Twisted Micro-Rebar Technology

Luke Pinkerton, PE
Helix Steel
Helix and Infrastructure

- 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
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)
Product Description

- Steel wire tensile strength: 270 ksi (1800 MPa)
- Electroplated zinc coating: 3 g/m³
- 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
Development Length

1/4” (8 mm) Helix Micro Rebar
Untwisting Governs
Bond Strength
Breaking Laws of Physics
Can Plastic Replace Steel?

**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
Proactive Reinforcement & Strain Capacity

[Graph showing tensile stress vs. strain for micro-reinforced and plain concrete.]

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 Design Classes and Selection

### Helix Design Classes

<table>
<thead>
<tr>
<th>Class</th>
<th>Assumptions</th>
<th>Applications</th>
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</table>
| 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
Designing with Helix
Another Piece of Rebar

- 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

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


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

**Increased Performance**

**Decreased Install Time**

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### Helix Results

<table>
<thead>
<tr>
<th></th>
<th>Rebar</th>
<th>Helix</th>
<th>Helix Results</th>
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<tbody>
<tr>
<td>Design</td>
<td>#4@12</td>
<td>18</td>
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<td>12@300</td>
<td>10.7</td>
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<td>Bending Strength</td>
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<td>31</td>
<td>k-in/ft</td>
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<tr>
<td></td>
<td>12</td>
<td>12</td>
<td>kN-m/m</td>
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<td>Shear Strength</td>
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<td>4.5</td>
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<tr>
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<td>161</td>
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<tr>
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<td>3610</td>
<td>5196</td>
<td>kN-mm/m</td>
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</table>

**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

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**Micro-Rebar**

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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.
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.
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.
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........
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.
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.
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

Growing List of DOTs including:

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

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<th>Method</th>
<th>JPCP</th>
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<tr>
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<tr>
<td>Concrete</td>
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<tr>
<td>#6@8” Long, #5@48 Trans</td>
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<td>Highway Design/Area</td>
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<td>Savings with Helix</td>
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<td>Total Savings</td>
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<tr>
<td>5%</td>
<td>$56,027 $287,618</td>
<td>Percent Savings</td>
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<td>20%</td>
<td>$56,027 $287,618</td>
<td>Savings $/mile</td>
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**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.
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
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
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