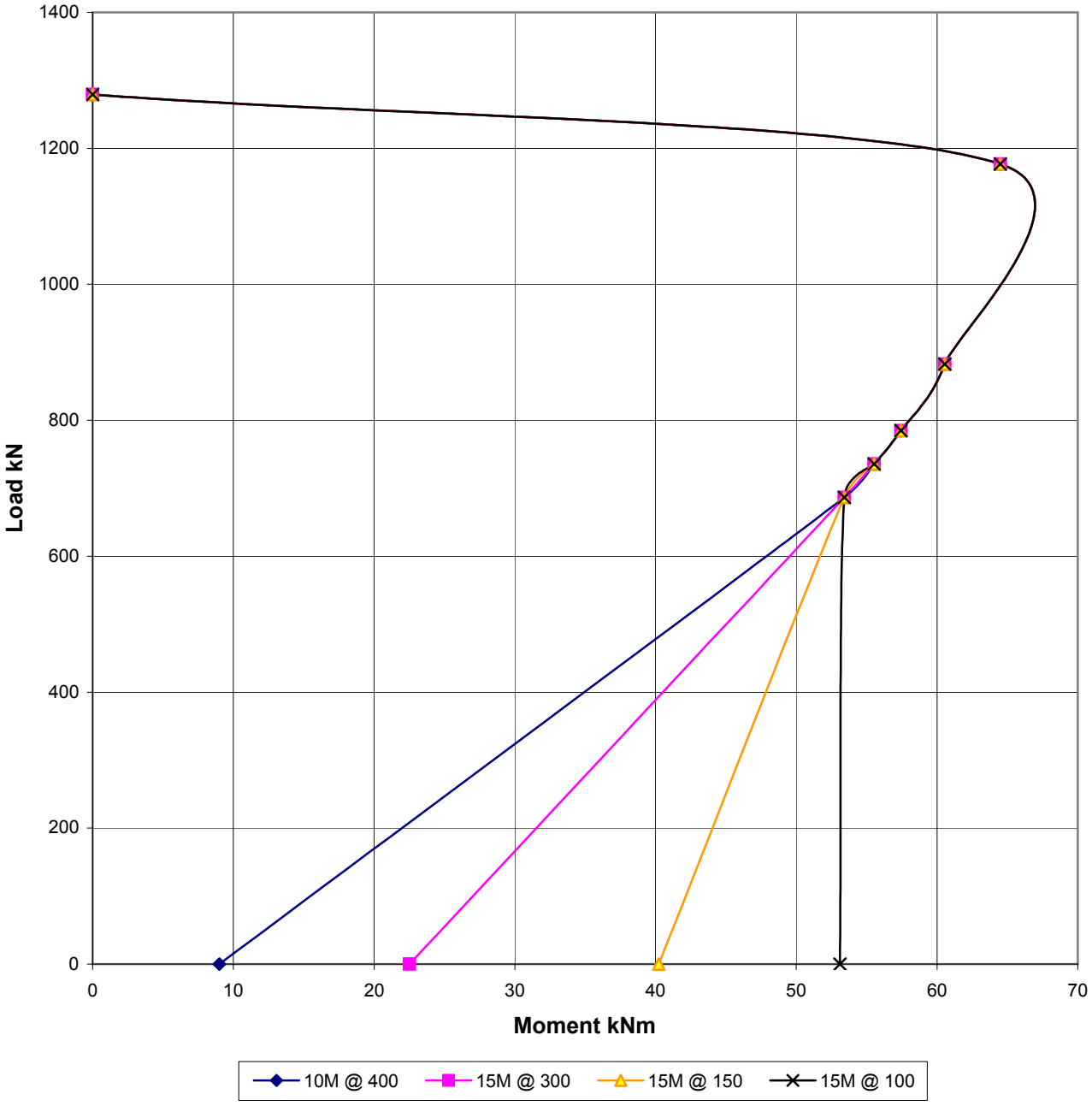
Rebar 10M
A_s 100 mm²

Rebar spacing mm		450	400	300	250	200	150	100
T	$\varphi_s A_s f_y$	75.6	85.0	113.3	136.0	170.0	226.7	340.0
ρ_g		*0.148%*	0.167%	0.222%	0.267%	0.333%	0.444%	0.667%
ρ		0.202%	0.227%	0.303%	0.364%	0.455%	0.606%	0.909%
a_{min}		7.088	7.974	10.632	12.758	15.947	21.263	31.895
c		7.704	8.667	11.556	13.867	17.334	23.112	34.668
c/d	limit 0.636	0.070	0.079	0.105	0.126	0.158	0.210	0.315
K_r		0.665	0.745	0.981	1.165	1.433	1.861	2.643
M_r	kNm/m	8.04	9.01	11.86	14.09	17.34	22.52	31.98
M_r (P = 0)		**INVALID**	**9.01**	**11.86**	**14.09**	**17.34**	**22.52**	**31.98**

Rebar 15M
A_s 200 mm²

Rebar spacing mm		450	400	300	250	200	150	100
T	$\varphi_s A_s f_y$	151.1	170.0	226.7	272.0	340.0	453.3	680.0
ρ_g		0.296%	0.333%	0.444%	0.533%	0.667%	0.889%	1.333%
ρ		0.404%	0.455%	0.606%	0.727%	0.909%	1.212%	1.818%
a_{min}		14.176	15.947	21.263	25.516	31.895	42.527	63.790
c		15.408	17.334	23.112	27.735	34.668	46.225	69.337
c/d	limit 0.636	0.140	0.158	0.210	0.252	0.315	0.420	0.630
K_r		1.285	1.433	1.861	2.186	2.643	3.325	4.389
M_r	kNm/m	15.55	17.34	22.52	26.45	31.98	40.23	53.11
M_r (P = 0)		**15.55**	**17.34**	**22.52**	**26.45**	**31.98**	**40.23**	**53.11**

Interaction Diagram



IntegraSpec® ICF Walls **110197**
Lateral Deflection **CAC Handbook Section 6.4** **2011-02-22**
Appendix 6

			Walls above grade Reinforcement at centre of wall		Walls below grade Reinforcement offset towards inside face of wall		
f'_c	20	MPa	20	20	20	20	20
thickness	150	mm	150	150	150	150	150
height	3.66	m	3.66	3.66	3.66	3.66	3.66
rebar size	10M		10M	10M	15M	15M	15M
rebar spacing	400	mm	300	200	300	200	150
M_a	**13.48**	**kNm**	**19.19**	**20.40**	**21.72**	**24.67**	**27.89**
(max service moment entered by trial & error so that deflection does not exceed the specified deflection limit)							
deflection limit	l/480		l/180	l/180	l/180	l/180	l/180
(walls may provide lateral support to brick veneer)			(walls do not support brittle finishes)				
b	1000	mm	1000	1000	1000	1000	1000
d	75	mm	110	110	110	110	110
K	1		1	1	1	1	1
(for Simple-Simple, K=1, for Fix-Fix, K=0.6, etc)							
λ	1.0		1.0	1.0	1.0	1.0	1.0
E_c	20125	MPa	20125	20125	20125	20125	20125
E_s	200000	MPa	200000	200000	200000	200000	200000
n	9.94		9.94	9.94	9.94	9.94	9.94
f_r	2.68	MPa	2.68	2.68	2.68	2.68	2.68
I_g	2.81E+08	mm^4	2.81E+08	2.81E+08	2.81E+08	2.81E+08	2.81E+08
y_t (rect sect)	75	mm	75	75	75	75	75
M_{cr}	10.06	kNm	10.06	10.06	10.06	10.06	10.06
As/1000 mm	250	mm^2	333	500	667	1000	1333
B	0.4025		0.3019	0.2012	0.1509	0.1006	0.0755
k	0.23		0.22	0.26	0.29	0.34	0.38
I_{cr}	1.00E+07	mm^4	2.91E+07	4.07E+07	5.12E+07	6.98E+07	8.60E+07
I_e	1.23E+08	mm^4	6.55E+07	6.96E+07	7.41E+07	8.42E+07	9.51E+07
deflection limit	7.63	mm	20.33	20.33	20.33	20.33	20.33
Δ_a for M_a	**7.61**	**mm**	**20.33**	**20.33**	**20.32**	**20.33**	**20.33**
Reinforcement			10M@300	10M@200	15M@300	15M@200	15M@150
Max Service Moment for deflection limit			19.19	20.40	21.72	24.67	27.89
Note that αH & αD =	1.50						
Equivalent Factored Moment for deflection limit			28.79	30.60	32.58	37.01	41.84
Design Moment Capacity		kNm	11.86	17.34	22.52	31.98	40.23
			OK	OK	OK	OK	OK

In all cases, the capacity based on the deflection limit exceeds the capacity based on moment capacity
Thus the deflection under the load that would generate the design moment will always be less than the deflection limit

IntegraSpec® ICF Walls
Lintels - Capacity

110197
2011-02-22
Appendix 7.1

Wall width b	150 mm	f_y	400 MPa	A_{smin}	0.0022 bh		
Aggregate a_g	14 mm	φ_s	0.85	α_1	0.82		
		f'_c	20 MPa	β_1	0.92		
		φ_c	0.65				

h mm	300	300	300	300	450	450	450	450	600	600
Rebar size	15M	15M	20M	20M	15M	15M	20M	20M	20M	20M
Rebar quantity	1	2	1	2	1	2	1	2	1	2
Moment Capacity										
A_s mm²	200	200	300	300	200	200	300	300	300	300
d mm	265	265	265	265	415	415	415	415	565	565
ρ_g	0.44%	0.89%	0.67%	1.33%	0.30%	0.59%	0.44%	0.89%	0.33%	0.67%
ρ	0.50%	1.01%	0.75%	1.51%	0.32%	0.64%	0.48%	0.96%	0.35%	0.71%
a	42.53	85.05	63.79	127.58	42.53	85.05	63.79	127.58	63.79	127.58
c	46.22	92.45	69.34	138.67	46.22	92.45	69.34	138.67	69.34	138.67
c/d 0.636	0.174	0.349	0.262	0.523	0.111	0.223	0.167	0.334	0.123	0.245
K_r	1.573	2.872	2.257	3.897	1.036	1.961	1.513	2.773	1.136	2.135
M_r	16.57	30.26	23.78	41.05	26.77	50.66	39.08	71.65	54.38	102.25
M_r kNm	**16.57**	**30.26**	**23.78**	**41.05**	**26.77**	**50.66**	**39.08**	**71.65**	**54.38**	**102.25**
Shear Capacity										
d_v mm	239				374	374			509	509	509
β	0.179				0.159	0.159			0.143	0.143	0.143
V_c kN	18.6				25.8	25.8			31.6	31.6	31.6
Stirrups											
A_s mm²	100				100	100			100	100	100
s_{max} mm	167				261	261			356	356	356
s mm	150				250	200			350	250	200
V_s kN	77.2				72.5	90.7			70.5	98.8	123.5
V_{fmax} for s_{max}	58.1				91.0				123.9		
(reduce s to $s_{max}/2$)	83				131				178		
s mm	75				125				175		
V_s kN	154.4				145.1				141.1		

IntegraSpec® ICF Walls **110197**
Seismic Loads - Building as a Whole **2011-02-22**
Appendix 8.1
Conventional Construction - "Non-Ductile" Walls CSA A23.3 21.8.3 **NBC 2010**
NBC 4.1.8.11.

$V = S(T_a)\, M_v\, I_E\, W \;/\; (R_d\, R_o)$
$V_{min} = S(2.0)\, M_v\, I_E\, W \;/\; (R_d\, R_o)$
$V_{max} = {}^2/_3\, S(0.2)\, I_E\, W \;/\; (R_d\, R_o)$ (for R_d >= 1.5)

R_d	1.5
R_o	1.3
I_E	1
M_v	1

V 0.51 W $S(T_a)$
V_{min} 0.51 W S(2.0)
0.34 W S(0.2)

$M_v\, I_E\, W \;/\; (R_d\, R_o)$ 0.51 W

Assume Site Class E

Period $0.05(h_n)^{0.75}$ Min T_a obtained with min h = 2.44 m T_a 0.0976 sec

S(T): For T < 0.2 $S(T) = S(0.2) = F_a\, S_a(0.2)$

F_a from Table 4.1.8.4.B plus City-specific $S_a(0.2)$ from Appendix C Table C-2

F_a	Calgary	Toronto	Halifax	NBC	NBC	Ottawa	Montréal	NBC	Vancouver	NBC
Sa(0.2)	0.15	0.22	0.23	**0.25**	**0.5**	0.64	0.64	**0.75**	0.94	**1.0**
Site Class										
A	0.7	0.7	0.7	**0.7**	**0.7**	0.76	0.76	**0.8**	0.80	**0.8**
B	0.8	0.8	0.8	**0.8**	**0.8**	0.86	0.86	**0.9**	0.98	**1**
C	1	1.0	1	**1**	**1**	1	1	**1**	1	**1**
D	1.3	1.3	1.3	**1.3**	**1.2**	1.14	1.14	**1.1**	1.10	**1.1**
E	2.1	2.1	2.1	**2.1**	**1.4**	1.23	1.23	**1.1**	0.95	**0.9**
F										

	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
$S_a(0.2)$	0.22	0.64	0.64	0.23	0.15	0.94
F_a (Class E)	2.10	1.23	1.23	2.1	2.1	0.95
$S(T),S(0.2) = F_a\, S_a(0.2)$	0.46	0.79	0.79	0.48	0.32	0.89
$V = 0.51\, W\, S(T_a)$	0.24 W	0.40 W	0.40 W	0.25 W	0.16 W	0.46 W
$V_{max} = 0.34\, W\, S(0.2)$	0.16 W	0.27 W	0.27 W	0.17 W	0.11 W	0.30 W

$S(2.0) = F_v\, S_a(2.0)$ F_v from $S_a(1.0)$

F_v from Table 4.1.8.4.C plus City-specific $S_a(1.0)$ from Appendix C Table C-2

F_v	Calgary	Toronto	Halifax	NBC	Ottawa	Montréal	NBC	NBC	Vancouver	NBC
Sa(1.0)	0.041	0.067	0.085	**0.1**	0.14	0.14	**0.2**	**0.3**	0.33	**0.4**
Site Class										
A	0.5	0.5	0.5	**0.5**	0.5	0.5	**0.5**	**0.5**	0.53	**0.6**
B	0.6	0.6	0.6	**0.6**	0.64	0.64	**0.7**	**0.7**	0.73	**0.8**
C	1	1	1	**1**	1	1	**1**	**1**	1	**1**
D	1.4	1.4	1.4	**1.4**	1.36	1.32	**1.3**	**1.2**	1.17	**1.1**
E	2.1	2.1	2.1	**2.1**	2.06	2.02	**2**	**1.9**	1.84	**1.7**
F										

City-specific $S_a(2.0)$ from Appendix C Table C-2

	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
$S_a(2.0)$	0.021	0.046	0.048	0.027	0.023	0.17
F_v (Class E)	2.1	2.06	2.02	2.1	2.1	1.84
$S(2.0) = F_v\, S_a(2.0)$	0.044	0.095	0.097	0.057	0.048	0.313
$V_{min} = 0.51\, W\, S(2.0)$	0.02 W	0.05 W	0.05 W	0.03 W	0.02 W	0.16 W
V_{max} governs	0.16 W	0.27 W	0.27 W	0.17 W	0.11 W	0.30 W

IntegraSpec® ICF Walls **110197**
Seismic Design - Building as a Whole **2011-02-22**
Appendix 8.2
NBC 2010

Load Combinations	Vertical Loads			Lateral Loads	
Case	Dead	Live	Snow	Wind	Seismic
1	1.4				
2 & 3	1.25	1.5	1.5	0.4	
4	1.25	0.5	0.5	1.4	
5	**1**	**0.5**	**0.25**		**1.0**

Building

Consider 18 m x 12 m building
Two storeys 3.66 m high ICF walls above grade with brick veneer
3.66 m high basement ICF wall

	thickness mm	γ kN/m³	Unit load kPa	length m	width m	height m	area m²	α	weight kN	(max - Vancouver) weight at each floor	seismic force 0.3 W	
Roof			0.5	18	12		216	1	108			
Snow (max - Montréal)			1.83	18	12		216	0.25	99	800	244	at roof
ICF Wall 2 - R	150	24	3.6	18	12	3.66	220	1	791			
Second floor			0.7	18	12		216	1	151	1337	407	at 2nd
ICF Wall G - 2	150	24	3.6	18	12	3.66	220	1	791			
Veneer G - R	90	20	1.8	18	12	7.32	439	1	791			
Ground floor			0.7	18	12		216	1	151	1139	347	at G
ICF Fdn Wall	150	24	3.6	18	12	3.66	220	1	791	395	120	at B
									3671	**kN**	**1119**	**kN**

Soils **Total lateral for building**

Consider 18 m long foundation wall, 3.66 m high, max backfill & seismic loads

	Reactions	kN/m	kN/m	m		
					Loads used are max (Vancouver)	
Backfill	top	10.93		18	that can be supported by a 150 mm wall:	
	base		28.42		3.66 m high wall with 3.05 m backfill	
Seismic	top	38.51			Force exerted against 18-metre long wall	
	base		38.51			
Total lateral for soil						
	top	49.44		890	kN	
	base		66.94	1205	kN	Note:

Total lateral	V_x kN	h_x m	$V_x h_x$ kNm	$Vh/\Sigma Vh$	F_{bldg} kN	F_{soil} kN	F_{total} kN	M kNm		
Roof	244	10.98	2675	0.39	432		432	4743		
Second	407	7.32	2982	0.43	481		481	3524		
Ground	347	3.66	1270	0.18	205	890	1095	4008		
Footing	120	0	0	0.00	0	1205	1205	0	Note:	Load at base does not cause shear in parallel side walls
Totals	1119		6927				3213	**12275**		

Approx overturning resistance 0.9 x ΣW x width/2
of building as a whole 0.9 3671 6 **19826 kNm** OK

Shear resisted by parallel walls 3213 -1205 2009 kN This is worst loaded wall.
To allow for eccentricity, assume 65% to one wall 1306 kN V_f for 2.44 m wall, 2.14 m backfill
Length of wall 12 m 109 kN/m (Vancouver), is
Shear stress V_f 150 mm wall **0.725 MPa** 0.536 MPa
V_c 0.519 MPa
V_s (for $A_{v\,min}$) $A_{v\,min}$ is 10M @ 1000 100 mm²/m 0.233 MPa
$A_{v\,prov}$ is 15M @ 100 2000 mm²/m
V_f **0.752 MPa** OK

IntegraSpec® ICF Walls **110197**
Foundation Walls - No Brick Veneer **2011-02-22**
Reinforcement **Table A1**
Summary - All Locations **From Appendix 5.3.1**
NBC 2010

Horizontal Reinforcement **10M @ 325** **All locations, all wall heights**

Vertical Reinforcement

Height of Wall	Height of Backfill	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
2.44	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
2.44	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
2.44	1.83	10M @ 400	10M @ 300	10M @ 300	10M @ 400	10M @ 400	10M @ 250
2.44	2.14	10M @ 300	10M @ 250	10M @ 250	10M @ 300	10M @ 300	10M @ 200
3.05	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
3.05	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300
3.05	1.83	10M @ 400	10M @ 250	10M @ 250	10M @ 400	10M @ 400	10M @ 200
3.05	2.14	10M @ 250	10M @ 200	10M @ 200	10M @ 250	10M @ 250	15M @ 300
3.05	2.44	10M @ 200	15M @ 300	15M @ 300	10M @ 200	10M @ 200	15M @ 200
3.05	2.75	15M @ 300	15M @ 200	15M @ 200	15M @ 300	15M @ 300	15M @ 150
3.66	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
3.66	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300
3.66	1.83	10M @ 300	10M @ 250	10M @ 250	10M @ 300	10M @ 300	10M @ 200
3.66	2.14	10M @ 250	15M @ 300	15M @ 300	10M @ 250	10M @ 250	15M @ 250
3.66	2.44	15M @ 300	15M @ 250	15M @ 200	15M @ 300	15M @ 300	15M @ 150
3.66	2.75	15M @ 250	15M @ 150	15M @ 150	15M @ 250	15M @ 250	15M @ 100
3.66	3.05	15M @ 200	15M @ 150	15M @ 100	15M @ 200	15M @ 200	15M @ 100
3.66	3.36	15M @ 150	15M @ 100	15M @ 100	15M @ 150	15M @ 150	N A

N A This combination of height and backfill exceeds max capacity of wall

IntegraSpec® ICF Walls **110197**
Foundation Walls - No Brick Veneer **2011-02-22**
Reinforcement **Table A2**
Summary - By PGA values **From Appendix 5.3.2**
NBC 2010

Horizontal Reinforcement **10M @ 325** **All locations, all wall heights**

Vertical Reinforcement

Height of Wall	Height of Backfill	PGA = 0.036	PGA = 0.15	PGA = 0.25	PGA = 0.40	PGA = 0.50	PGA = 0.61
2.44	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
2.44	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300
2.44	1.83	10M @ 400	10M @ 400	10M @ 400	10M @ 300	10M @ 250	10M @ 200
2.44	2.14	10M @ 300	10M @ 300	10M @ 300	10M @ 200	10M @ 200	15M @ 300
3.05	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
3.05	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 300	10M @ 300	10M @ 250
3.05	1.83	10M @ 400	10M @ 400	10M @ 300	10M @ 250	10M @ 200	15M @ 300
3.05	2.14	10M @ 250	10M @ 250	10M @ 200	15M @ 300	15M @ 300	15M @ 250
3.05	2.44	10M @ 200	10M @ 200	15M @ 300	15M @ 250	15M @ 200	15M @ 150
3.05	2.75	15M @ 300	15M @ 300	15M @ 250	15M @ 200	15M @ 150	15M @ 150
3.66	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
3.66	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 300	10M @ 300	10M @ 250
3.66	1.83	10M @ 300	10M @ 300	10M @ 300	10M @ 200	15M @ 300	15M @ 300
3.66	2.14	10M @ 250	10M @ 250	10M @ 200	15M @ 300	15M @ 250	15M @ 200
3.66	2.44	15M @ 300	15M @ 300	15M @ 250	15M @ 200	15M @ 150	15M @ 150
3.66	2.75	15M @ 250	15M @ 250	15M @ 200	15M @ 150	15M @ 100	15M @ 100
3.66	3.05	15M @ 200	15M @ 200	15M @ 150	15M @ 100	15M @ 100	N A
3.66	3.36	15M @ 150	15M @ 150	15M @ 100	15M @ 95	N A	N A

N A This combination of height and backfill exceeds max capacity of wall

IntegraSpec® ICF Walls **110197**
Foundation Walls - With Brick Veneer **2011-02-22**
Reinforcement **Table B1**
Summary - All Locations **From Appendix 5.4.1**
NBC 2010

Horizontal Reinforcement **10M @ 325** **All locations, all wall heights**

Vertical Reinforcement

Height of Wall	Height of Backfill	Toronto	Ottawa	Montréal	Halifax	Calgary	Vancouver
2.44	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
2.44	1.53	10M @ 400	10M @ 300	10M @ 300	10M @ 400	10M @ 400	10M @ 300
2.44	1.83	10M @ 300	10M @ 250	10M @ 250	10M @ 300	10M @ 300	10M @ 200
2.44	2.14	10M @ 250	10M @ 200	10M @ 200	10M @ 250	10M @ 250	15M @ 300
3.05	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400
3.05	1.53	10M @ 300	10M @ 300	10M @ 300	10M @ 300	10M @ 300	10M @ 250
3.05	1.83	10M @ 250	10M @ 200	10M @ 200	10M @ 250	10M @ 250	15M @ 300
3.05	2.14	10M @ 200	15M @ 300	15M @ 300	10M @ 200	10M @ 200	15M @ 250
3.05	2.44	15M @ 300	15M @ 250	15M @ 250	15M @ 300	15M @ 300	15M @ 200
3.05	2.75	15M @ 250	15M @ 200	15M @ 200	15M @ 250	15M @ 250	15M @ 150
3.66	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300
3.66	1.53	10M @ 300	10M @ 300	10M @ 250	10M @ 300	10M @ 300	10M @ 250
3.66	1.83	10M @ 250	10M @ 200	10M @ 200	10M @ 250	10M @ 250	15M @ 300
3.66	2.14	15M @ 300	15M @ 250	15M @ 250	15M @ 300	15M @ 300	15M @ 200
3.66	2.44	15M @ 250	15M @ 200	15M @ 200	15M @ 250	15M @ 250	15M @ 150
3.66	2.75	15M @ 200	15M @ 150	15M @ 150	15M @ 200	15M @ 200	15M @ 100
3.66	3.05	15M @ 150	15M @ 100	15M @ 100	15M @ 150	15M @ 150	15M @ 100
3.66	3.36	15M @ 100	15M @ 100	15M @ 100	15M @ 100	15M @ 100	N A

N A This combination of height and backfill exceeds max capacity of wall

IntegraSpec® ICF Walls **110197**
Foundation Walls - With Brick Veneer **2011-02-22**
Reinforcement **Table B2**
Summary - By PGA values **From Appendix 5.4.2**
NBC 2010

Horizontal Reinforcement **10M @ 325** **All locations, all wall heights**

Vertical Reinforcement

Height of Wall	Height of Backfill	PGA = 0.036	PGA = 0.15	PGA = 0.25	PGA = 0.40	PGA = 0.50	PGA = 0.61
2.44	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300
2.44	1.53	10M @ 400	10M @ 400	10M @ 400	10M @ 300	10M @ 250	10M @ 250
2.44	1.83	10M @ 300	10M @ 300	10M @ 300	10M @ 200	10M @ 200	15M @ 300
2.44	2.14	10M @ 250	10M @ 250	10M @ 200	15M @ 300	15M @ 300	15M @ 300
3.05	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300	10M @ 300
3.05	1.53	10M @ 300	10M @ 300	10M @ 300	10M @ 250	10M @ 250	10M @ 200
3.05	1.83	10M @ 250	10M @ 250	10M @ 250	10M @ 200	15M @ 300	15M @ 300
3.05	2.14	10M @ 200	10M @ 200	15M @ 300	15M @ 300	15M @ 250	15M @ 200
3.05	2.44	15M @ 300	15M @ 300	15M @ 300	15M @ 200	15M @ 200	15M @ 150
3.05	2.75	15M @ 250	15M @ 250	15M @ 200	15M @ 150	15M @ 150	15M @ 100
3.66	1.22	10M @ 400	10M @ 400	10M @ 400	10M @ 400	10M @ 300	10M @ 300
3.66	1.53	10M @ 300	10M @ 300	10M @ 300	10M @ 250	10M @ 200	10M @ 200
3.66	1.83	10M @ 250	10M @ 250	10M @ 200	15M @ 300	15M @ 300	15M @ 250
3.66	2.14	15M @ 300	15M @ 300	15M @ 300	15M @ 250	15M @ 200	15M @ 150
3.66	2.44	15M @ 250	15M @ 250	15M @ 250	15M @ 150	15M @ 150	15M @ 100
3.66	2.75	15M @ 200	15M @ 200	15M @ 150	15M @ 100	15M @ 100	15M @ 95
3.66	3.05	15M @ 150	15M @ 150	15M @ 150	15M @ 100	N A	N A
3.66	3.36	15M @ 100	15M @ 100	15M @ 100	N A	N A	N A

N A This combination of height and backfill exceeds max capacity of wall

IntegraSpec® ICF Walls **110197**
Lintels - Reinforcement **2011-02-22**
Table C
Calculate shear at support + 0.24 m (CSA A23.3 11.3.2) **From Appendix 7.1**

Openings in full-height ICF walls
(Includes arching effects in uninterrupted walls, or max 2.5 m height of ICF wall between openings)

Factored Load	24.7 kN/m		Lintel	Reinforcement	
Span	Moment	Shear	Depth	Tension	Shear
0.9	2.50	5.19	300	1-15M	no stirrups
1.2	4.45	8.90	300	1-15M	no stirrups
1.8	10.01	16.32	300	1-15M	no stirrups
2.1	13.63	20.02	300	1-15M	10M@150
2.4	17.80	23.73	300	2-15M	10M@150
2.7	22.53	27.44	300	2-15M	10M@150
3.0	27.81	31.15	300	2-15M	10M@150
3.3	33.65	34.86	300	2-20M	10M@150
3.6	40.05	38.56	300	2-20M	10M@150
3.9	47.00	42.27	450	2-15M	10M@250
4.2	54.51	45.98	450	2-20M	10M@250
4.5	62.57	49.69	450	2-20M	10M@250
4.8	71.19	53.40	450	2-20M	10M@250

Openings in basement ICF walls supporting full-height wood-framed walls

Factored Load	45.3 kN/m		Lintel	Reinforcement	
Span	Moment	Shear	Depth	Tension	Shear
0.9	4.59	9.52	300	1-15M	no stirrups
1.2	8.16	16.31	300	1-15M	no stirrups
1.8	18.35	29.91	300	2-15M	10M@150
2.1	24.98	36.71	300	2-15M	10M@150
2.4	32.63	43.50	300	2-20M	10M@150
2.7	41.29	50.30	450	2-15M	10M@250
3.0	50.98	57.10	450	2-20M	10M@250
3.3	61.69	63.89	450	2-20M	10M@250
3.6	73.41	70.69	600	2-20M	10M@250
3.9	86.16	77.49	600	2-20M	10M@250
4.2	99.92	84.29	600	2-20M	10M@250
4.5	114.70	91.08	N A	N A	N A
4.8	130.51	97.88	N A	N A	N A