UHPC Application in Cladding Panels

Luke Pinkerton, PE
Founder and Chief Technology Officer
TSMR Steel
Tornado Resistance: The Pensmore Estate

Category: Residential
Contractor: Huff Construction
Location: Highlandville, Missouri
Application: Walls, Slabs, Precast Trim and Cladding

TSMR Dosage:
- Walls - 22.5 - 45 lbs/yd, (27 kg/m³)
- Slabs - 37.5 lbs/yard (20 kg/m³)
- Roof - 60 lbs/yard (36 kg/m³)
- Cladding – 150 (90 kg/m³)

At 10 lbs per cubic yard, TSMR Steel ensures our homes meet the FEMA spec for tornadoes and hurricanes.

– Terry Yoder, T & D Concrete
Twisted Steel Micro Reinforcement History

- Mid 1990’s: Early Research: Pullout, Small Beams, Direct Tension at University of Michigan – “Torex”
- 2003 TSMR Steel Licenses Torex Technology
- Early 2000’s: UHPC research on “Torex”,
- 2009: UHPC Research with “TSMR”: UAE University, Amer El Diab
- 2014-2017: Implementation of “TSMR” UHPC at Pensmore – Cladding
Twisted Steel Micro Reinforcement

- High Tensile Strength ~ 300 times Concrete
- High Modulus – 6 Concrete Modulus of Elasticity
- Strong Bond – Engages Concrete before cracking

1/4” (8 mm) TSMR Micro Rebar

Untwisting Governs

Bond Strength

Proactive

Helix 5-25 Dosage (lb/yd)

Modulus of Rupture (psi)

Reactive

Concrete

Twisting Steel Micro Reinforcement

- High Tensile Strength ~ 300 times Concrete
- High Modulus – 6 Concrete Modulus of Elasticity
- Strong Bond – Engages Concrete before cracking

1/4” (8 mm) TSMR Micro Rebar

Untwisting Governs

Bond Strength

Proactive

Helix 5-25 Dosage (lb/yd)

Modulus of Rupture (psi)

Reactive

Concrete

Twisting Steel Micro Reinforcement

- High Tensile Strength ~ 300 times Concrete
- High Modulus – 6 Concrete Modulus of Elasticity
- Strong Bond – Engages Concrete before cracking

1/4” (8 mm) TSMR Micro Rebar

Untwisting Governs

Bond Strength
<table>
<thead>
<tr>
<th>TSMR Product</th>
<th>Steel Type</th>
<th>Length</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>TSMR 5-13</td>
<td>Galvanized Steel</td>
<td>0.5 in / 12.5 mm</td>
<td>0.02 in / 0.5 mm</td>
</tr>
<tr>
<td>TSMR 5-25</td>
<td>IAPMO ER 279</td>
<td>1 in / 25 mm</td>
<td>0.02 in / 0.5 mm</td>
</tr>
<tr>
<td>TSMR 8-52</td>
<td>Bright Steel</td>
<td>2 in / 50 mm</td>
<td>0.03 in / 0.8 mm</td>
</tr>
</tbody>
</table>

Steel wire tensile strength: 270 ksi / 1800 MPa
15 Years and 36 Countries
Helix Micro Rebar Tensile measured the same way as rebar 6” (150 mm) sample

Proactive Phase – Micro Cracking 140 micro-strain (Plain concrete 60)

Reactive Phase – Post Dominant Crack to 1000 micro-strain
Helix increases tensile strength
Helix is more flexible in tension
Helix promotes micro cracking
Uniform ES Report # 0279: All Inclusive Guidance for Helix Design

- Design Instructions
- Restrictions
- Examples
- QC Requirements

Helix Evaluation Report

EVALUATION SUBJECT:
HELIX 5-25 MICRO-REBAR CONCRETE REINFORCEMENT SYSTEM

REPORT HOLDER:
Polyesters, I.C.C. dba Helix Steel
2360 Washtenaw Ave
Suite 201
Ann Arbor, MI 48104
734-332-2114
www.helixsteel.com
info@helixsteel.com

CSI Division: 03 00 00 - CONCRETE
CSI Section: 03 20 00 - CONCRETE REINFORCEMENT

1.0 SCOPE OF EVALUATION

1.1 Compliance to the following codes & regulations:
- 2015, 2012 and 2009 International Residential Code (IRC)

1.2 Evaluated in Accordance with:

1.3 Properties Assessed:
- Shrinkage and temperature-crack control in concrete
- Structural tension and shear resistance in concrete
- Fire Resistance

2.0 PRODUCT USE

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

2.1 Helix 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 24.6 and Chapter 14 of ACI 318-11 and Section 7.12 and Chapter 22 of ACI 318-11 and ACI 318-08 (as referenced in Section 1901.2 of the IBC and Sections R404.1.2 and R611.12 of the IRC).

2.2 Helix 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 318-14 Section 1.10, ACI 318-11 Section 1.4 and Section 104.11 of the IBC and IRC.

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

3.0 PRODUCT 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 Product Information: 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 208.3 ksi (+/- 21.8 ksi (1850 MPa +/- 150 MPa) and a minimum of 3 g/cm² zinc coating. The length (L) is 1.0 inch = 0.1 inch (25 mm +/- 0.004 mm), equivalent diameter is 0.020 inch +/- 0.001 inch (0.5 mm +/- 0.02 mm), and cross sectional area is 0.9003 square inches (0.196 mm²). Each Helix Micro-Rebar has a minimum of one helical degree turn. Helix Micro-Rebars are packaged in 22.5-pound (10.2 kg) boxes, 45-pound (20.4 kg) boxes or 2450-pound (1111 kg) bags.

3.2 Normal Weight Concrete with a minimum 24 day compressive strength of 3,000 psi (20.67 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.

4.2 Class A - Shrinkage and Temperature Reinforcement

4.2.1 Helix 5-25 Micro-Rebar replaces deformed reinforcement bars (rebars) or welded wire reinforcement for shrinkage and temperature reinforcement specified in Section 24.6 of ACI 318-14 and Section 7.12 of ACI 318-11 and ACI 318-08 in members complying with the requirements of Section 14.1.3 (a or b) of ACI 318-14 and Section 22.2.1 (a or b) of ACI 318-11 and ACI 318-08. This application includes plain concrete structures designed in accordance with Chapter 14 of ACI 318-14 or Chapter 22 of ACI 318-11 and ACI 318-08 (as referenced in Section 1901.2 of the IBC and Sections 404.1.2 and R611.12 of the 2015 IRC or Sections 404.1.2 and R611.12 of the 2012 or 2009 IRC).

4.2.2 Helix 5-25 Micro-Rebar replaces shrinkage and temperature reinforcement in non-composite in place form steel deck applications.

4.2.3 Helix 5-25 Micro-Rebar may be used in any concrete structure where reinforcement is not required by the IBC or
Performs 100% better than leading (80/60) hook ended fiber in notched Beam Test in Normal Strength Concrete (Testing done by Sika)
Table 1
Variation of main mix composition and compressive strength.

<table>
<thead>
<tr>
<th>Mix composition</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cementing materials (kg/m³)</td>
<td>775</td>
<td>775</td>
<td>900</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Silica fume (%)</td>
<td>15%</td>
<td>15%</td>
<td>17.5%</td>
<td>17.5%</td>
<td>17.5%</td>
</tr>
<tr>
<td>Water/Binder ratio</td>
<td>0.23</td>
<td>0.23</td>
<td>0.23</td>
<td>0.24</td>
<td>0.24</td>
</tr>
<tr>
<td>Water/Cement ratio</td>
<td>0.27</td>
<td>0.27</td>
<td>0.27</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>Fine aggregate (%)</td>
<td>45%</td>
<td>60%</td>
<td>60%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>- Coarse sand (%)</td>
<td>76%</td>
<td>100%</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
</tr>
<tr>
<td>- Dune sand (%)</td>
<td>24%</td>
<td>0%</td>
<td>30%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>Coarse aggregate (%)</td>
<td>55%</td>
<td>40%</td>
<td>40%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>28 days compressive strength (MPa)</td>
<td>88</td>
<td>92</td>
<td>110</td>
<td>95</td>
<td>85</td>
</tr>
<tr>
<td>91 days compressive strength (MPa)</td>
<td>105</td>
<td>110</td>
<td>135</td>
<td>115</td>
<td>100</td>
</tr>
</tbody>
</table>

Fig. 5. Splitting tensile strength for different steel fiber volume fraction.
Cladding: The Pensmore Estate

Category: Precast
Contractor: Huff Construction
Location: Highlandville, Missouri
Application: Cladding
Original Design: 1" thick Cladding Panels
TSMR Dosage: 1" thick Cladding Panels with 150 lb/yd³ (100 kg/m³)
Cladding System

High Strength Mortar

w/c = 0.35
150 lb/yd TSMR
F’c = 13,000 psi

Panel Assembly Detail
3/5/2013
Cladding System
Cladding System
Twisted Steel Micro Reinforcement

Rebar Only
2 Layers #3 at 100 mm
100 mm thick Panel

10 lb (4.5 kg) C4

TSMR 5-25 at 30 kg/m³
2 layers #3 at 150 mm
100 mm thick panel
Basic Properties

<table>
<thead>
<tr>
<th>Compressive Strength (psi)</th>
<th>Plain Concrete</th>
<th>Helix 5-25 at 150 lb/yd (.11%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stress (psi)</th>
<th>Plain Concrete</th>
<th>Helix 5-25 at 150 lb/yd (.11%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Compressive Strength**
- **Modulus of Rupture**
- **Splitting Tensile**
Gargoyles
Cladding: The Pensmore Estate

Category: Precast
Contractor: Huff Construction
Location: Highlandville, Missouri
Application: Cladding
Original Design: 1" thick Cladding Panels
TSMR Dosage: 1" thick Cladding Panels with 150 lb/yd³
(90 kg/m³)
• Naaman, Antione, E. “New Fiber Technology”, Concrete International, American Concrete Institute, July 1998
• C Sujivorakul, “Development of high performance fiber-reinforced cement composites using twisted polygonal steel fibers”.- 2002

Thank you to Steve Huff for providing access to Pensmore and allowing photographs of cladding manufacture
Helix Steel has been able to meet both the concrete reinforcement specification for the MTA’s East Side Access project and deliver on the demanding supply schedule.

– Leon "Lonnie" Jacobs, Frontier Kemper
Increased Speed of Construction by 16 days, while Reducing Carbon Footprint by 186 tons.

Category: Residential High Rise
Contractor: XDG Construction
Location: Waterloo, Ontario, Canada
Application: Shear Walls
Original Design: 10” Wall with 2-Layers 15M @24” OCEW
Helix Dosage: 10” Wall w/10 lbs/yd³ (6 kg/m³) 15M @ 15” OC Horizontal, 15M @ 21” OC Vertical

ADDED HELIX STEEL VALUE IN WALLS
Increase in Shear Strength: 70%
Increase in Modulus of Rupture: 18%
Increase in Durability: 19%
Increase Speed of Construction: 16 Days
Reduction in Carbon Footprint: 186 Tons
Category: Commercial
Partner: Helix Australia
Location: North Melbourne Victoria, Australia
Application: Slab on Grade, Slab on Metal Deck Pad, Crane and Strip Footings, AFS Walls
Helix Design: SOG - 8 kg/m³ (13.5 lb/yd³) SOMD - 20 kg/m³ (33 lb/yd³) and N12-200 EW TOP and N16-200 EW BTM Pad & Crane Footings Helix Hybrid Design Strip Footings - 8 kg/m³ (13.5 lb/yd³)

Helix Steel has enabled us to accelerate our construction timelines by eliminating a lot of the steel.
– Anthony Edwards
Slab on Metal Deck: Behr Automotive

Category: Commercial
Contractor: Barnes & Sweeney
Location: Troy, Michigan
Application: Slab on Grade, Slab on Metal Deck
Original Design: 4" SOG with 6x6, W2.1/W2.1 mesh
4" SOMD with 6x6, W2.1/W2.1 mesh
Helix Dosage: SOG and SOMD with 9 lb/yd³ (6 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 194%
Increase in Modulus of Rupture: 9%
Increase in Durability: 22%
Increased Speed of Construction: 10 Days
Tornado Resistance: The Pensmore Estate

Category: Residential
Contractor: Huff Construction
Location: Highlandville, Missouri
Application: Walls, Slabs, Precast Trim and Cladding
Helix Dosage:
- Walls - 22.5 - 45 lbs/yd, (27 kg/m³)
- Slabs - 34 lbs/yd (20 kg/m³)
- Roof - 60 lbs/yd (36 kg/m³)
- Cladding - up to 140 lbs/yd³ (85 kg/m³)

ADDED HELIX STEEL VALUE IN WALLS
Increase in Shear Strength: 247%
Increase in Modulus of Rupture: 23%
Increase in Durability: 38%

At 10 lbs per cubic yard, Helix Steel ensures our homes meet the FEMA spec for tornadoes and hurricanes.
– Terry Yoder, T & D Concrete
Above Grade Walls: The Villages Florida

Category: Residential
Contractor: T & D Concrete
Location: The Villages, Florida
Application: Poured Walls, Floors, Foundations
Original Design: 6x6, W2.9 /W2.9 WWF Wire Mesh
Helix Dosage: 10 lbs/yd³ (6 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 96%
Increase in Modulus of Rupture: 18%
Increase in Durability: 17%
Number of Homes: 8032 Homes
Reduction in Carbon Footprint: 117,000 Tons

At 10 lbs per cubic yard, Helix Steel ensures our homes meet the FEMA spec for tornadoes and hurricanes.
– Terry Yoder, T & D Concrete
ICF Condos: Indigo Green Development

Category: Residential
Contractor: Indigo Green Development
Location: Indigo Bay, St Maarten, Caribbean
Application: Walls, Slabs, Stairs
Helix Dosage:
- 8" Walls - 15 lb/yd³ (9 kg/m³) with 1 Layer #3 @ 18'
- Slabs, Stairs - 9 lbs/yd³ (6 kg/m³)

ADDED HELIX STEEL VALUE IN WALLS
- Increase in Shear Strength: 96%
- Increase in Modulus of Rupture: 18%
- Increase in Durability: 19%
Foundations and Slabs: Kone Central

Category: Commercial
Contractor: Ryan Companies & Treiber Construction
Location: Moline, Illinois
Application: Slab on Grade, Slab on Metal Deck, Topping
Original Design: SOG - 13.5” with #5@12” OCEW T&B
SOMD - 10” section with #5@15” OC
Topping - 4.25” with plastic fibers
Helix Dosage: SOG 18 lb/yd³ + #5@12” OC;
SOMD 13.5 lbs/yd³, Topping 5 lbs/yd³

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 243%
Increase in Modulus of Rupture: 25%
Increase in Durability: 44%
Increased Speed of Construction: 11 Days
Reduction in Carbon Footprint: 55 Tons
Reduced Carbon Footprint by 63 tons and increased Speed of Construction by 10 days.

By using Helix Steel, Century Concrete saved one day for every 10,000 square feet of rebar removed.

– Wes Atkinson, Century Concrete

Category: Infrastructure
Contractor: Century Concrete
Location: Harrisonburg, Virginia
Application: Slab on Grade, Slab on metal deck, Topping & Stairs
Original Design: SOG with 6x6, 2.9W x 2.9W
SOMD with 4x4, 3.5W x 3.5W
Helix Dosage: SOG & SOMD, 15 lb/yd³ (8 kg/m³)
Topping & Stairs, 9 lb/yd³ (5 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 291%
Increase in Modulus of Rupture: 29%
Increase in Durability: 20%
Increased Speed of Construction: 25 Days
Reduction in Carbon Footprint: 175 Tons
### Slab on Grade & Metal Deck: Landmark Hospital

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>Commercial</td>
</tr>
<tr>
<td>Contractor</td>
<td>Hoffman Construction Company</td>
</tr>
<tr>
<td>Location</td>
<td>Missouri</td>
</tr>
<tr>
<td>Application</td>
<td>Slab on Metal Deck</td>
</tr>
<tr>
<td>Original Design</td>
<td>4.5” (115 mm) thick section, 1 layer of W2.0 bars at 5.7” (150 mm)</td>
</tr>
<tr>
<td>Helix Dosage</td>
<td>4.5” (115 mm) thick section, 9 lb/yd³ (5 kg/m³)</td>
</tr>
</tbody>
</table>

#### ADDED HELIX STEEL VALUE
- Increase in Shear Strength: 177%
- Increase in Modulus of Rupture: 3%
- Increase in Durability: 15%
- Increased Speed of Construction: 15 Days
- Reduction in Carbon Footprint: 41 Tons
Category: Commercial
Contractor: Century Concrete
Location: Arlington, Virginia
Application: Slab on Grade, Slab on Metal Deck
Original Design: 6” SOG with 6x6, 2.9W x 2.9W
5.25” SOMD with 6x6, 2.9W x 2.9W
4.5” SOMD with 6x6, 1.4W x 1.4W
4” SOMD with 6x6, 1.4W x 1.4W

Helix Dosage: 9 lb/yd³ (5 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 192%
Increase in Modulus of Rupture: 18%
Increase in Durability: 22%
Increased Speed of Construction: 30 Days
Reduction in Carbon Footprint: 245 Tons
<table>
<thead>
<tr>
<th>Category:</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Granger Construction</td>
</tr>
<tr>
<td>Location:</td>
<td>East Lansing, Michigan</td>
</tr>
<tr>
<td>Application:</td>
<td>Slab on Grade and Slab on Metal Deck</td>
</tr>
<tr>
<td>Original Design:</td>
<td>3.5” thick sections, 6x6, W3.0/W3.0 mesh</td>
</tr>
<tr>
<td>Helix Dosage:</td>
<td>3.5” thick sections with 9 lb/yd³ (5 kg/m³)</td>
</tr>
</tbody>
</table>

**ADDED HELIX STEEL VALUE**

<table>
<thead>
<tr>
<th>Increase in Shear Strength:</th>
<th>194%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increase in Modulus of Rupture:</td>
<td>18%</td>
</tr>
<tr>
<td>Increase in Durability:</td>
<td>22%</td>
</tr>
<tr>
<td>Increased Speed of Construction:</td>
<td>7 Days</td>
</tr>
<tr>
<td>Reduction in Carbon Footprint:</td>
<td>33 Tons</td>
</tr>
<tr>
<td>Category:</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Manson Construction</td>
</tr>
<tr>
<td>Location:</td>
<td>Seattle, Washington</td>
</tr>
<tr>
<td>Application:</td>
<td>Pier Foundation</td>
</tr>
<tr>
<td>Original Design:</td>
<td>30” piles, 8- #6 w/ #3@12” hoop</td>
</tr>
<tr>
<td>Helix Dosage:</td>
<td>25 lb/yd³ (15 kg/m³) and 31.5 lb/yd³ (19 kg/m³)</td>
</tr>
</tbody>
</table>

**ADDED HELIX STEEL VALUE**
- Increase in Shear Strength: 111%
- Increase in Modulus of Rupture: 40%
- Increase in Durability: 45%
- Increased Speed of Construction: 4 Days
- Reduction in Carbon Footprint: 40 Tons

Helix Steel was used to fully replace all of the #6 rebar cages in 53 piles.
Foundation Slabs: Wind Farm

Category: Infrastructure
Contractor: Leighton Constructions
Location: Macarthur, Victoria AUS
Application: Wind Turbine Foundation
Original Design: N24 bar at 140mm each way
Helix Dosage: 18 kg/m³ (30 lb/yd³)
After more than two and a half years of daily usage, the SOG is in excellent condition, without a single crack. – Juan Aguilera Villarreal, Tecnor

<table>
<thead>
<tr>
<th>Category:</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Tecnor</td>
</tr>
<tr>
<td>Location:</td>
<td>Pesqueria, Nuevo Leon, Mexico</td>
</tr>
<tr>
<td>Application:</td>
<td>Exterior Slab on Grade</td>
</tr>
<tr>
<td>Original Design:</td>
<td>1 layer of #6 rebar at 12”</td>
</tr>
<tr>
<td>Helix Dosage:</td>
<td>30 lb/yd³ (18 kg/m³)</td>
</tr>
</tbody>
</table>

**ADDED HELIX STEEL VALUE**

- Increase in Shear Strength: 585 %
- Increase in Modulus of Rupture: 18 %
- Increase in Durability: 60 %
- Increased Speed of Construction: 40 Days
- Reduction in Carbon Footprint: 771 Tons
Concrete placement with Helix Steel went smoothly and enabled an excellent finish.

– Kinghorn Construction

<table>
<thead>
<tr>
<th>Category</th>
<th>Commercial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>Kinghorn Construction</td>
</tr>
<tr>
<td>Location</td>
<td>Rogers, MN</td>
</tr>
<tr>
<td>Application</td>
<td>Slab on Ground, Interior and Exterior</td>
</tr>
<tr>
<td>Original Design</td>
<td>Interior SOG 6” w/#3 Bars @ 18” OCEW</td>
</tr>
<tr>
<td></td>
<td>Exterior SOG 8” w/#4 Bars @ 18” OC</td>
</tr>
<tr>
<td>Helix Dosage</td>
<td>Interior &amp; Exterior slabs; 9 lb/yd³ (6 kg/m³)</td>
</tr>
</tbody>
</table>

**ADDED HELIX STEEL VALUE**

- Increase in Shear Strength: 163 %
- Increase in Modulus of Rupture: 21 %
- Increase in Durability: 23 %
- Increased Speed of Construction: 12 Days
Foundation Slabs: Monterrey International Airport

Category: Infrastructure
Contractor: Tecnor
Location: Apodaca, Nuevo León, Mexico
Application: Slab on Grade, Terminal Foundation
Original Design: #3 Rebar @ 14" OCEW
Helix Dosage: SOG 10 lb/yd³ (6 kg/m³)
Foundation Slab 10 lb/yd³ (6 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 224%
Increase in Modulus of Rupture: 10%
Increase in Durability: 25%
Increased Speed of Construction: 20 Days
Reduction in Carbon Footprint: 88 Tons
Pavements: BP Service Station

We required less resources on the job, including people, material and equipment.
– iCrete Commercial Concrete

Category: Industrial
Contractor: iCrete Commercial Concrete
Location: Melton, Victoria, Australia
Application: Slabs, Footers, Heavy Pavements
Original Design: Slabs and Heavy Pavement, SL92 mesh
                   Footers, SL102 Mesh
Helix Dosage: Slabs & Heavy Pavement, 7 kg/m³ (12 lb/yd³)
              Footers, 11 kg/m³ (18.5 lb/yd³)
Industrial Slab on Grade: Detroit Diesel

Category: Industrial
Contractor: Aristeo Construction
Location: Detroit, Michigan
Application: Slab on Grade
Original Design: 2 layers of #4 @ 12”
Helix Dosage: 15 lb/yd³ (9 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 133 %
Increase in Modulus of Rupture: 12 %
Increase in Durability: 30 %
Increased Speed of Construction: 10 Days
Reduction in Carbon Footprint: 38 Tons
<table>
<thead>
<tr>
<th>Category</th>
<th>Commercial</th>
<th>ADDED HELIX STEEL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>Kent Companies</td>
<td>Increase in Shear Strength: 194%</td>
</tr>
<tr>
<td>Location</td>
<td>Grand Rapids, MI</td>
<td>Increase in Modulus of Rupture: 18%</td>
</tr>
<tr>
<td>Application</td>
<td>Slab on Metal Deck</td>
<td>Increase in Durability: 22%</td>
</tr>
<tr>
<td>Original Design</td>
<td>4.5” thick section with 1 layer of 6X6, W2.5/W2.5 mesh</td>
<td>Increased Speed of Construction: 10 Days</td>
</tr>
<tr>
<td>Helix Dosage</td>
<td>4.5” thick section with 8 lb/yd³ (5 kg/m³)</td>
<td>Reduction in Carbon Footprint: 63 Tons</td>
</tr>
</tbody>
</table>
Category: Precast
Contractor: Premarc Corporation
Location: Durant, Michigan
Application: Multi Compartment Tank
Original Design: 12" Concrete Pipe, 1 layer W5 bars at 6
Helix Design: 12" Concrete Pipe, 30 lb/yd^3 (18 kg/m^3)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 465 %
Increase in Modulus of Rupture: 28 %
Increase in Durability: 62 %
Category: Precast
Contractor: Dalmaray Precast Concrete Products
Location: Janesville, Wisconsin
Application: Multi Compartment Tank
Original Design: Custom Heavy Mesh equivalent to #3 rebar at 12" OCEW.

Helix Design: 80 lb (36 kg) of Helix per tank along with a single “ring bar” around the top edge of tank.

Since using Helix Steel our work-force does not have to deal with the stress and strain of lifting and placing heavy rebar and mesh mats.

– Vice President – Aaron Ausen
Category: Precast
Contractor: Old Castle Precast/Colorado Precast
Location: Loveland, Colorado
Application: 15,500 gallon tank
Original Design: Rebar & Mesh
Helix Dosage: Hybrid with 45 lbs/yd³ (27 kg/m³)

I'm pretty thrilled with how the Helix is working with our designs. It is saving a lot of labor.
– Precast Engineer - Kim Fenstresserry
Shotcrete: Durango Mazatlan Tunnels

Category: Underground
Contractor: Tecnor
Location: Mazatlan, Mexico
Application: Shotcrete
Helix Dosage: 9 lb/yd³ (5 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 194%
Increase in Modulus of Rupture: 18%
Increase in Durability: 22%
Increased Speed of Construction: 7 Days
Reduction in Carbon Footprint: 33 Tons
Helix Steel creates a safer work environment, increases productivity, reduces our costs, produces a stronger slab and removes any issues with steel placement.

– Projects Co-ordinator, Kestrel Coal -Rio Tinto
ICF Single Family Home: Carew Residence

Category: Residential
Contractor: TF Forming Systems
Location: Appleton, Wisconsin
Application: Foundation Walls
Helix Dosage: 9 lbs/yd$^3$

By incorporating Helix Steel in our design, we attained a higher level of structural reinforcement.

– Richard Mortlock, TF Forming Systems
Category: Residential
Client: AcuBuild
Location: New South Wales, Sydney, Australia
Application: Foundation Walls, Slabs and Stairs
Helix Dosage: 5 kg/m³ (9 lb/yd³)

Helix Steel was designed into a suspended slab, ICF walls and the stairs.
– Kevin Fuller, Helix Steel Australasia.
Category: Industrial
Contractor: Granger Construction Company
Location: Eaton Rapids, Michigan
Application: Industrial Slab on Grade
Original Design: 36” SOG with 2 layers of #6 rebar at 15”
Helix Dosage: 10 lb/yd³ (6 kg/m³)
At 50 lb/yd³, the Helix Steel design ensures the wall systems can withstand winds up to 150 mph.
<table>
<thead>
<tr>
<th>Category</th>
<th>Precast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor</td>
<td>Huff Construction</td>
</tr>
<tr>
<td>Location</td>
<td>Highlandville, Missouri</td>
</tr>
<tr>
<td>Application</td>
<td>Cladding</td>
</tr>
<tr>
<td>Original Design</td>
<td>1&quot; thick Cladding Panels</td>
</tr>
<tr>
<td>Helix Dosage</td>
<td>1&quot; thick Cladding Panels with 166 lb/yd³ (100 kg/m³)</td>
</tr>
</tbody>
</table>

**ADDED HELIX STEEL VALUE**
- Increase in Shear Strength: 1191%
- Increase in Modulus of Rupture: 98%
- Increase in Durability: 302%
Pavements: Martin Marietta Aggregates

<table>
<thead>
<tr>
<th>Category:</th>
<th>Infrastructure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Capital Concrete</td>
</tr>
<tr>
<td>Location:</td>
<td>Columbia, South Carolina</td>
</tr>
<tr>
<td>Application:</td>
<td>Heavy Pavement</td>
</tr>
<tr>
<td>Original Design:</td>
<td>12” Concrete Pavement</td>
</tr>
<tr>
<td>Helix Dosage:</td>
<td>6” Concrete Pavement with 30 lbs/\text{yd}^3 (18 kg/m^3)</td>
</tr>
</tbody>
</table>

By using Helix Steel, we were able to reduce the pavement thickness in half.
## Jointless Slab on Grade: Alstom

<table>
<thead>
<tr>
<th>Category:</th>
<th>Industrial</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Ryan Companies</td>
</tr>
<tr>
<td>Location:</td>
<td>Amarillo, Texas</td>
</tr>
<tr>
<td>Application:</td>
<td>Industrial Slab on Grade, Foundations</td>
</tr>
<tr>
<td>Original Design:</td>
<td>2 layers of #5 @ 14”</td>
</tr>
<tr>
<td>Helix Dosage:</td>
<td>25 lb/yd³ (15 kg/m³)</td>
</tr>
</tbody>
</table>

### ADDED HELIX STEEL VALUE
- Increase in Shear Strength: 264 %
- Increase in Modulus of Rupture: 16 %
- Increase in Durability: 51 %
- Increased Speed of Construction: 6 Days
- Reduction in Carbon Footprint: 30 Tons

Concrete placement with Helix Steel went smoothly and enabled an excellent finish.

– Kinghorn Construction
Category: Industrial
Contractor: Swederski Concrete Construction, Inc.
Location: Charlotte, North Carolina
Application: Exterior Pavements
Original Design: 2 layers of #5 rebar @12”
Helix Dosage: 27 lb/yd³ (16 kg/m³)

ADDED HELIX STEEL VALUE
Increase in Shear Strength: 283 %
Increase in Modulus of Rupture: 51 %
Increase in Durability: 36 %
Increased Speed of Construction: 21 Days
Reduction in Carbon Footprint: 600 Tons
### Precast Storm Shelters: Lee’s Precast

<table>
<thead>
<tr>
<th>Category:</th>
<th>Precast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractor:</td>
<td>Lee's Precast Concrete, INC</td>
</tr>
<tr>
<td>Location:</td>
<td>Aberdeen, Mississippi</td>
</tr>
<tr>
<td>Application:</td>
<td>Precast Storm Shelter</td>
</tr>
<tr>
<td>Helix Dosage:</td>
<td>18 lb/yd$^3$ (11 kg/m$^3$)</td>
</tr>
</tbody>
</table>

We have used Helix Steel every day for years. It works, saves time and money, and our team loves it!

– General Manager - Allen Lee