HELIX™

Twisted Micro-Rebar Technology

Luke Pinkerton, PE
Helix Steel

Helix and Infrastructure

UAF INE AUTC

And the ALASKA CONCRETE ALLIANCE

- Case Studies,
- troubleshooting and problem solving
- Cast-in-place operations
- Mix designs
- Concrete composition
- More science/research on concrete mixes

Helix for Blast Resistance

Rebar Only

With Helix & 50% Less Rebar

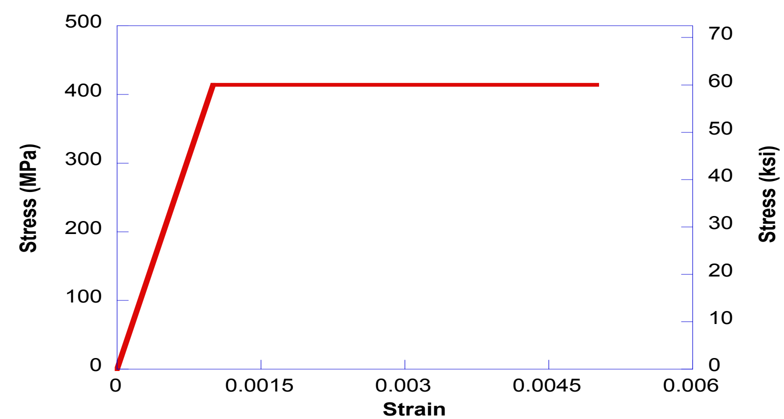
HELIX™ **Micro-Rebar**

12 Years and 30 Countries: Slabs - Complex Structures

HELIX™ Micro-Rebar

Reinforced Concrete Development Length

- R/C is a Two Part System: Concrete fails before rebar works
- Rebar Development Length: required to develop full tensile stress. #6 bar (20 mm) is about 2 ft (600 mm)



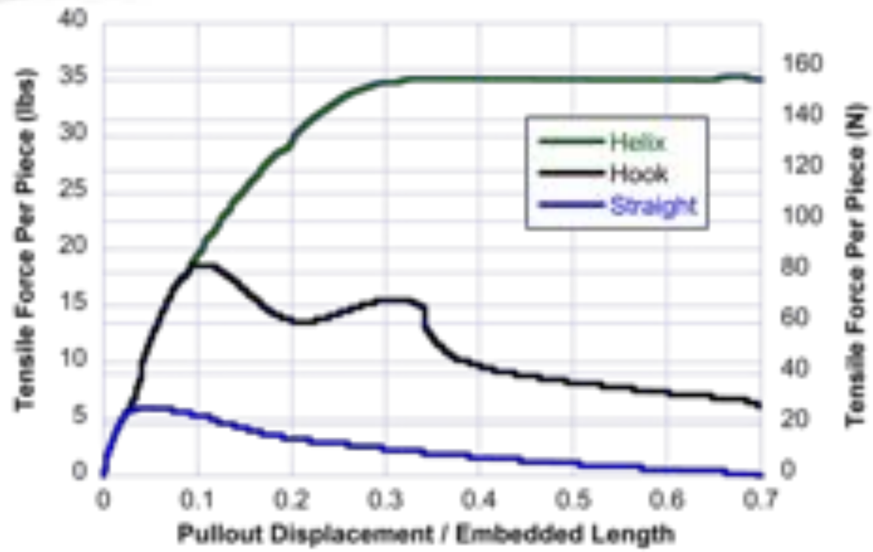
HELIX™ Micro-Rebar

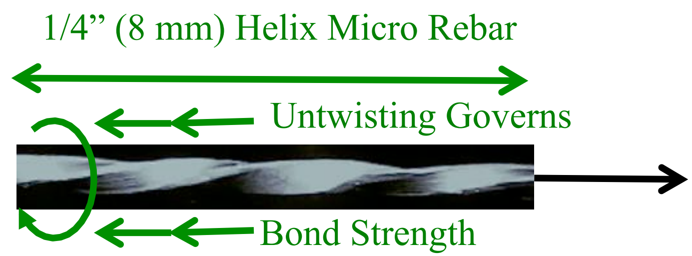
Product Description

- Steel wire tensile strength: 270 ksi (1800 MPa)
- Electroplated zinc coating: 3 g/m^3
- Length: 1.0 inch (25 mm),
- Equivalent diameter: 0.020 inch (0.5 mm)
- Rectangular Cross Sectional Shape
- Each Helix Micro-Rebar has a minimum of one 360-degree twist.
- 11,000 parts per pound

HELIX™ Micro-Rebar

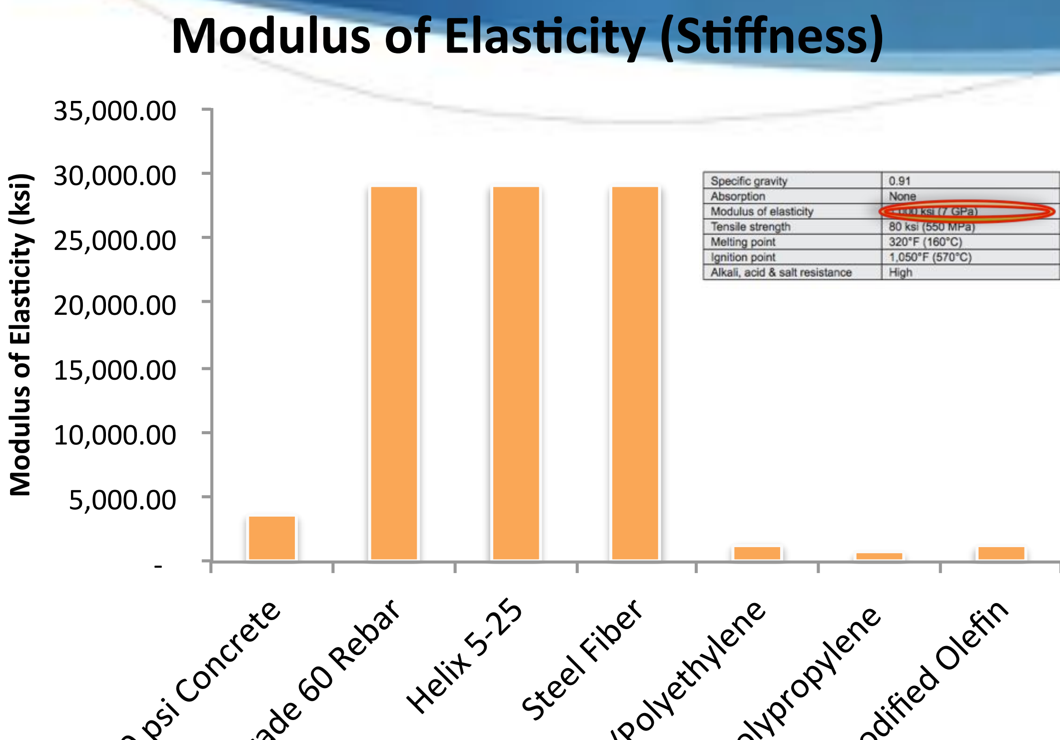
Helix Micro Rebar Development Length





HELIX™ Micro-Rebar

Breaking Laws of Physics
Can Plastic Replace Steel?



Specific gravity	0.91
Absorption	None
Modulus of elasticity	[illegible] ksi (7 GPa)
Tensile strength	80 ksi (550 MPa)
Melting point	320°F (160°C)
Ignition point	1,050°F (570°C)
Alkali, acid & salt resistance	High

Helix

- 8 x Stiffer than Concrete
- 6 x bond of smooth steel

Synthetic Fibers

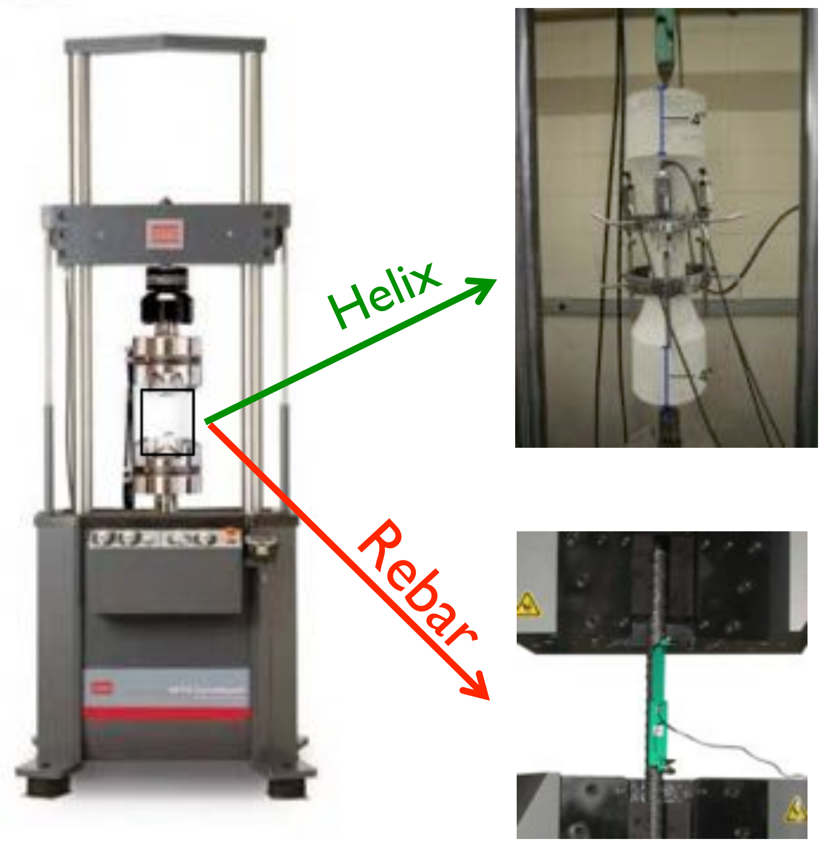
- 1/3 the stiffness of Concrete
- 1/20 the stiffness of Steel
- Acts as **void** until stretched
- No force until 1 mm crack and “band is stretched”

Large crack width testing

Plastic Shrinkage

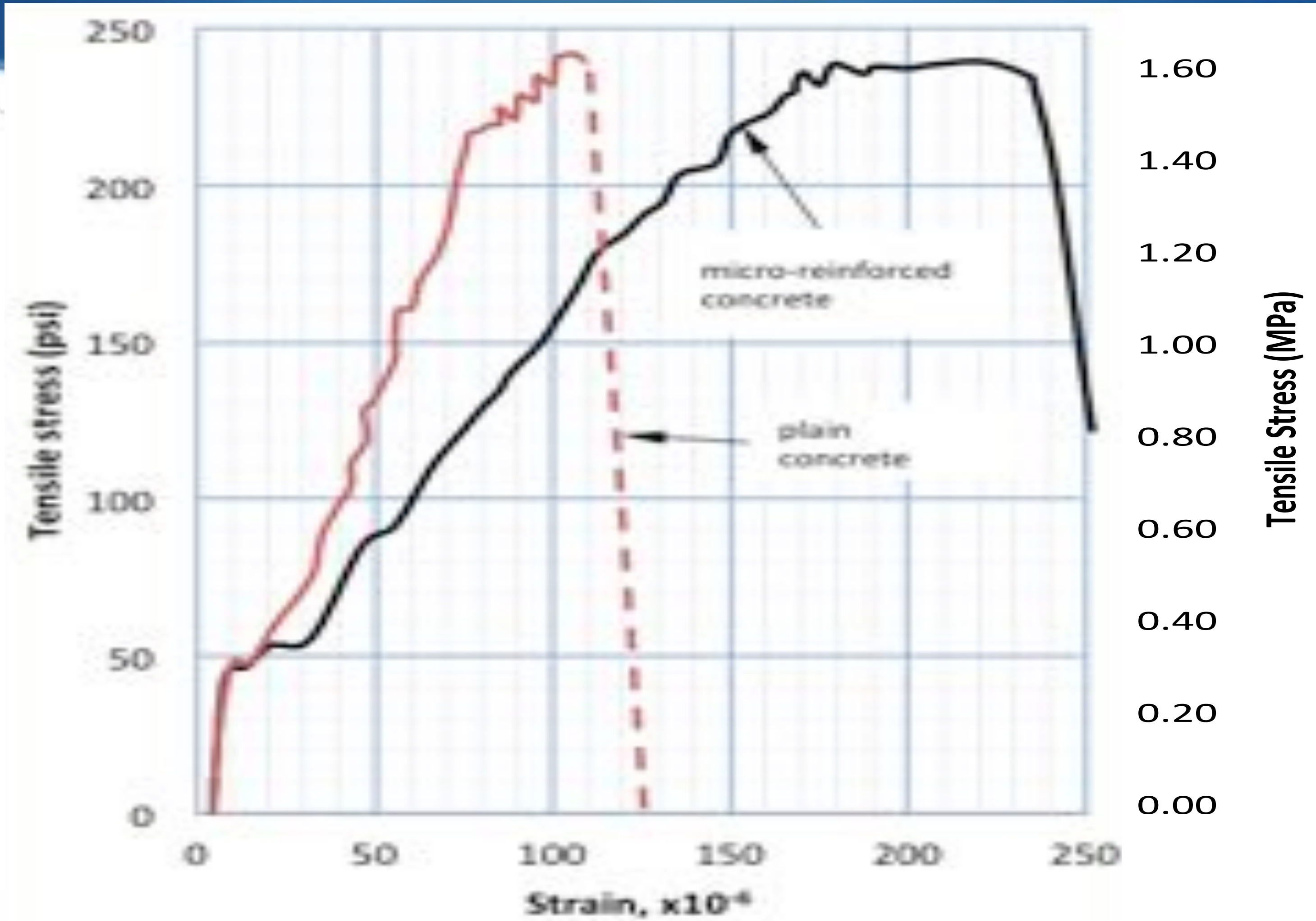
Helix Tensile Resistance
ASTM E111 Rebar Test

- ASTM E-111 Test Setup
- Hourglass 6” (150 mm) Diameter
- 4 inch (100 mm) Gage Length
- Machine plots tensile stress vs. strain
- ISO/IEC 17025 Laboratory



HELIX™

Proactive Reinforcement & Strain Capacity



HELIX Micro-Rebar

Development of a LRFD Tensile Resistance Model

- Load and Resistance Factor Design (LRFD) – J.G. MacGregor,

- Required Information
  1. Resistance Functions (Force & Distribution)
  2. Variations (Force & Distribution)
  3. Consequence of failure (Classes)
  4. Field Test Results (Calibration)

- Output
  1. Tensile Resistance Equation (function of dosage and f’c)
  2. Resistance Factor

HELIX™ Micro-Rebar

Helix Design Classes and Selection

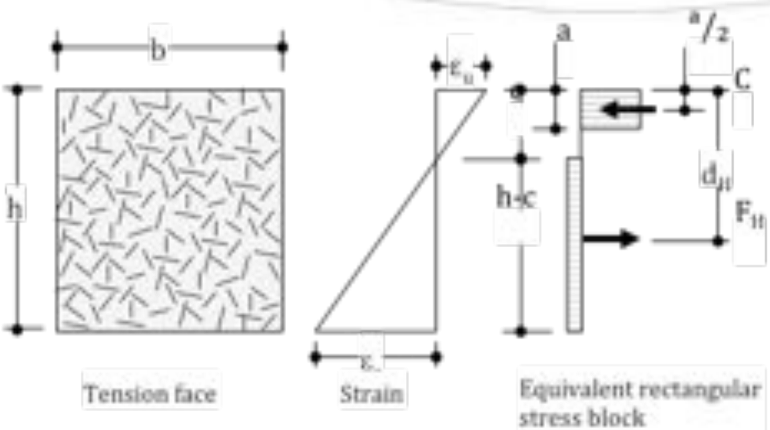
Helix Design Classes

Class	Assumptions	Applications
A	Micro-Cracking I FS 3.7 Strain Limit 110 με	Shrinkage and Temperature Soil Supported Structures
B	Micro-Cracking II FS 5 (LRFD) Strain Limit 110 με	Soil Supported Structures, Arches, Laterally Supported walls
C	Multiple Crack III FS 8.5 (LRFD) Strain Limit 1000 με	Suspended Cast in Pace Concrete, Other Structures, Limitation Apply

Class B Example – Wall

HELIX™ Micro-Rebar

Designing with Helix Another Piece of Rebar



$$c = \frac{-h + \sqrt{h^2 + 4(1-\beta)\frac{2M}{0.85f'_c\beta b}}}{2(1-\beta)}$$

- A Familiar Design Process
  1. Compute A_s Required at Tension Centroid
  2. Table 1: Number of Helix
  3. Table 2: Helix Dosage

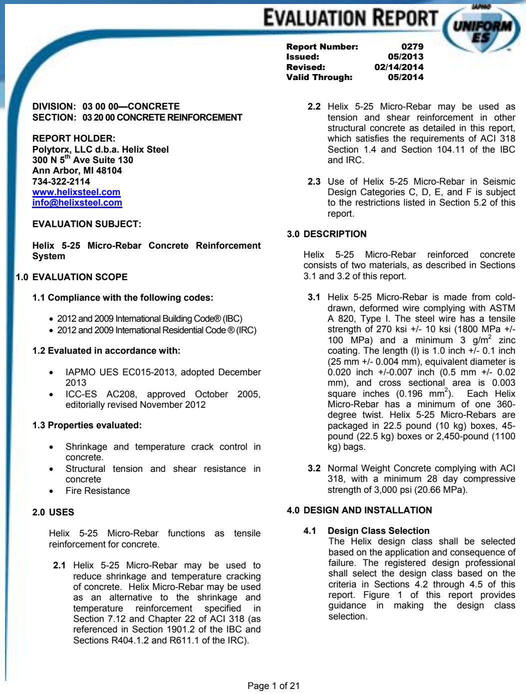
- Ensuring Stability
  - Design Class Selection (A, B or C)
  - Stability Requirements (Soil, Arch or Lateral Support or Hybrid)
  - Strain Check

HELIX™ Micro-Rebar

Approved

ISO/IEC Guide 65 Evaluation Report

- Assurance of Structural Capacity
- Assurance of Fire Resistance
- Public Reviewed Design Method
- ISO/IEC 17025 (IAS) Laboratory
- Recognized in 99 countries



EVALUATION REPORT

Report Number: 0279
Issued: 05/2013
Revised: 02/14/2014
Valid Through: 05/2014

DIVISION: 03 00 00—CONCRETE
SECTION: 03 20 00 CONCRETE REINFORCEMENT

REPORT HOLDER:
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EVALUATION SUBJECT:

Helix 5-25 Micro-Rebar Concrete Reinforcement System

1.0 EVALUATION SCOPE

1.1 Compliance with the following codes:

- 2012 and 2009 International Building Code® (IBC)
- 2012 and 2009 International Residential Code ® (IRC)

1.2 Evaluated in accordance with:

- IAPMO UES EC015-2013, adopted December 2013
- ICC-ES AC208, approved October 2005, editorially revised November 2012

1.3 Properties evaluated:

- Shrinkage and temperature crack control in concrete.
- Structural tension and shear resistance in concrete
- Fire Resistance

2.0 USES

Helix 5-25 Micro-Rebar functions as tensile reinforcement for concrete.

2.1 Helix 5-25 Micro-Rebar may be used to reduce shrinkage and temperature cracking of concrete. Helix Micro-Rebar may be used as an alternative to the shrinkage and temperature reinforcement specified in Section 7.12 and Chapter 22 of ACI 318 (as referenced in Section 1901.2 of the IBC and Sections R404.1.2 and R611.1 of the IRC).

2.2 Helix 5-25 Micro-Rebar may be used as tension and shear reinforcement in other structural concrete as detailed in this report, which satisfies the requirements of ACI 318 Section 1.4 and Section 104.11 of the IBC and IRC.

2.3 Use of Helix 5-25 Micro-Rebar in Seismic Design Categories C, D, E, and F is subject to the restrictions listed in Section 5.2 of this report.

3.0 DESCRIPTION

Helix 5-25 Micro-Rebar reinforced concrete consists of two materials, as described in Sections 3.1 and 3.2 of this report.

3.1 Helix 5-25 Micro-Rebar is made from cold-drawn, deformed wire complying with ASTM A 820, Type I. The steel wire has a tensile strength of 270 ksi +/- 10 ksi (1800 MPa +/- 100 MPa) and a minimum 3 g/m^2 zinc coating. The length (l) is 1.0 inch +/- 0.1 inch (25 mm +/- 0.004 mm), equivalent diameter is 0.020 inch +/-0.007 inch (0.5 mm +/- 0.02 mm), and cross sectional area is 0.003 square inches (0.196 mm^2). Each Helix Micro-Rebar has a minimum of one 360-degree twist. Helix 5-25 Micro-Rebars are packaged in 22.5 pound (10 kg) boxes, 45-pound (22.5 kg) boxes or 2,450-pound (1100 kg) bags.

3.2 Normal Weight Concrete complying with ACI 318, with a minimum 28 day compressive strength of 3,000 psi (20.66 MPa).

4.0 DESIGN AND INSTALLATION

4.1 Design Class Selection
The Helix design class shall be selected based on the application and consequence of failure. The registered design professional shall select the design class based on the criteria in Sections 4.2 through 4.5 of this report. Figure 1 of this report provides guidance in making the design class selection.

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HELIX™ Micro-Rebar

Why Specify Helix?
Increased Performance
Decreased Install Time

	Rebar	Helix		Helix Results
Design	#4@12	18	lb/yd	
	12@#300	10.7	kg/m^3	
Bending Strength	31	31	k-in/ft	**Equal or Better**
	12	12	kN-m/m	
Shear Strength	3.4	13.5	k/ft	**250% Increase**
	54	211	kN/m	
1st Crack Strength	596	609	psi	**10% Increase**
	4.1	4.5	MPa	
Durability	115	161	lb-in/ft	**50% Increase**
	3610	5196	kN-mm/m	

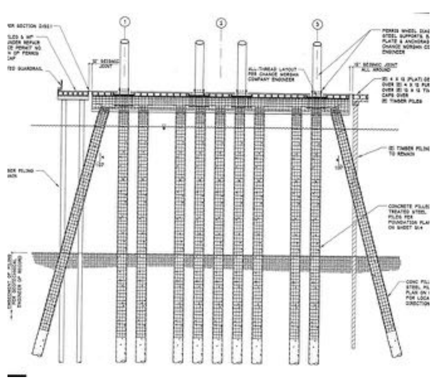
Direct Cost Savings 20%

"We saved one day for every 10,000 (900 square meters) square feet when substituting Helix for rebar"
– Wes Atkinson, Century Concrete

HELIX™ **Micro-Rebar**

Seattle Pier 57 Piles

- **Project:** Seattle Pier 57 Pile Foundation, March 2012
- **Helix Design:** 53 steel piles received 24,000 pounds of Helix micro rebar to replace all #6 rebar cages saving money, reducing schedule and increasing strength.



HELIX™ Micro-Rebar

Heavily Loaded SOG

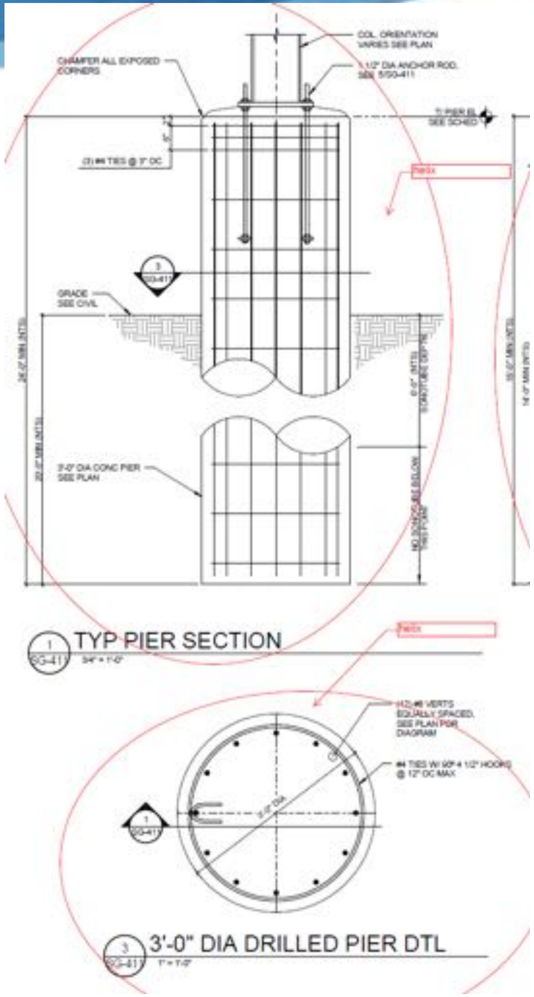
- **Project** - A slab designed for heavy loading was specified at 16" thick and with #6 bar spaced at 9" both top & bottom with a 6-6-6-6 mesh.

- **Helix Design** - 50 lbs/yd of Helix replaced rebar and mesh, increasing the first crack resistance by 84% and resulting in a 42% cost savings.

HELIX™ Micro-Rebar

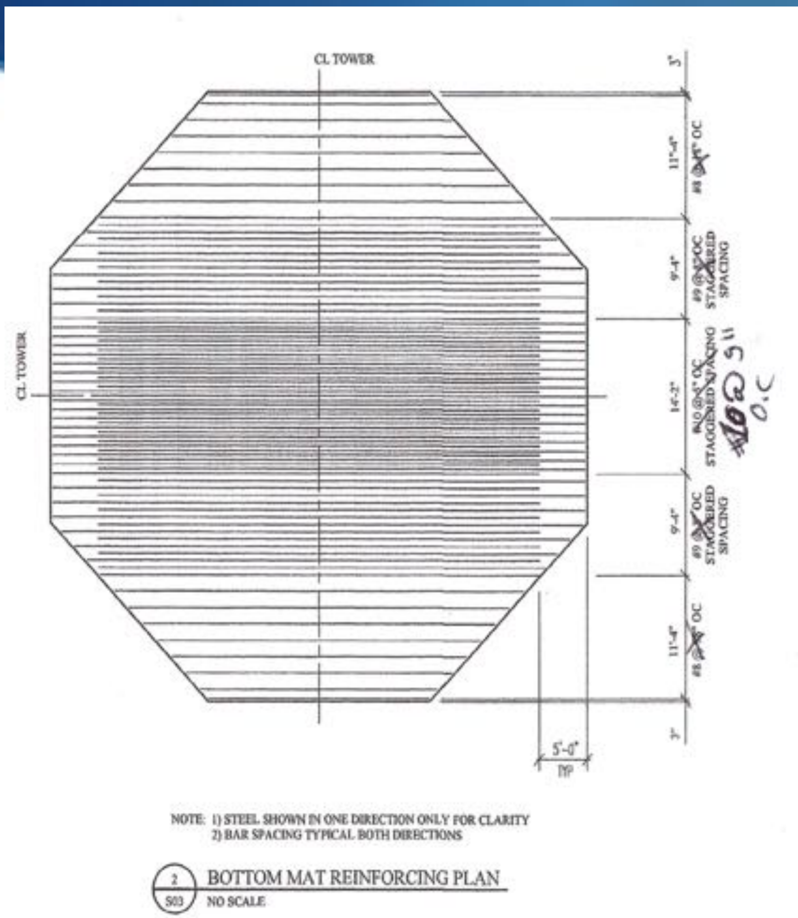
Refinery Piles

- **Project** – Refinery typical concrete pile – (12) # 8 vertical rebar with #4 horz on 12' oc.
- **Helix Design** – 45 pounds/cy of Helix reduced the rebar to (4) #6 rebar – horiz steel, only needed at anchor bolt area and for ease of construction.



HELIX™ Micro-Rebar

Wind Farm Foundations



- **Project** – 53 Wind farm towers in Washington with large concrete and rebar foundations.

- **Helix Design** – 45 pounds of Helix reduced the rebar use and would have saved the contractor $880,000 in material costs over all towers IF, they had known about Helix……..

HELIX™ Micro-Rebar

Thin White Topping.

- **Project** – Commercial pavement rehab.
- **Helix Design** – 1.5 inch to 1.75 inch parking lot with 20 pounds of helix and the tractor trailer and loaded van rolled over it.. .no cracks.

HELIX™ Micro-Rebar

Sidewalks

- **Project:** A large university pours 8" thick sidewalks to allow heavy equipment to drive over the surface. Engineers were looking for a way to decrease costs without sacrificing strength or quality.
- **Helix Design:** Helix was added at a dosage of 20 lb/yd in a 6" thick slab. The result? A cost savings of 15% and greatly increased strength over the plain 8" concrete.

HELIX™ Micro-Rebar

Case Study: Mining Road

- **Project:** 12” thick concrete was poured to allow heavy equipment to drive over the surface. After three years, the road was in shambles.

- **Helix Solution:** Helix was added at a dosage of 40 lb/yd but with only 6” of concrete. The result? After three years, the road doesn't have a single visible crack and it was 20% less expensive to pour.

Interstate Highway

Method	JPCP		CRCP			
Description	Jointed Plain Concrete Pavement		Continous Rebar Reinforced Concrete Pavement		Helix Reinforced Pavement	
Usage in US	43 States Use		9 State Use			
Concrete						
Concrete Thickeness		13		12	10	in
Concrete Installed Cost	$	85	$	85	85	$/yd
Contraction Joints						
Contraction Joint Spacing		12				ft
Joint Installation Cost	$	250	$	-		$/Joint
Dowel Spacing		1		1	1	ft
Dowel Installed Cost		10		0	10	$/dowel
Total Joint Cost	$	730	$	-	$ -	$/Joint
Helix						
Helix Dosage		0		0	36	lb/yd
Helix Installed Cost	$	1.65	$	1.65	$ 1.65	$/lb
Rebar						
#6@8" Long, #5@48 Trans	$	-	$	2.44	$ -	$/sqft
Highway Design/Area						
Lane/Shoulder Width		12		12	12	ft
Lanes & Shoulders		4		4	4	lanes
Total Width		48		48	48	ft
Number of Miles		100		100	100	mile
Total Surface Area		25343928		25343928	25343928	sqft
Total Conc volume		1016886		938664	782220	yds
Total Helix Required		0		0	28159920	lbs
# Contraction Joints		44000		0	0	
Comparative Costs						
Concrete Cost	$	86,435,310	$	79,786,440	$ 66,488,700	
Contracton Joint Cost	$	32,119,909	$	-	$ -	
Helix Cost	$	-	$	-	$ 46,463,868	
Rebar Cost	$	-	$	61,927,888	$ -	
Total Cost	$	118,555,219	$	141,714,328	$ 112,952,568	
Savings with Helix	$	5,602,651	$	28,761,760	Total Savings	
		5%		20%	Percent Savings	
	$	56,027	$	287,618	Savings $/mile	

Growing List of DOTs including:

- Virginia
- North Carolina
- Texas
- Michigan
- Georgia
- Oregon
- California
- Mexico

Interstate Highway

- **Project**: Oregon DOT test pour at milepost 211, south of Corvallis.

- **Helix Design:** Dose at 37 lb/cy to replace all rebar, but ODOT decided to include rebar and test for durability. Additional pours are being considered.

ICF Construction Example

- **Project**: ICF Wall rebar both horizontal and vertical rebar.
- **Helix Design**: rebar both horizontal and vertical replaced by Helix. Lintel horizontal remains, and one vert on each side of windows and doors. Dowel between cold joints.

HELIX™ Micro-Rebar

Placing and Finish

- Placing Per Standard Practice
  - ACI 305R
  - ACI 302. 1R -60 9.6 and 11.2.2.1.
  - ACI 207 (Mass Concrete)
- Finishing per Standard Practice
  - ACI 302.1R
  - Note ACI 544-3R recommendations
  - Adequate Paste Development
- Helix 3-Part CSI Specification

HELIX™ Micro-Rebar

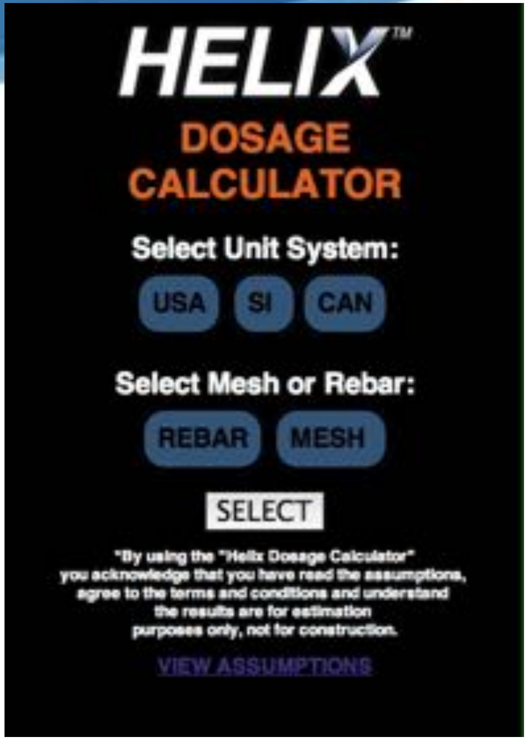
Next Step: How to Include Helix on your next project

① Engineer Using ESR for helix contact us at engineering.support@helixsteel.com we will respond in 24 hours or less

② Note the drawing with the Helix alternative: *“Use the rebar as shown on the drawing or XX lb/yd Helix 5-25 (meets UES ESR #0279)”*

③ When required use Helix sample CSI format specification www.helixsteel.com/specify-helix

④ Submit to Helix engineering to activate tensile resistance warrantee (email or web form)



www.helixcalculator.com

CSI Building Knowledge Improving Project Delivery

HELIX™ Micro-Rebar

Twisted Micro-Rebar Technology

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