713 W Ellsworth Rd, Suite C
Ann Arbor, MI 48108
Phone: 734-322-2114
Fax: 734-661-0393

January 1, 2008

Re: Rebar replacement with Helix

Dear ICF Builder

Attached is the engineering information for ICF walls reinforced with Helix. This letter contains all the required calculations and supporting data to allow Helix to be used in place of rebar designs derived from the NAHB Prescriptive Method for Insulating Concrete Forms in Residential Construction.

To assure a conservative design, the flexural strength of the original rebar design is normalized to the post crack strength of Helix reinforced concrete and a 50% margin of safety is applied to determine the Helix dosage (the amount of Helix added per cubic yard of concrete). Three tables are attached to this letter showing recommended dosages for 4", 6" and 8" thick ICF walls along with the increase in post crack strength over grade 60 rebar designs. Prescriptive tables, per the familiar NAHB format, that include Helix dosages along with sample calculations are also attached. These tables are for use in non-seismic zones.

Although complete replacement of all rebar within walls is always possible, keeping lintel reinforcement typically leads to a more economical design and doweling is still required to connect separate pours (cold joints).

Helix is the only reinforcement that increases concrete's first crack strength as rebar only provides strength after a crack forms. Another major benefit for ICF construction is Helix may be poured or pumped directly into place with no need to install rebar first.

Please contact us with any questions you may have at 734-322-2114 or tech@helixfiber.com.

Sincerely,

Luke R Pinkerton

Luke Pinkerton, PE
Enclosures:
Dosage Table
Helix Prescriptive Tables
Sample Calculation

HELIX™

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4” ICF Walls

#4 Rebar Spacing	Rebar Structural Capacity (kip-in)	Recommended Helix (lb/yd)	Helix Structural Capacity (kip-in)
more than 33” OC	≤ 8.5	**10**	**13**
22” to 33” OC	13 to 8.5	**15**	**19**
17” to 21” OC	16 to 13	**25**	**24**
15” to 16” OC	18 to 17	**30**	**27**

#5 Rebar Spacing	Rebar Structural Capacity (kip-in)	Recommended Helix (lb/yd)	Helix Structural Capacity (kip-in)
more than 33” OC	≤ 13	**15**	**19**
26” to 33” OC	16 to 13	**25**	**24**
23” to 25” OC	18 to 17	**30**	**27**

6” ICF Walls

#4 Rebar Spacing	Rebar Structural Capacity (kip-in)	Recommended Helix (lb/yd)	Helix Structural Capacity (kip-in)
more than 21" OC	≤ 20	**10**	**28**
15" to 21" OC	28 to 20	**15**	**42**
13" to 14" OC	32 to 30	**20**	**48**
11" to 12" OC	37 to 34	**25**	**54**
10" OC	41	**30**	**60**

# 5 Rebar Spacing	Rebar Structural Capacity (kip-in)	Recommended Helix (lb/yd)	Helix Structural Capacity (kip-in)
more than 33" OC	≤ 20	**10**	**28**
23" to 33" OC	28 to 20	**15**	**42**
20" to 22" OC	32 to 29	**20**	**48**
17" to 19" OC	37 to 34	**25**	**54**
16" OC	39	**30**	**60**

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8” ICF Walls

#4 Rebar Spacing	Rebar Structural Capacity (kip-in)	Recommended Helix (lb/yd)	Helix Structural Capacity (kip-in)
more than 16" OC	≤ 35	**10**	**51**
11" to 16" OC	50 to 35	**15**	**75**
9" to 10" OC	61 to 55	**25**	**96**

#5 Rebar Spacing	Rebar Structural Capacity (kip-in)	Recommended Helix (lb/yd)	Helix Structural Capacity (kip-in)
more than 25" OC	≤ 35	**10**	**51**
17" to 25" OC	50 to 35	**15**	**75**
15" to 16" OC	57 to 53	**20**	**85**
13" to 14" OC	65 to 61	**25**	**96**
12" OC	70	**30**	**106**

SI Units: 1 lb/cubic yard = 0.6 kg/m^3, 1 inch = 2.54 cm, 1 kip-in/ft = 36 kg-m/m

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Above Grade Prescriptive Table: 3.5" to 5.5" Flat ICF Walls

Design Wind Pressure (psf)	Maximum Wall Height per Story (ft)	Minimum Vertical Reinforcement					
		Supporting Roof or Non-Load Bearing Wall		Supporting Light Frame Second Story and Roof		Supporting ICF Second Story and Light Fram Roof	
		Minimum wall thickness (inches)					
		3.5	5.5	3.5	5.5	3.5	5.5
20	8	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	9	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	10	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
30	8	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	9	Design Required	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	10	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
40	8	15 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	Design Required	10 lb/yd Helix
	9	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	10	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
50	8	Design Required	10 lb/yd Helix	15 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	9	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	10	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
60	8	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	9	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	10	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
70	8	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	9	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	10	Design Required	15 lb/yd Helix	Design Required	15 lb/yd Helix	Design Required	10 lb/yd Helix
80	8	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	9	Design Required	15 lb/yd Helix	Design Required	10 lb/yd Helix	Design Required	10 lb/yd Helix
	10	Design Required	15 lb/yd Helix	Design Required	15 lb/yd Helix	Design Required	15 lb/yd Helix

SI Units: 1 lb/cubic yard = 0.6 kg/m^3, 1 inch = 2.54 cm, 1ft = 0.304 m, 1mph = 1.6 km/hr

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Below Grade Prescriptive Table 5.5 inch flat walls

Maximum Wall Height (feet)	Maximum Unbalanced Backfill Height (feet)	Maximum Vertical Reinforcement		
		Maximum Equivalent Fluid Density 30 pcf	Maximum Equivalent Fluid Density 45 pcf	Maximum Equivalent Fluid Density 60 pcf
8	4	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	5	10 lb/yd Helix	10 lb/yd Helix	15 lb/yd Helix
	6	10 lb/yd Helix	15 lb/yd Helix	20 lb/yd Helix
	7	10 lb/yd Helix	20 lb/yd Helix	40 lb/yd Helix
9	4	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	5	10 lb/yd Helix	10 lb/yd Helix	15 lb/yd Helix
	6	10 lb/yd Helix	15 lb/yd Helix	30 lb/yd Helix
	7	15 lb/yd Helix	30 lb/yd Helix	40 lb/yd Helix
	8	20 lb/yd Helix	40 lb/yd Helix	60 lb/yd Helix
10	4	10 lb/yd Helix	10 lb/yd Helix	10 lb/yd Helix
	5	10 lb/yd Helix	10 lb/yd Helix	15 lb/yd Helix
	6	15 lb/yd Helix	20 lb/yd Helix	30 lb/yd Helix
	7	15 lb/yd Helix	30 lb/yd Helix	40 lb/yd Helix
	8	30 lb/yd Helix	40 lb/yd Helix	Design Required
	9	40 lb/yd Helix	Design Required	Design Required

SI Units: 1 lb/cubic yard = 0.6 kg/m^3, 1 inch = 25.4 mm, 1mph = 1.6 km/hr

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Sample Calculation: 6” ICF Wall with #4@10” OC

	Case 1	Case 2
Input Values	**6" ICF wall with #4@10" OC**	**6" ICF Wall with 30 lb/yd Helix**
Slab Properties		
Slab Thickness, in	6	6
Width b, in	12	12
Concrete Properties		
Compressive Strength, psi	4000	4000
εc	0.003	0.003
Mesh/Rebar Properties		
Rebar/Mesh Area, in^2	0.2	
Bar Spacing, in	10	
Depth, in	3.0	
Number of layers of rebar/mesh	1	
Steel Yield Strength, psi	60	
Steel Modulus of Elasticity, ksi	29000	
Helix Properties		
Dosage, lb/yd^3	0	30
F'e Resistance Factor		0.75
Factored Design Strength F'e, psi	0	302
Calculations	**Case 1**	**Case 2**
Neutral Axis & ACI Stress Block		
ρ (based on h and spacing)	0.33%	0.00%
Ag equivalent (based on b), in^2	72	72
As equivalent (based on b), in^2	0.24	0.00
β	0.85	0.85
ec	0.003	0.003
c, in	0.415	0.57
a, in	0.353	0.48
Compressive & Tensile Resistance		
Concrete Compression (Cc), kip	14.40	20
Rebar/mesh Tension (T steel), kip	14.40	0.000
Helix Tension (T helix), kip	0.000	20
Results	**Case 1**	**Case 2**
	6" ICF wall with #4@10" OC	**6" ICF Wall with 30 lb/yd Helix**
Moment Resistance, kip-in	**41**	**60**
Percent Increase		46%
First Crack Strength, kip-in	**35**	**54**
Percent Increase		54%
Shear Strength, kip	**14**	**19**
Percent Increase		36%

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Sample Detailed Calculations - 6" ICF Wall

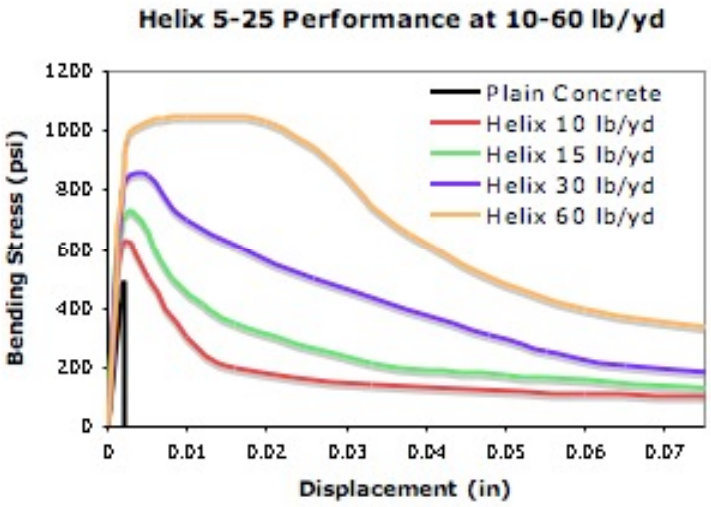
Sample ICF Calculation 6" Wall
Case 2
6" ICF Wall with 30 lb/yd Helix
2/18/08

Input Parameters

Slab Thickness, h	6	in
f'c	4000	psi
fy	60	ksi
E steel	29000	ksi
εc	0.003	
b selected	12	in

Helix Material Properties

Sample Helix Beam Test Data



Sample Helix JSCE SF-4 Test Data

Dosage	Effective Strength F'e
10	183 psi
15	256 psi
30	431 psi
60	647 psi

f'e= this is an average measure of the post cracking strength

Sample Helix Modulus of Rupture Test Data

Dosage	JSCE SF-4 f'e
0	500 psi
10	610 psi
15	700 psi
30	848 psi
60	1052 psi

The modulus of rupture is the peak bending stress.

Selected Helix Resistance Factor	0.75	The helix resistance factor is set based on material property variations (both in concrete and Helix). To level the playing field in the comparison the standard resistance factor for rebar/mesh is divided out and no resistance factor is applied to the rebar/mesh option.
Standard Bending Resistance Factor	1	
Adjusted Resistance Factor	0.75	
JSCE SF-4 Effective Strength	402 psi	This value is derived from our database from tests conducted at an independent lab at the exact dosage or interpolated between higher and lower dosages
Helix contribution	302 psi	Effective Strength X Adjusted Resistance Factor

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Detailed Calculations Continued

Bending Strength Calculation

As, steel area (if applicable)		in^2 Cross sectional area of mesh or rebar steel
d, rebar depth (if applicable)		in depth of rebar or mesh
Ag, section area	72	in ^2 Depth X b
β, stress block constant	0.85	per ACI 318 If f'c >8000 beta=0.65 If f'c < 8000 beta= 1.05-.05*f'c/1000
c, neutral axis depth	0.567	in $c = \frac{As \cdot h + f'helix \cdot b \cdot h}{0.85 \cdot f'c \cdot b \cdot \beta + f'helix \cdot b}$
a, depth of stress block	0.482	in a= beta X c
Cc, concrete compressive force	19.7	kip Cc= 0.85*f'c/1000*b*a
Cs, steel compressive force	0	kip c<steel depth Cs= 0 c>steel depth Cs= As*fy
Ts, Tensile contribution of rebar/mesh	0	kip Cs=0 Ts= As*Fy Cs non zero Ts= 0
Tf, Tensile contribution of Helix	19.68	kip (Helix Contribution/1000)*(depth-c)*b
Mn, Moment Strength	**60**	**kip-in** Sum of the moments Cc*(steel depth-a/2)+Tf*(h-d-(h-c)/2)

First Crack Strength

MOR, Modulus of Rupture	748	psi From Helix Test Database
First Crack Strength (moment)	**54**	**kip-in** (MOR*b*h^2)/1000

Shear Strength

Vs, Shear Resistance Rebar/Mesh	0	kip (As*fy*1000)*(number of layers)
Vh, Shear Resistance Helix	19	kip From Helix Test Database
Shear Resistance	**19**	**kip** Vs+Vh

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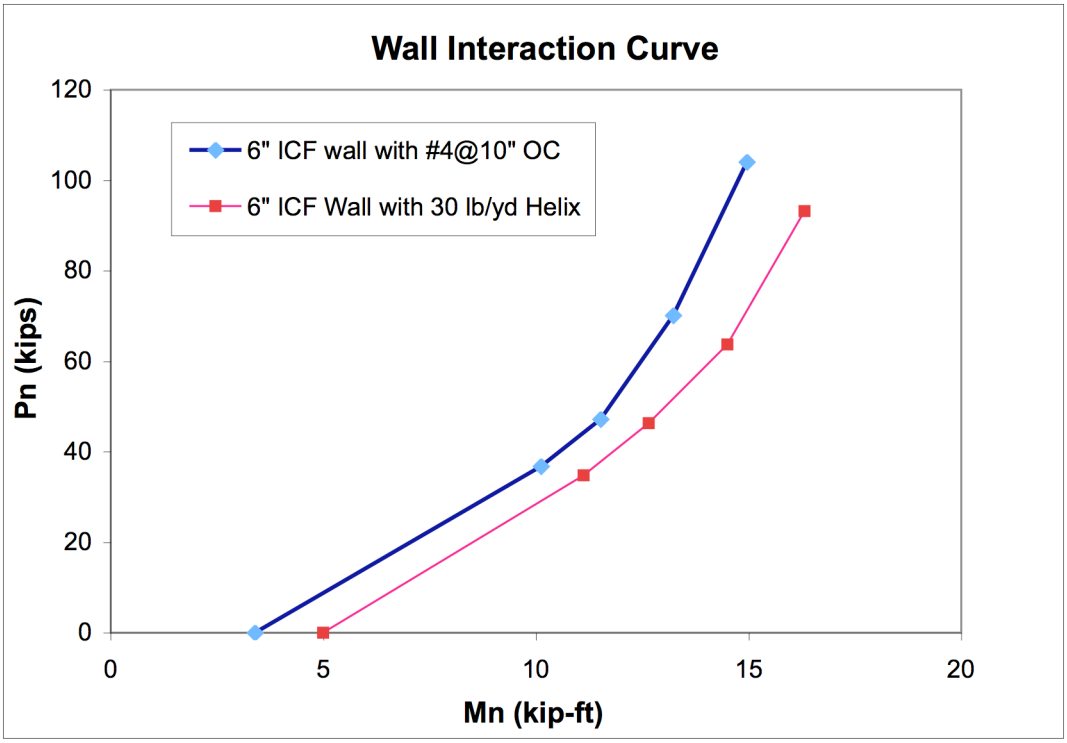

Helix resistance is calculated using standard test data and ACI based methods modified to account for the fiber contribution to the tensile and shear strength of the concrete.

Helix is approved for use in concrete under the American Concrete Institute's "Building Code Requirements for Structural Concrete and Commentary (ACI 318-05)". This document is referenced by all building codes in the United States for concrete design.

Helix has undergone extensive laboratory and field-testing - more than 5000 tests over ten years. Helix has been evaluated under and meets ALL performance based industry test methods and standards including, but not limited to:

- ASTM A-820 (Standard steel fiber specification),
- ASTM C1018-97 (Flexural Strength),
- ASTM C1609 (Flexural Strength),
- JSCE SF4 (Flexural Strength),
- ASTM C1399 (Supported flexural strength),
- SDI 5.5 (Composite Deck),
- UL263 (Composite Deck),
- ASTM C1227 (Septic Tanks),
- ASTM C76 (Pipes),
- ICC A208 (Slabs), and
- TR-34 (Slab on Grade Design).