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GeoStructural Solutions

Product Information Review
Case Histories

Chris Wilkinson, Product Manager
Geostructural Business Unit

November 21st 2017

Typical Skyline Steel Products

Multiple Skyline Steel products; one jobsite

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Skyline Steel
Geostructural Business Unit

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Skyline Steel Fabrication Facilities

High Strength Threaded Bar Systems

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Brief History of Threaded Bar

- 1950 Dywidag started it's license business in Europe
- Hot rolled threadbar systems were introduced to the USA in 1968
- 1979 DSI strengthened it's material supply business and went international
- Late 1980's early 1990's William Form Engineering began offering cold rolled versions of fully threaded bar
- In 2008, Skyline Steel began manufacturing cold rolled threaded bar
- In 2012, the Geostructural Business Unit was organized at Skyline Steel after being acquired by Nucor Corporation
- Skyline now offer's hot rolled threaded and cold rolled bar in reinforcing steel grades and 150 KSI Post Tensioning steel
- Bar fabrication solutions were developed… wind turbine anchor bolts, assembled bar cages, ground anchors, tie rod systems, drilled pile reinforcement and soil nailing products

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Rebar vs. Pre-stressing/Post-Tensioning Steel

- **Grade 80 & 100**
  - Reinforcing Steel ASTM A615
  - Steel Mill Hot Rolled Threads & Skyline Steel Machined Cold Rolled Threads
  - 11 Sizes #6 - #28
- **Grade 150**
  - Post-Tensioning Steel ASTM A722
  - Skyline Steel Machined Cold Rolled Threads
  - 8 Sizes 1" – 3-1/2"

Reinforcing Steel Specification

Designation: A615/A615M – 16

American Association State Highway and
Transportation Officials Standard
AASHTO No.: M 31

Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement[1]

This standard is issued under the fixed designation A615/A615M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers deformed and plain carbon-steel bars in cut lengths and coils for concrete reinforcement. Steel bars containing alloy additions, such as with the Association for Iron and Steel Technology and the Society of Automotive Engineers series of alloy steels, are permitted if the resulting product meets all the other requirements of this specification. The standard sizes and dimensions of deformed bars and their number designations are given in Table 1.

1.3 Plain bars, in sizes up to and including 2½ in. [63.5 mm] in diameter in coils or cut lengths, when ordered shall be furnished under this specification in Grade 40 [280], Grade 60 [420], Grade 75 [520], Grade 80 [550], and Grade 100 [690]. For ductility properties (elongation and bending), test provisions of the nearest smaller nominal diameter deformed bar size shall apply. Requirements providing for deformations and marking shall not be applicable.

NOTE 3—Welding of the material in this specification should be

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Rebar Sizes

A615/A615M – 16

TABLE 1 Deformed Bar Designation Numbers, Nominal Weights [Masses], Nominal Dimensions, and Deformation Requirements

Bar Designation No.	Nominal Weight, lb/ft [Nominal Mass, kg/m]	Nominal Dimensions[A]			Deformation Requirements, in. [mm]		
		Diameter, in. [mm]	Cross-Sectional Area, in. ^{2} [mm ^{2}]	Perimeter, in. [mm]	Maximum Average Spacing	Minimum Average Height	Maximum Gap (Chord of 12.5 % of Nominal Perimeter)
3 [10]	0.376 [0.560]	0.375 [9.5]	0.11 [71]	1.178 [29.9]	0.262 [6.7]	0.015 [0.38]	0.143 [3.6]
4 [13]	0.668 [0.994]	0.500 [12.7]	0.20 [129]	1.571 [39.9]	0.350 [8.9]	0.020 [0.51]	0.191 [4.9]
5 [16]	1.043 [1.552]	0.625 [15.9]	0.31 [199]	1.963 [49.9]	0.437 [11.1]	0.028 [0.71]	0.239 [6.1]
6 [19]	1.502 [2.235]	0.750 [19.1]	0.44 [284]	2.356 [59.8]	0.525 [13.3]	0.038 [0.97]	0.286 [7.3]
7 [22]	2.044 [3.042]	0.875 [22.2]	0.60 [387]	2.749 [69.8]	0.612 [15.5]	0.044 [1.12]	0.334 [8.5]
8 [25]	2.670 [3.973]	1.000 [25.4]	0.79 [510]	3.142 [79.8]	0.700 [17.8]	0.050 [1.27]	0.383 [9.7]
9 [29]	3.400 [5.060]	1.128 [28.7]	1.00 [645]	3.544 [90.0]	0.790 [20.1]	0.056 [1.42]	0.431 [10.9]
10 [32]	4.303 [6.404]	1.270 [32.3]	1.27 [819]	3.990 [101.3]	0.889 [22.6]	0.064 [1.63]	0.487 [12.4]
11 [36]	5.313 [7.907]	1.410 [35.8]	1.56 [1006]	4.430 [112.5]	0.987 [25.1]	0.071 [1.80]	0.540 [13.7]
14 [43]	7.65 [11.38]	1.693 [43.0]	2.25 [1452]	5.32 [135.1]	1.185 [30.1]	0.085 [2.16]	0.648 [16.5]
18 [57]	13.60 [20.24]	2.257 [57.3]	4.00 [2581]	7.09 [180.1]	1.58 [40.1]	0.102 [2.59]	0.864 [21.9]
20 [64][B]	16.69 [24.84]	2.500 [63.5]	4.91 [3167]	7.85 [199.5]	1.75 [44.5]	0.113 [2.86]	0.957 [24.3]

[A] The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same weight [mass] per foot [metre] as the deformed bar.
[B] Refer to Note 2.

Rebar Grades

TABLE 2 Tensile Requirements

	Grade 40 [280][A]	Grade 60 [420]	Grade 75 [520]	Grade 80 [550]	Grade 100 [690]
Tensile strength, min, psi [MPa]	60 000 [420]	90 000 [620]	100 000 [690]	105 000 [725]	115 000 [790]
Yield strength, min, psi [MPa]	40 000 [280]	60 000 [420]	75 000 [520]	80 000 [550]	100 000 [690]
Elongation in 8 in. [200 mm], min, %					
Bar Designation No.					
3 [10]	11	9	7	7	7
4, 5 [13, 16]	12	9	7	7	7
6 [19]	12	9	7	7	7
7, 8 [22, 25]	. . .	8	7	7	7
9, 10, 11 [29, 32, 36]	. . .	7	6	6	6
14, 18, 20 [43, 57, 64]	. . .	7	6	6	6

[A] Grade 40 [280] bars are furnished only in sizes 3 through 6 [10 through 19].

ASTM A615 Most Likely Grades In The Near Future

TABLE 2 Tensile Requirements

	Grade 40 [280][A]	Grade 60 [420]	Grade 75 [520]	Grade 80 [550]	Grade 100 [690]
Tensile strength, min, psi [MPa]	60 000 [420]	90 000 [620]	100 000 [690]	105 000 [725]	115 000 [790]
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6 [19]	12	9	7	7	7
7, 8 [22, 25]	. . .	8	7	7	7
9, 10, 11 [29, 32, 36]	. . .	7	6	6	6
14, 18, 20 [43, 57, 64]	. . .	7	6	6	6

[A] Grade 40 [280] bars are furnished only in sizes 3 through 6 [10 through 19].

Designation: A722/A722M – 12

Standard Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete[1]

This standard is issued under the fixed designation A722/A722M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers uncoated high-strength steel bars intended for use in pretensioned and post-tensioned prestressed concrete construction or in prestressed ground anchors. Bars are of a minimum ultimate tensile strength level of 1035 MPa (150 000 psi).

1.2 Two types of bars are provided: Type I bar has a plain surface and Type II bar has surface deformations.

1.3 Supplementary requirements of an optional nature are provided. They shall apply only when specified by the purchaser.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A700 Practices for Packaging, Marking, and Loading Methods for Steel Products for Shipment

E30 Test Methods for Chemical Analysis of Steel, Cast Iron, Open-Hearth Iron, and Wrought Iron (Withdrawn 1995)[3]

2.2 *Government Standards:*[4]

MIL-STD-129 Marking for Shipment and Storage

2.3 *U.S. Federal Standards:*[4]

Fed. Std. 123 Marking for Shipment (Civil Agencies)

3. Ordering Information

3.1 Orders for material under this specification should include the following information:

3.1.1 Quantity,

3.1.2 Name of material (uncoated high-strength bars for prestressing concrete),

3.1.3 ASTM designation and year of issue,

3.1.4 Size and length,

3.1.5 Type,

3.1.6 Special inspection requirements, if desired (see Section 12),

3.1.7 Special preparation for delivery, if desired (see Section 11),

3.1.8 Load-elongation curve, if required (see Section 15), and

3.1.9 Supplementary requirements, if desired.

NOTE 1—A typical ordering description is as follows: 50 uncoated high-strength steel bars for prestressing concrete to ASTM A722/A722M – __; 26 mm diameter, 12.20 m long, Type II; packed in accordance with A700; meeting supplementary bending properties.

4. Materials and Manufacture

4.1 The bars shall be rolled from properly identified heats of ingot cast or strand cast steel. The standard sizes and dimensions of Type I and II bars shall be those listed in Table 1 and Table 2, respectively.

4.2 The bars shall be subjected to cold-stressing to not less than 80 % of the minimum ultimate strength, and then shall be stress-relieved, to produce the prescribed mechanical properties.

5. Chemical Composition

5.1 An analysis of each heat of steel shall be made by the manufacturer from test samples taken during the pouring of each heat.

5.1.1 Choice and use of chemical composition and alloying elements, to produce the mechanical properties of the finished bar prescribed in 6.2, shall be made by the manufacturer, subject to the limitations in 5.1.2.

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

Current edition approved May 1, 2012. Published May 2012. Originally approved in 1975. Last previous edition approved in 2007 as A722/A722M – 07. DOI: 10.1520/A0722_A0722M-12.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

*A Summary of Changes section appears at the end of this standard

TABLE 1 Nominal Dimensions for Type I (Plain) Bars

Nominal Diameter		Nominal Weight (Mass)		Nominal Area[A]	
in.	mm	lb/ft	kg/m	in.^{2}	mm^2
3/4	19	1.50	2.23	0.44	284
7/8	22	2.04	3.04	0.60	387
1	25	2.67	3.97	0.78	503
1 1/8	29	3.38	5.03	0.99	639
1 1/4	32	4.17	6.21	1.23	794
1 3/8	35	5.05	7.52	1.48	955

[A] Nominal area is determined from the nominal diameter in inches [millimetres].

TABLE 2 Nominal Dimensions for Type II (Deformed) Bars

Nominal Diameter[A]		Nominal Weight (Mass)		Nominal Area[B]	
in.	mm	lb/ft	kg/m	in.^{2}	mm^2
5/8	15	0.98	1.46	0.28	181
3/4	20	1.49	2.22	0.42	271
1	26	3.01	4.48	0.85	548
1 1/4	32	4.39	6.54	1.25	806
1 3/8	36	5.56	8.28	1.58	1019
1 3/4	46	9.10	13.54	2.58	1664
2 1/2	65	18.20	27.10	5.16	3331
3	75	24.09	35.85	6.85	4419

[A] Nominal diameters are for identification only.
[B] Nominal area is determined from the bar weight [mass] less 3.50% for the weight [mass] of the deformations.

5.1.1 Choice and use of chemical composition and alloying elements, to produce the tensile properties of the bars prescribed in Section 6, shall be made by the manufacturer, subject to the limitations in 5.1.2.

5.1.2 On heat analysis, phosphorus and sulfur shall not exceed the following:

Phosphorus	0.040 %
Sulfur	0.050 %

5.2 A product analysis may be made by the purchaser from the bar representing each heat of steel. The phosphorus and sulfur contents thus determined shall not exceed the limits specified in 5.1.2 by 0.008 %.

6. Tensile Requirements

6.1 Tension tests shall be conducted in accordance with Test Methods and Definitions A370.

6.2 Bars shall have a minimum tensile strength of 150 000 psi [1035 MPa].

6.3 The minimum yield strength of Type I and Type II bars shall be 85 % and 80 %, respectively, of the minimum tensile strength of the bars. The yield strength shall be determined by either of the methods described in Test Methods and Definitions A370; however, in the extension under load method, the total strain shall be 0.7 %, and in the offset method the offset shall be 0.2 %.

6.4 The minimum elongation after rupture shall be 4.0 % in a gage length equal to 20 bar diameters, or 7.0 % in a gage length equal to 10 bar diameters.

6.5 The minimum reduction of area from the nominal area shall be 20 % for Type I plain bars.

7. Number of Tests

7.1 The number of tension test specimens shall be one from each 39 tons [36 tonnes] or fraction thereof, of each size of bar rolled from each heat but not less than two tension test specimens from each heat.

7.2 For Type II bars, one set of dimensional property tests including bar weight [mass], and spacing, height and projected area of deformations shall be made of each bar size rolled from each heat.

8. Retests

8.1 If any tensile property of any tension test specimen is less than that specified, and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the test specimen before testing, a retest shall be permitted.

8.2 If the results of an original tension test specimen fail to meet specified requirements, two additional tests shall be made on specimens from the same heat and bar size, and if failure occurs in either of these tests, the bar size from that heat shall be rejected.

8.3 If any test specimen fails because of mechanical reasons such as failure of testing equipment, it shall be discarded and another specimen taken.

8.4 If any test specimen develops flaws, it shall be discarded and another specimen of the same size bar from the same heat substituted.

9. Test Specimens

9.1 Tension test specimens shall be the full section of the bar as rolled. Machined-reduced section test specimens are not permitted. All unit stress determinations shall be based on the nominal area shown in Table 1 or Table 2.

10. Requirements for Deformations

10.1 Type II bars shall have deformations spaced uniformly along the length of the bar. The deformations on opposite sides of the bar shall be similar in size and shape. The average spacing or distance between deformations on both sides of the bar shall not exceed seven-tenths of the nominal diameter of the bar.

10.2 The minimum height and minimum projected area of the deformations shall conform to the requirements shown in Table 3.

10.3 *Mechanical Coupling*—For those bars having deformations arranged in a manner to permit coupling of the bars with a screw-on type coupler, it shall be the responsibility of the finished-bar manufacturer to demonstrate that a bar cut at any point along its length may be coupled to any other length of bar and that a coupled joint is capable of developing the minimum specified tensile strength of the coupled bars.

11. Measurements of Deformations

11.1 The average spacing of deformations shall be determined by dividing a measured length of the bar specimen by the number of individual deformations and fractional parts of

Common Types of Continuously Threaded Bar

Hot Rolled Thread Cold Rolled Thread

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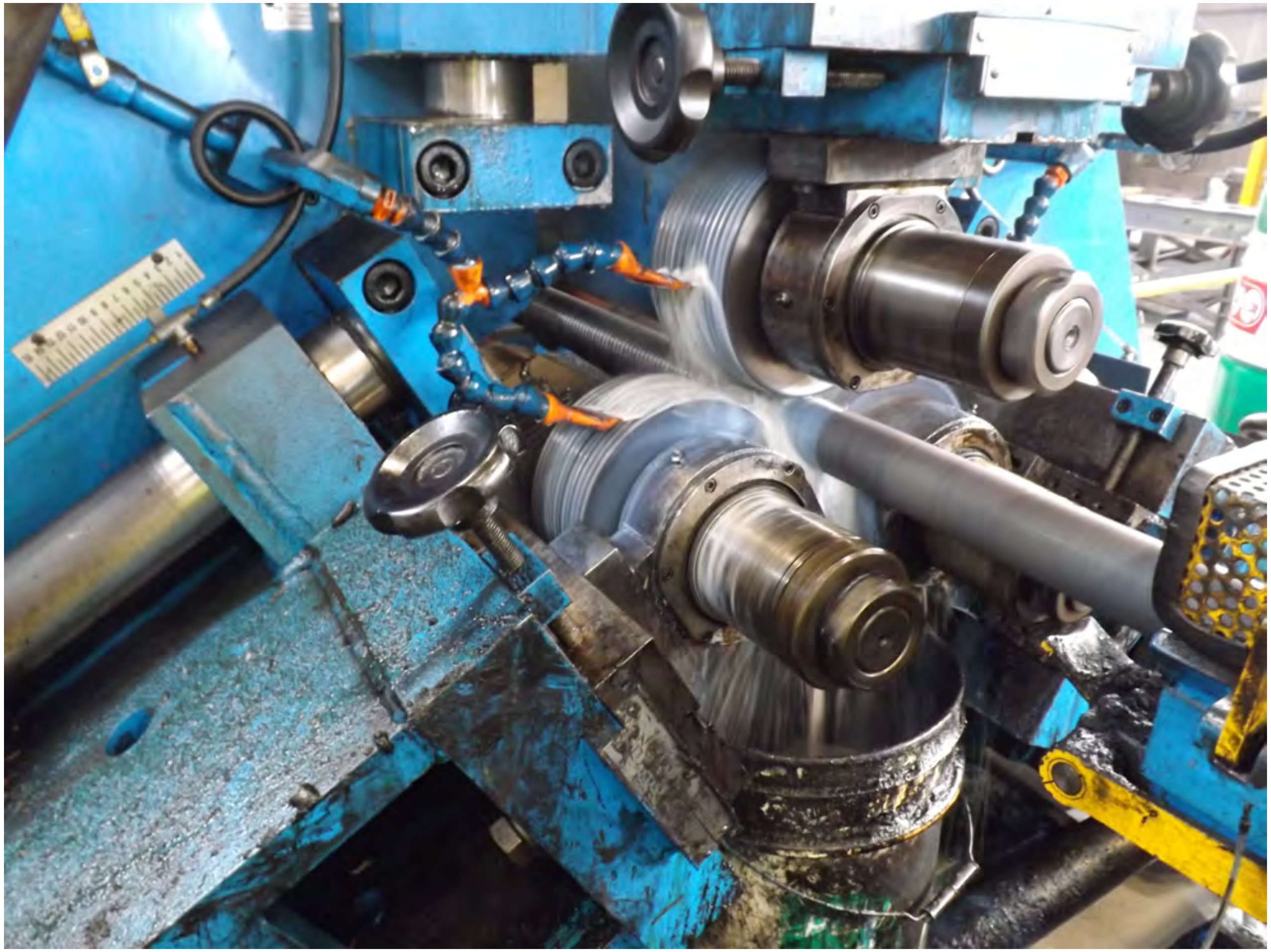
Three Die Continuous Threading



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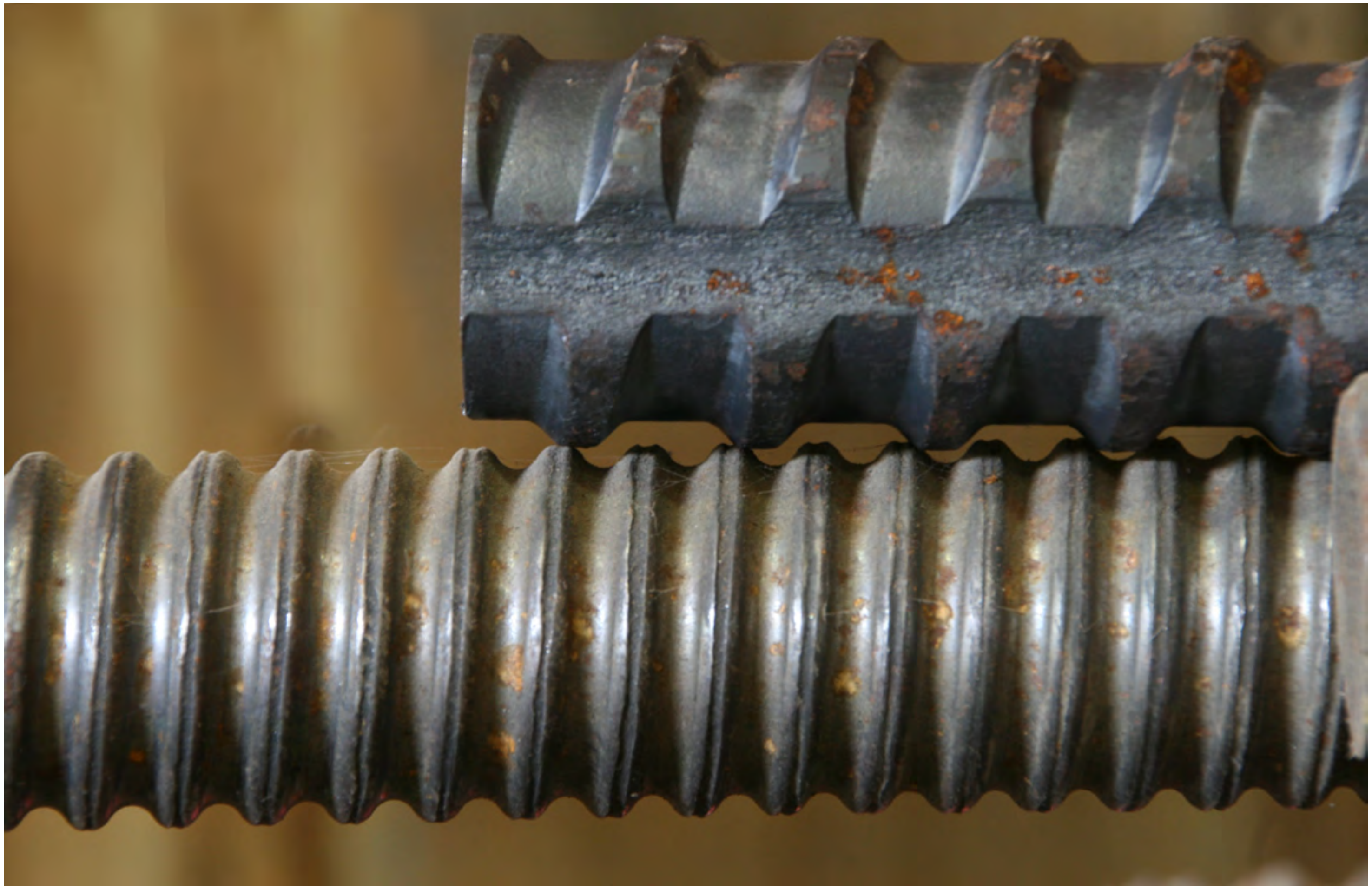
Hot Rolled vs. Cold Rolled Threads



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Hot Rolled Threaded Bar Inventory

Epoxy Coated Hot Rolled Threaded Bar

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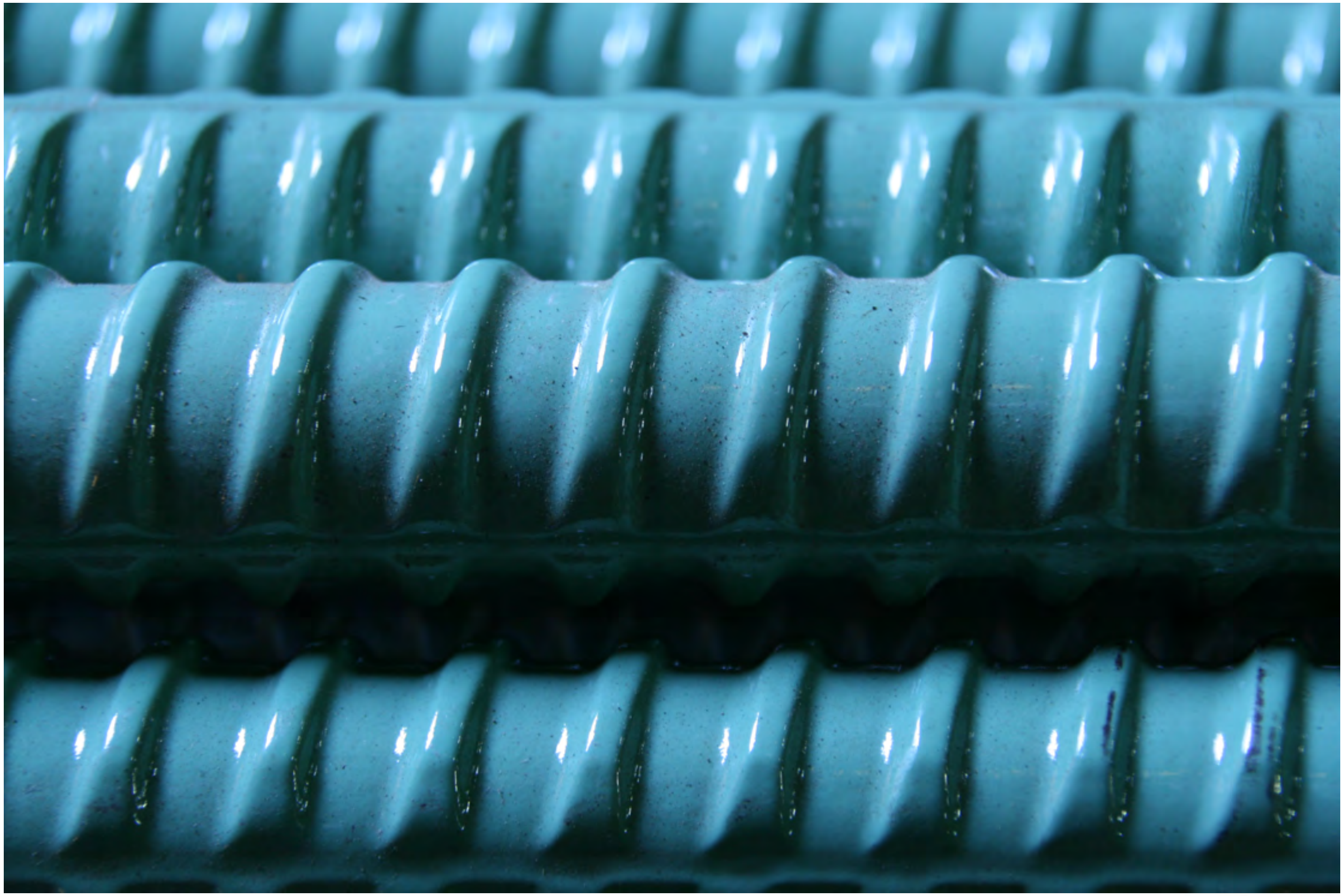
Hot Rolled Epoxy Coated Threaded Bar



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Typical Threaded Bar Applications

- Post-Tensioning
- Pile Test Anchors
- Rock Anchors
- Concrete Ties
- Hanger Bolts
- Lifting and Jacking
- Structural Steel Frame Ties
- Shear Pins
- Bridge Retrofits
- Temporary High Strength Connections
- Tower Base Plate Anchor Bolts
- Seismic Restrainer Systems
- Tie Back Systems
- Concrete Reinforcement Bars
- Corrosion Protection Anchors
- Wood Structure Post-Tensioning Systems
- Ground Anchors and Soil Nails

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Contractor Installed Centralizers On Site

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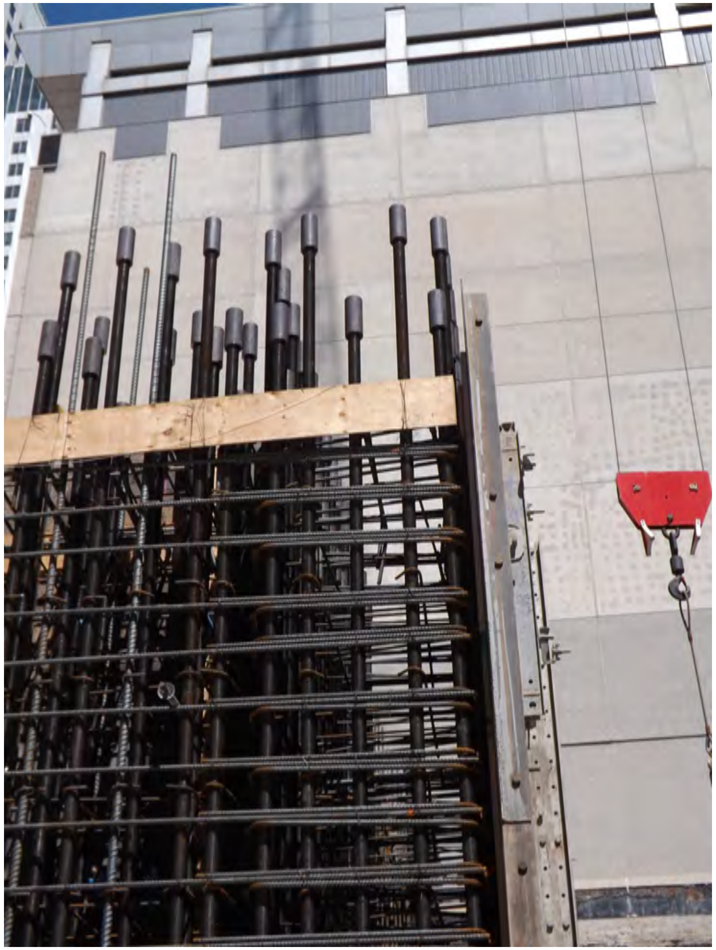
Anchored Cable Stayed Bridge

Anchored Cable Stayed Bridge
Anchor Terminations

Boston Gardens Column Steel
Threaded Bar Reinforcing Systems

Threaded Bar Used As Reinforcing Steel For Columns



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Threaded Bar Used As Reinforcing Steel For Columns

CASE STUDY:

Threaded Bar Concrete Slab Reinforcing

Project Partners

<u>Contractors:</u>

Herman Construction Services
Sunrise, Florida

Howard S. Wright Construction Co.
Scottsdale, Arizona

<u>Engineer:</u>

McCarthy Engineering
Clearwater, Florida

Products

One ton of 1 ¾" Grade 150 threaded bars

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CASE STUDY:

Threaded Bar Concrete Slab Reinforcing

Solution

Skyline's threaded bar system allowed the couplers to sit flush with the base plate and surface of the concrete slab. This eliminated the need to jack up the dome 12 inches in order to set the beams over the bolts to the final fixed position.

The second part of the system was securing the columns to the bases with either 20" or 32" sections of threaded bar.

The collection of thread bars, washers, hex nuts, jam nuts and couplers delivered by Skyline saved contractor approximately $60,000.

After 15 months of work, a dedication service led by the papal ambassador to the United States celebrated the new renovations to the Cathedral of St. Jude the Apostle. The parishioners were welcomed back to the church on 5th Avenue with unobstructed sight lines to the altar and an overall increase of 8,000 square feet with wider aisles.

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Large Scale Slope Stabilization
Soil Nails

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Large Scale Slope Stabilization
Soil Nails

Class I Permanent
DCP Grouted Anchors

Bar Fabrication Services Available From Skyline Steel

Bar Cages
Bundled Bar Configurations
Corrosion Protection Systems

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Threaded Bar Cages




READING
20 TON

CASE STUDY:

Threaded Bar Cages

Project Partners

<u>Owner:</u>

Magellan Development Group, Chicago, IL

<u>Contractor:</u>

James McHugh Construction Company &
Adolfson & Peterson Construction (JV)
Chicago, IL & Minneapolis, MN

<u>Subcontractor:</u>

Veit & Company, Rogers, MN

<u>Engineer:</u>

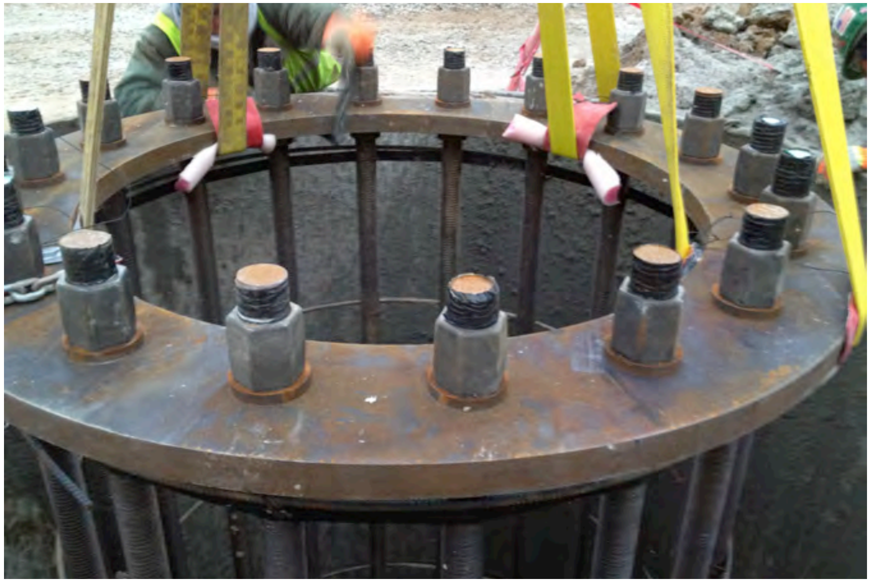
Magnusson Klemencic Associates
Seattle, WA

<u>Architect:</u>

Loewenberg Architects LLC, Chicago, IL

Products

#18 Threaded Bar Cages



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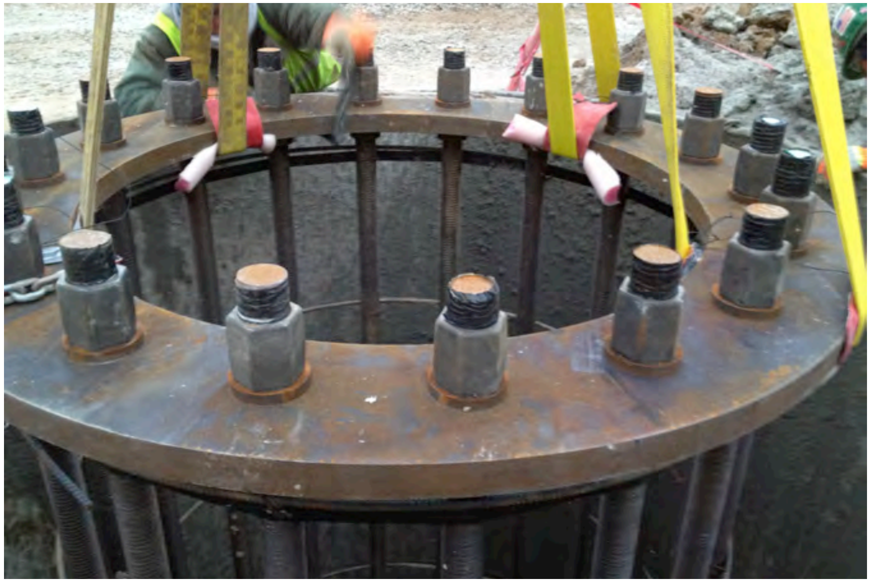
CASE STUDY:

Threaded Bar Cages

Problem

The jobsite was on a ¼ city block, which is quite small for building a high rise. The space was further limited by the presence of two drill rigs, two cranes and a concrete crew. Due to the limited space, even moving around the jobsite was a challenge. It would have been extremely difficult for Veit & Company to build 50-70' long rebar cages 3' to 6' in diameter onsite.



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CASE STUDY:

Threaded Bar Cages

Solution

Veit & Company partnered with Skyline Steel to redesign the rebar cages and allow Skyline Steel to build and fully assemble them prior to delivery. The rebar cages were built in Skyline Steel's yard located in Camp Hill, PA. Grade 75 threaded bars were used to replace the rebars with couplings and hex nuts helping to ease constructability. Specially designed end plates and spacers were used to keep all the bars aligned during assembly and cage installation.

Cage Section Delivered On Flat Bed

Multiple Sections of Cages Coupled Downhole

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Lowering Cage Section Downhole

CASE STUDY:

Threaded Bar Caisson Cage Reinforcement

Project Partners

Owner

China Overseas America, Inc. – New York, NY

General Contractor

Nordic Contracting – Ledgewood, NJ
Plaza Construction – New York, NY

Foundation Contractor

Linde-Griffith Construction – Newark, NJ

Products

Threaded Bar: #28 in 60 ft. lengths
Pipe: 36 in. and 48 in. OD x ½ in.

Project Time Frame

January 2016 to January 2017

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CASE STUDY:

Threaded Bar Caisson Cage Reinforcement

Problem

Several issues combined to make this an interesting project for everyone involved. The soils at the site were glacial till and medium/soft rock, the water table was at 5 feet, and the height of the building made it imperative that the foundation work be extremely deep and flexible.

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CASE STUDY:

Threaded Bar Caisson Cage Reinforcement

Solution

Skyline was able to design threaded bar caissons in 9-, 10-, and 13-bar varieties. These #28 threaded bar cages measured approximately 60 ft. in length, and fit inside both 36 in. and 48 in. OD x ½ in. wall pipe for the drilled shafts.

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MASSport Cage Being Assembled at Skyline Camp Hill, PA

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Epoxy Coated ASTM 934 Threaded Bars
Wire Tied Butt Welded Hoops

MASSport Cages – Zone Of Transition Couplers #28 To #18 Bars – All Hardware and Plates H D Galv

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Bottom View of Cage
Note: the Cross Sonic Logging Tubes

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Assembled MASSPort Cage Being Delivered by Truck

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Massport Cage Transferred From Truck To Barge

MASSport Cage Being Lowered Into Drilled Caisson

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109 ft Long Cage Leaving Skyline Steel Manufacturing Plant At Camp Hill, PA For Manhattan

Lowering Cages over 100 ft Long in NYC

Corrosion Protection For High Strength Threaded Bars

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Corrosion Protection Systems

PTI Class I (Double Corrosion Protection)

- Ensures protection of the load carrying steel by completely isolating it from the environment
- Relies on passivation of the steel by the alkali cement grout. Shop grouted under standardized quality control procedures
- DCP system has a thick tough plastic outer layer that is an impermeable barrier

Corrosion Protection

Corrosion protection is a technique used to extend the design life of an anchor. It is extremely important to protect the integrity of the steel which could be significantly damaged if a method of corrosion protection is not utilized. The level of corrosion protection varies and is controlled by the aggressiveness of the environment and the desired design life. It is the responsibility of the design engineer to select an appropriate level of protection.

All bar and strand anchors can be supplied with a protective smooth-walled PVC tube. While the standard PVC tube is 0.035 inch thick, other options are available upon request.

The following corrosion protection options are available for all bars and strands:

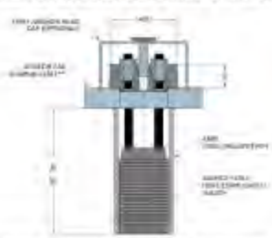
Double Corrosion Protection (DCP)/PTI Class I

With Double Corrosion Protection, the threaded bar is typically encased in a factory grouted, PVC or HDPE corrugated plastic. DCP fabrication is used mainly for permanent applications or in uncertain and aggressive environments. For strand anchors, the strand is placed in the corrugated duct in the factory and grouted entirely in the field.

Class I Protection:
Bar Anchor (DCP)

Class I Protection:
Strand Anchor (DCP)

Details of PTI Class I DCP Strand Anchor Head



**Skyline Steel can provide a customized bearing plate solution.

Anchor Head & Duct Dimensions for DCP Strand Anchors						
Max. No. of Strands	Corrugated Sheath		Trumpet Pipe		Anchor Head	
	OD in	ID in	OD in	ID in	AØ in	H in
2-3	2.33 [illegible]	2.00 [illegible]	4.00 [illegible]	3.548 [illegible]	4.70 [illegible]	1.80 [illegible]
3-7*	3.60 [illegible]	3.00 [illegible]	4.50 [illegible]	4.026 [illegible]	5.60 [illegible]	2.20 [illegible]
8-12*	4.80 [illegible]	4.00 [illegible]	6.625 [illegible]	6.065 [illegible]	6.80 [illegible]	1.70 [illegible]

* The above table is based on a 3/4" OD PE Grout Tube installed inside corrugated sheath, other variations available. Consult your sales representative.

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Permanent Anchors, PTI Class I (DCP) Grouting, Cartersville GA

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DCP's Ready To Ship

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DCP Tie Rods

- Corrugated PVC or HDPE Sheathing
- Shop-Grouted Skyline Facility

Corrosion Protection Systems

PTI Class II (Single Corrosion Protection)

- The steel is encased over the free length with a smooth sheath acting as a bond breaker over corrosion inhibiting compound
- The protection of the steel in the bond length is protected by the alkali cement grout installed in the field as borehole grout
- Epoxy coatings provide additional protection as an impermeable barrier but does not qualify as Type I DCP

Epoxy Coatings

Fusion Bonded Epoxy Coating
ASTM A775 & A934

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Alternative Corrosion Protection
Hot Dipped Galvanizing

- Hot- Dip Galvanizing is a sacrificial system. Works very well above ground. Requires oxygen, water to develop a cell
- Zinc is a less noble metal than steel therefore is consumed at a rate determined by the aggressivity of the environment
- There will be a limited life span to the protection system
- Zinc will go into solution in a strong alkali like fresh cement grout in the borehole. It is not known how effective the galvanizing is in this zone
- H D Galv and epoxy coating of bars is not used in Europe

Large Capacity Marine Tie Rod Systems Available Through Skyline Steel

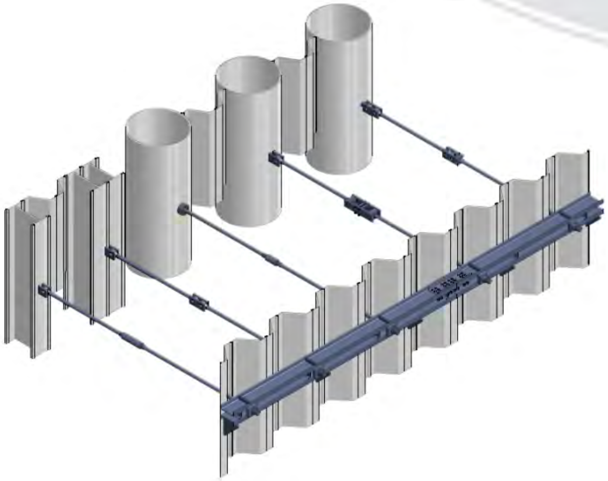
Grouted Anchor Bulkhead

Tie Rods

Main features of ASDO Marine Tie bars

ASDO Marine

- Large diameter (3" to 7" threads) tie bars
- High load capacity (upto 3,163kips yield
- Upset forging technology, allows
  - Upset forged threads
  - Upset forged articulated ends



- Standard range of articulated solutions for high modulus walls (eg HZ, tube or concrete)

Main synergy with Skyline – Tie bars for marine structures

ASDO Marine

Aqaba Port, Jordan

ANKER SCHROEDER
ASDO steel tension members

What is upset forging?

Standard round bars are heated at the ends

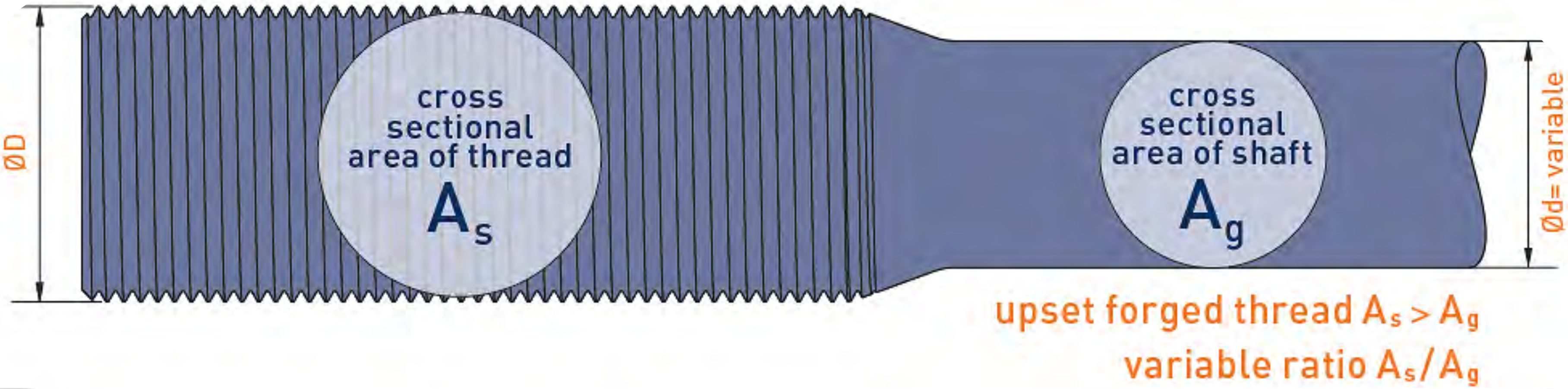
- Bars upto 72ft long can be heated in this way

Upset forging

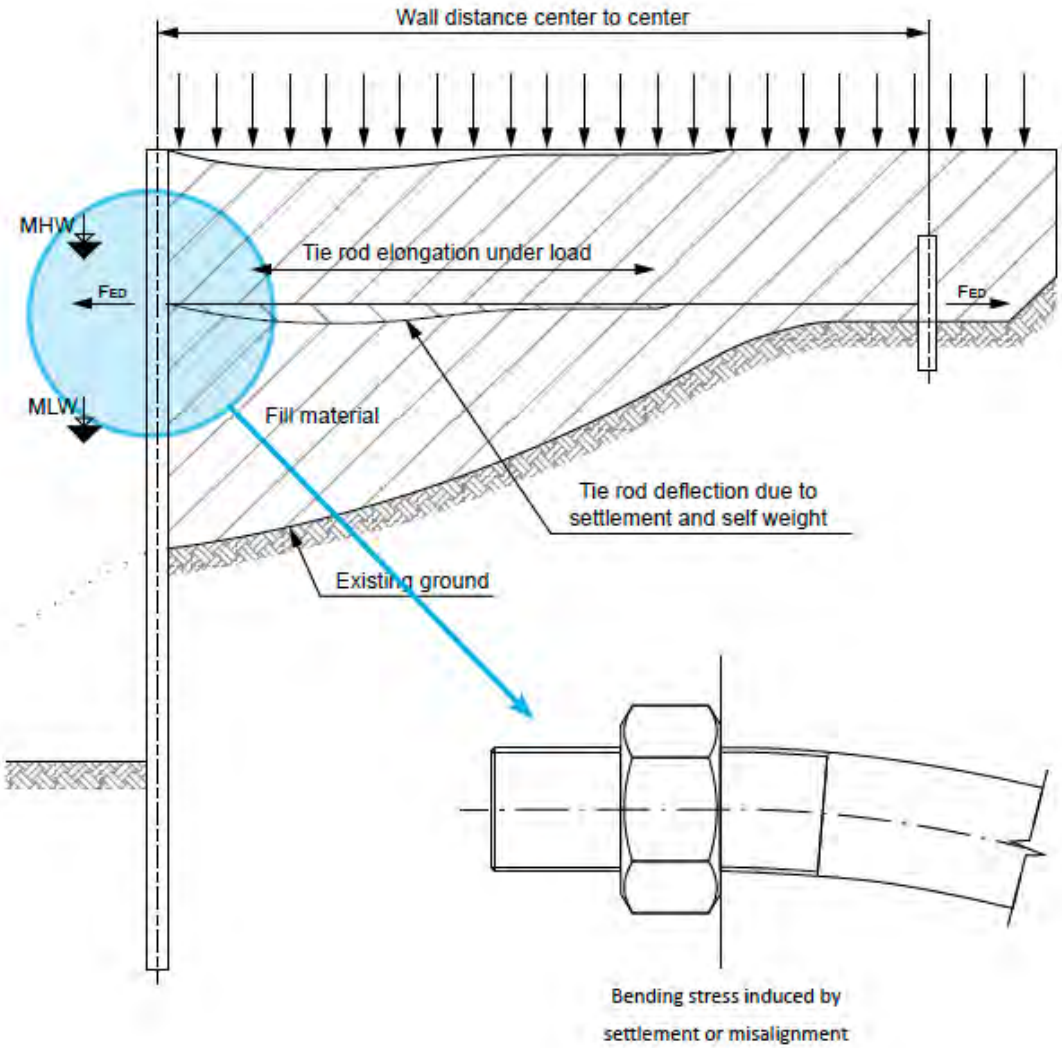
ASDO Marine

After heating the ends are formed using closed dies, into various shapes, eg

- Upset threads
  - Thread stress area is increased so it is greater than the shaft thus reducing stress in the thread (the vulnerable part of a tie bar)



ANKER SCHROEDER
ASDO steel tension members



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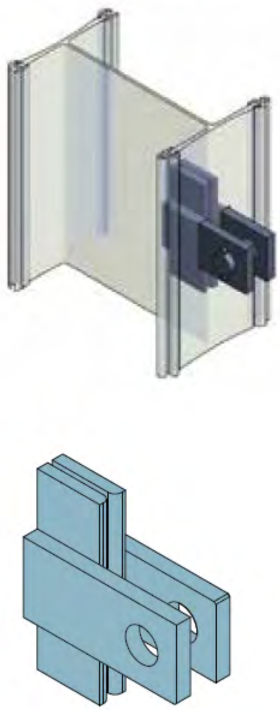
T-Plates with articulation

T-Plates for HZ-piles



Forged Eyebolts And Transition Couplers

Tie Bars with Articulation

	Bar	Thread Diameter D_t in mm	Shaft Diameter D_s in mm	Thread: Tensile Stress Area A_s in² mm²	Thread: Yield Capacity Th_y kips kN	Thread: Ultimate Capacity Th_u kips kN	Shaft: Gross Area A_g in² mm²	Shaft: Yield Capacity Sh_y kips kN	Shaft: Ultimate Capacity Sh_u kips kN	Recommended Design Capacity: ASD* kips kN	Recommended Design Capacity: LRFD* kips kN
Cold/Hot Rolled Bars	#8	1.000 25	1.000 25	0.79 510	59.3 263.8	79 351.4	0.79 510	59.3 263.8	79 351.4	36 158	56 251
Cold/Hot Rolled Bars	#9	1.125 28	1.125 28	1.00 645	75.0 333.6	100 444.8	1.00 645	75.0 333.6	100 444.8	45 200	71 317
Cold/Hot Rolled Bars	#10	1.250 32	1.250 32	1.27 819	95.3 423.9	127 564.9	1.27 819	95.3 423.9	127 564.9	57 254	91 403
Cold/Hot Rolled Bars	#11	1.375 35	1.375 35	1.56 1,006	117.0 520.5	156 694.0	1.56 1,006	117.0 520.5	156 694.0	70 312	111 494
Cold/Hot Rolled Bars	#14	1.750 45	1.750 45	2.25 1,452	168.7 750.4	225 1,000.9	2.25 1,452	168.7 750.4	225 1,000.9	101 449	160 713
Cold/Hot Rolled Bars	#18	2.250 55	2.250 55	4.00 2,581	300.0 1,334.5	400 1,779.4	4.00 2,581	300.0 1,334.5	400 1,779.4	180 799	285 1,268
Cold/Hot Rolled Bars	#20	2.500 64	2.500 64	4.91 3,168	368.0 1,637.0	491 2,184.0	4.91 3,168	368.0 1,637.0	491 2,184.0	220 980	350 1,555
Cold/Hot Rolled Bars	#24	3.000 76	3.000 76	7.07 4,561	530.0 2,356.0	707 3,144.9	7.07 4,561	530.0 2,356.0	707 3,144.9	317 1,411	503 2,238
Cold/Hot Rolled Bars	#28	3.500 89	3.500 89	9.61 6,200	720.0 3,206.0	960 4,274.0	9.61 6,200	720.0 3,206.0	960 4,274.0	432 1,920	685 3,046
End Threaded Forged Bars	M 85/76	3.3 83	2.99 76	7.67 4,948	556 2,474	734 3,266	7.03 4,536	510 2,286	673 2,994	305 1,358	484 2,155
End Threaded Forged Bars	M 90/80	3.5 90	3.15 80	8.67 5,591	628 2,795	830 3,690	7.79 5,027	565 2,513	746 3,318	338 1,505	537 2,388
End Threaded Forged Bars	M 95/85	3.7 95	3.35 85	9.72 6,273	705 3,137	931 4,140	8.80 5,675	638 2,837	842 3,745	382 1,699	606 2,695
End Threaded Forged Bars	M 100/90	3.9 100	3.54 90	10.84 6,995	786 3,497	1,038 4,616	9.86 6,362	715 3,181	944 4,199	428 1,905	679 3,022
End Threaded Forged Bars	M 105/95	4.1 105	3.74 95	12.02 7,755	872 3,878	1,151 5,119	10.99 7,088	797 3,544	1,052 4,678	477 2,122	757 3,367
End Threaded Forged Bars	M 110/100	4.3 110	3.94 100	13.26 8,556	962 4,278	1,269 5,647	12.17 7,854	883 3,927	1,165 5,184	529 2,351	839 3,731
End Threaded Forged Bars	M 115/105	4.5 115	4.13 105	14.56 9,395	1,056 4,697	1,394 6,201	13.42 8,659	973 4,330	1,285 5,715	583 2,593	925 4,113
End Threaded Forged Bars	M 120/110	4.7 120	4.33 110	15.92 10,274	1,155 5,137	1,524 6,781	14.73 9,503	1,068 4,752	1,410 6,272	640 2,845	1,015 4,514
End Threaded Forged Bars	M 125/115	4.9 125	4.53 115	17.35 11,191	1,258 5,596	1,661 7,386	16.10 10,387	1,168 5,193	1,541 6,855	699 3,110	1,109 4,934
End Threaded Forged Bars	M 130/120	5.1 130	4.72 120	18.83 12,149	1,366 6,074	1,803 8,018	17.53 11,310	1,271 5,655	1,678 7,464	761 3,386	1,208 5,372
End Threaded Forged Bars	M 135/125	5.3 135	4.92 125	20.37 13,145	1,478 6,573	1,950 8,676	19.02 12,272	1,379 6,136	1,821 8,099	826 3,674	1,310 5,829
End Threaded Forged Bars	M 140/130	5.5 140	5.12 130	21.98 14,181	1,594 7,090	2,104 9,359	20.57 13,273	1,492 6,637	1,969 8,760	893 3,974	1,417 6,305
End Threaded Forged Bars	M 145/135	5.7 145	5.31 135	23.65 15,256	1,715 7,628	2,264 10,069	22.19 14,314	1,609 7,157	2,124 9,447	963 4,286	1,528 6,799
End Threaded Forged Bars	M 150/140	5.9 150	5.51 140	25.37 16,370	1,840 8,185	2,429 10,804	23.86 15,394	1,730 7,697	2,284 10,160	1,036 4,609	1,644 7,312
End Threaded Forged Bars	M 155/145	6.1 155	5.71 145	27.16 17,524	1,970 8,762	2,600 11,566	25.60 16,513	1,856 8,256	2,450 10,899	1,111 4,944	1,763 7,844
End Threaded Forged Bars	M 160/150	6.3 160	5.91 150	29.01 18,716	2,104 9,358	2,777 12,353	27.39 17,671	1,986 8,836	2,622 11,663	1,189 5,291	1,887 8,394
End Threaded Forged Bars	M 165/155	6.5 165	6.10 155	30.92 19,948	2,242 9,974	2,960 13,166	29.25 18,869	2,121 9,435	2,800 12,454	1,270 5,649	2,015 8,963

The recommended design capacities are based on AISC/ASD and AASHTO/LRFD design methodologies for steel structures and retaining walls. Additional reduction factors from EN1993-5 are applied to the tie-rods based on their ability to articulate. Sample calculations can be found on pages 43 and 45 of this brochure.

Sample Calculations

Fully Threaded Bar with Articulation

Bar Designation: #8 (1.0 in)

Yield / Tensile: 75 / 100 ksi

Thread & Shaft Properties

Tensile Stress Area (A_t) = $0.79\ in^2$

Yield Capacity (Sh_y, Th_y) = $(0.79\ in^2) * (75\ ksi)$
= 59.3 kips

Ultimate Capacity (Sh_u, Th_u) = $(0.79\ in^2) * (100\ ksi)$
= 79 kips

Recommended Design Capacity (F_t)

ASD

F_t = Lesser of:

$Sh_y / 1.67$ = $(0.79\ in^2) * (75\ ksi) / 1.67$
= 36 kips

$0.9 * Th_u / 2$ = $0.9 * (0.79\ in^2) * (100\ ksi) / 2.0$
= 36 kips

F_t = 36 kips

LRFD

F_t = Lesser of:

$0.95 * Sh_y$ = $0.95 * (0.79\ in^2) * (75\ ksi)$
= 56 kips

$0.9 * 0.8 * Th_u$ = $0.9 * 0.8 * (0.79\ in^2) * (100\ ksi)$
= 57 kips

F_t = 56 kips

End Threaded Bar with Articulation

Nominal Upset

Thread Diameter (D_T) = 3.9 in

Shaft Diameter (D_g) = 3.54 in

Steel Grade (f_y) = 72.52 / 95.69 ksi (500 / 660 MPa)

Thread Properties

Tensile Stress Area (A_t) = $10.84\ in^2$

Yield Capacity (Th_y) = $(10.84\ in^2) * (72.52\ ksi)$
= 786 kips

Ultimate Capacity (Th_u) = $(10.84\ in^2) * (95.69\ ksi)$
= 1038 kips

Shaft Properties

Gross Area (A_g) = $9.86\ in^2$

Yield Capacity (Sh_y) = $(9.86\ in^2) * (72.52\ ksi)$
= 715 kips

Ultimate Capacity (Sh_u) = $(9.86\ in^2) * (95.69\ ksi)$
= 944 kips

Recommended Design Capacity (F_t)

ASD

F_t = Lesser of:

$Sh_y / 1.67$ = $(9.86\ in^2) * (72.52\ ksi) / 1.67$
= 428 kips

$0.9 * Th_u / 2$ = $0.9 * (10.84\ in^2) * (95.69\ ksi) / 2.0$
= 467 kips

F_t = 428 kips

LRFD

F_t = Lesser of:

$0.95 * Sh_y$ = $0.95 * (9.86\ in^2) * (72.52\ ksi)$
= 679 kips

$0.9 * 0.8 * Th_u$ = $0.9 * 0.8 * (10.84\ in^2) * (95.69\ ksi)$
= 747 kips

F_t = 679 kips

Multi Strand Ground Anchors

Temporary
Permanent
Load Distributive
Removable

Multi-Strand Anchors

- Current brochure shows up to 12 strands
- Skyline has recently developed a 19 strand head of ductile iron, made in the USA
- Cast heads are now available 4, 7, 9, 12 and 19 strands
- Available as PTI rated Class I DCP, Permanent or Class II SCP, Temporary
- Skyline offers both manufacturing methods of hot melt extruded HDPE or stuffed tube strand anchors

Multi-Strand Anchor Systems

Multi-Strand Anchors – ASTM A 416						
No. of Strands	Nominal Cross Section Area (Aps) in² mm²	Ultimate Strength (Fpu x Aps) kips kN	Maximum Jacking Load (0.8 x Fpu x Aps) kips kN	Maximum Design Load (0.6 x Fpu x Aps) kips kN	Minimum Lockoff Load* (0.5 x Fpu x Aps) kips kN	Nominal Steel Weight (bare strand) lbs/ft kg/m
1	0.217 140	58.6 261	46.9 208	35.2 156	29.3 130	0.74 1.08
2	0.434 280	117.2 521	93.7 417	70.3 312	58.6 260	1.48 2.17
3	0.651 420	175.8 782	140.6 625	105.5 469	87.9 391	2.21 3.25
4	0.868 560	234.4 1,043	187.5 834	140.6 625	117.2 521	2.95 4.34
5	1.085 700	293.0 1,303	234.4 1,042	175.8 781	146.5 651	3.69 5.42
6	1.302 840	351.6 1,564	281.3 1,251	221.0 938	175.8 782	4.43 6.50
7	1.519 980	410.2 1,825	328.2 1,460	246.1 1,095	205.1 912	5.17 7.59
8	1.736 1,120	468.8 2,085	375.0 1,668	281.3 1,251	234.4 1,042	5.90 8.67
9	1.953 1,260	527.4 2,346	421.9 1,876	316.4 1,407	263.7 1,173	6.64 9.76
10	2.170 1,400	586.0 2,607	469.0 2,085	351.6 1,564	293.0 1,303	7.38 10.84
11	2.387 1,540	644.6 2,867	515.7 2,293	386.8 1,720	322.3 1,433	8.12 11.92
12	2.604 1,680	703.2 3,128	562.6 2,502	421.9 1,876	351.6 1,564	8.86 13.01

Aps = Area Prestressing Steel, Fpu = Minimum Ultimate Tensile Strength

**Maximum lockoff load shall not exceed (0.7 x Fpu x Aps), maximum jacking load shall not exceed (0.8xFpu x Aps)*

4 Strand Anchor Head
Lock Off Wedges And Bearing Plate

West Village NYC Temporary Tiebacks

West Village NYC Temporary Tiebacks

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West Village Temporary Strand Anchors

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Bearing Plate Supported On H Pile By Welded Gussetts

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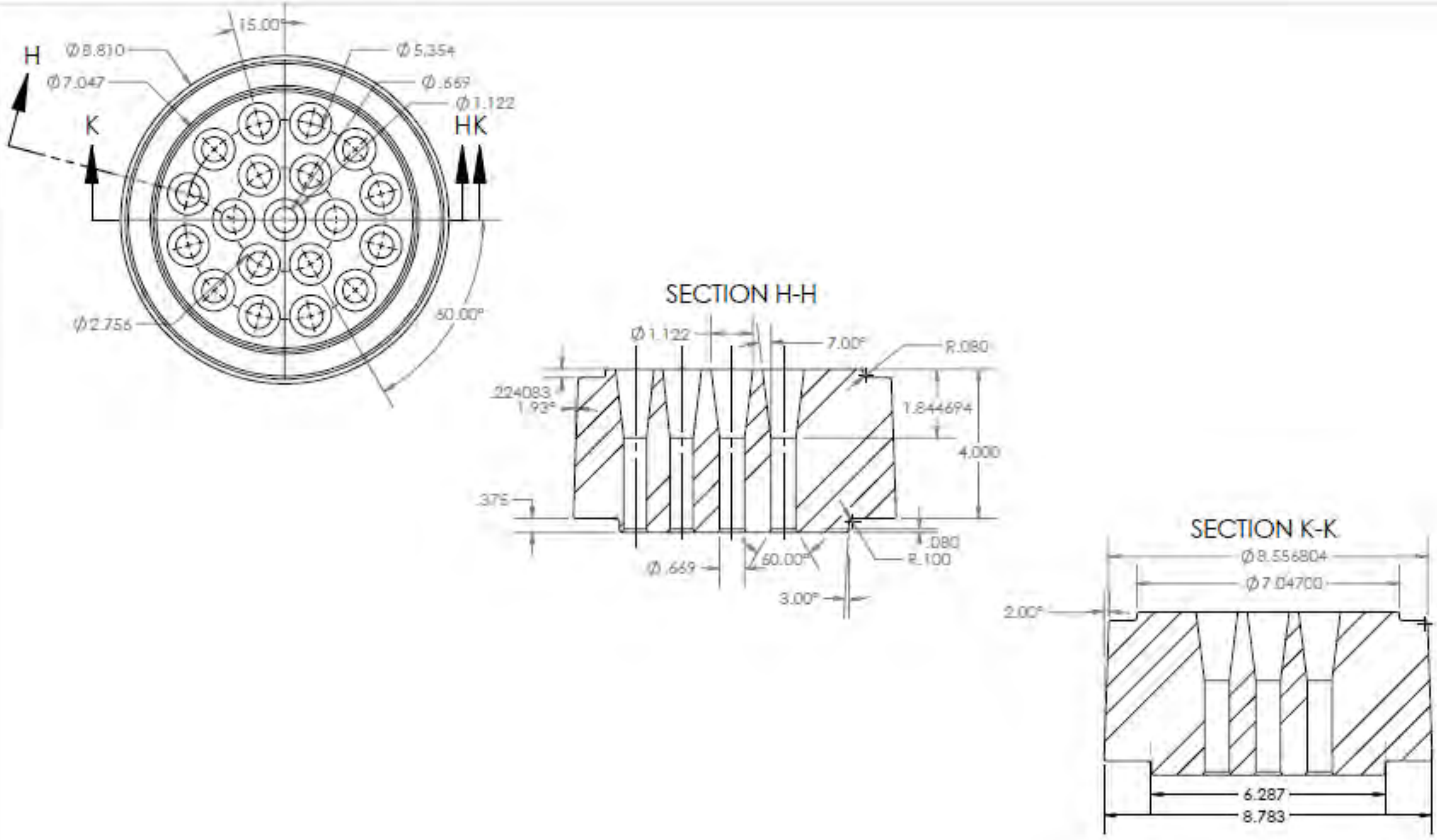

		UNLESS OTHERWISE SPECIFIED:		NAME	DATE	
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL± ANGULAR: MACH± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±	DRAWN			
			CHECKED			TITLE:
			ENG APPR.			
			MFG APPR.			
		INTERPRET GEOMETRIC TOLERANCING PER:	Q.A.			
		MATERIAL	COMMENTS:			SIZE A DWG. NO. 19 Strand Anchorhead DRAWING REV
NEXT ASSY	USED ON	FINISH				
APPLICATION		DO NOT SCALE DRAWING				SCALE: 1:4 WEIGHT: SHEET 1 OF 1

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19 Strand Anchor Heads At The Test Lab

5,000 Kip Universal Testing Machine

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New Skyline Steel Extrusion Line

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Extrusion Head

Computer controlled process

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In-line, Continuous, Quality Control
Electronic Thickness Monitoring

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Extruded Strand Take-up Process

Strand Anchor Assembly

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CASE STUDY:

Strand Anchor/Removable Strand Anchor

Project Partners

<u>Owner:</u>

Related Companies – New York, NY

<u>Construction Manager</u>:

Tutor Perini Corporation – New York, NY

<u>Foundation/Excavation Contractor:</u>

New York Concrete Corporation – Staten Island, NY

<u>Support of Excavation Engineer</u>

FNA Associates – New York, NY

Product

Removable Strand Anchors

CASE STUDY:

Strand Anchor/Removable Strand Anchor

Problem

A portion of the north support of excavation (SOE) wall, approximately 250 feet, ran adjacent to a large operating rail yard where the owner did not want any permanent steel to encroach over their property line due to planned secant wall and caisson installations on the property. This future work was going to be in conflict with the traditional tieback system that was designed for this particular portion of the SOE wall.

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CASE STUDY:

Strand Anchor/Removable Strand Anchor

Solution

Skyline Steel was currently supplying NYCC with the steel sheeting for the massive 90,000 sq. ft. cofferdam. Once the need for the removable system arose, Skyline Steel's Geostructural division got to work and began consulting with NYCC to formulate the LDCA system.

Skyline Steel supplied 33 sets of 3-strand load distributive compression type removable anchors. These anchors, made up of one single and one double anchor body, would allow the load to be distributed along the bond length.

Once the temporary anchors were no longer necessary, the strands were able to be removed quickly and easily. They just needed to be rotated to release the wedge in the anchor body and then pulled through the PE sheathing; which is typically done by hand.

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Traditional Hollow Ram Testing
Rental Equipment From Skyline Steel

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Stressing with independent frame of reference and dial gauges

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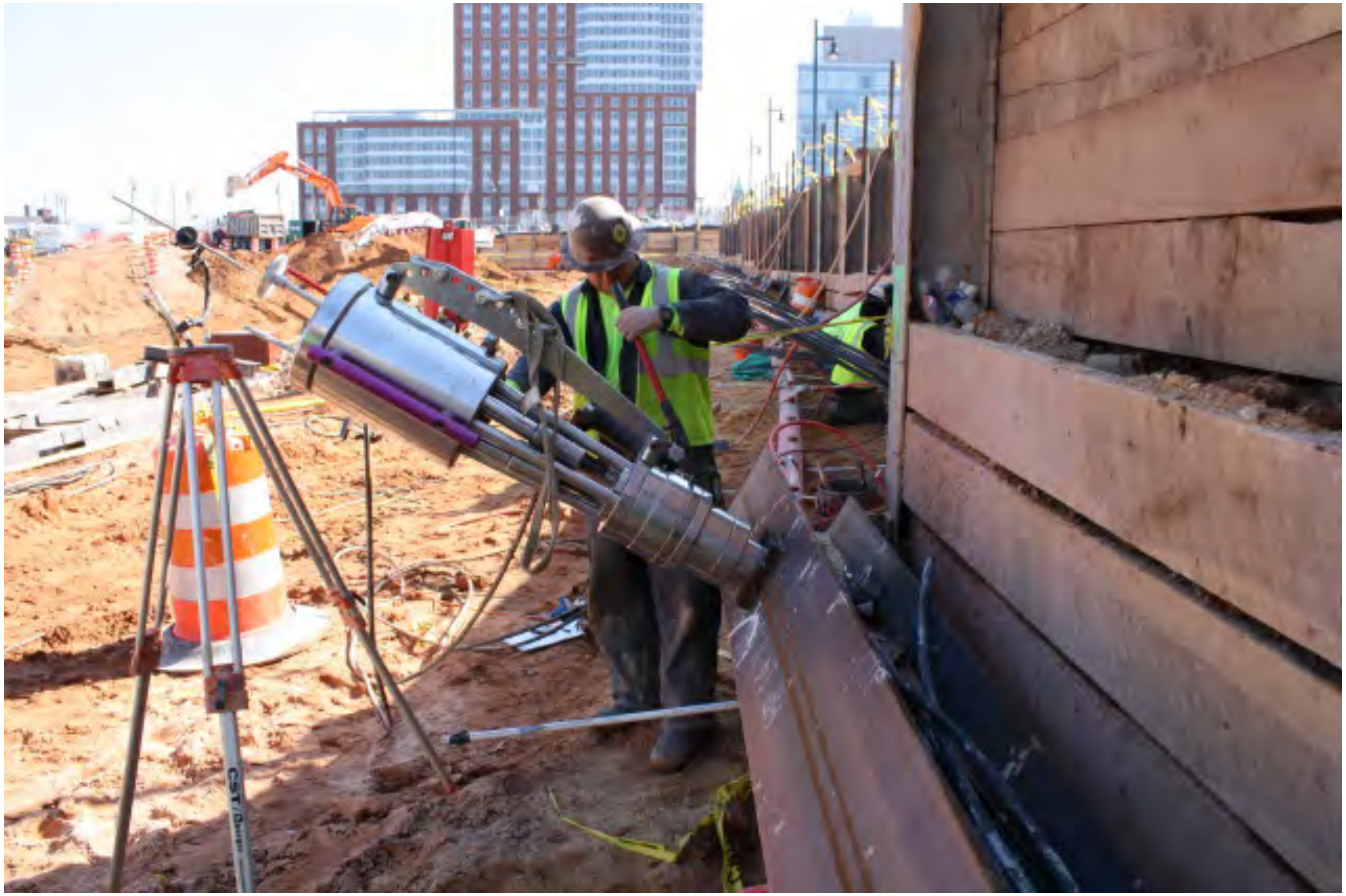
Multi Ram 'Smart Jack'
Stresses Different Length Strands Simultaneously



Calibrating A Smart Jack With Different Length Strands

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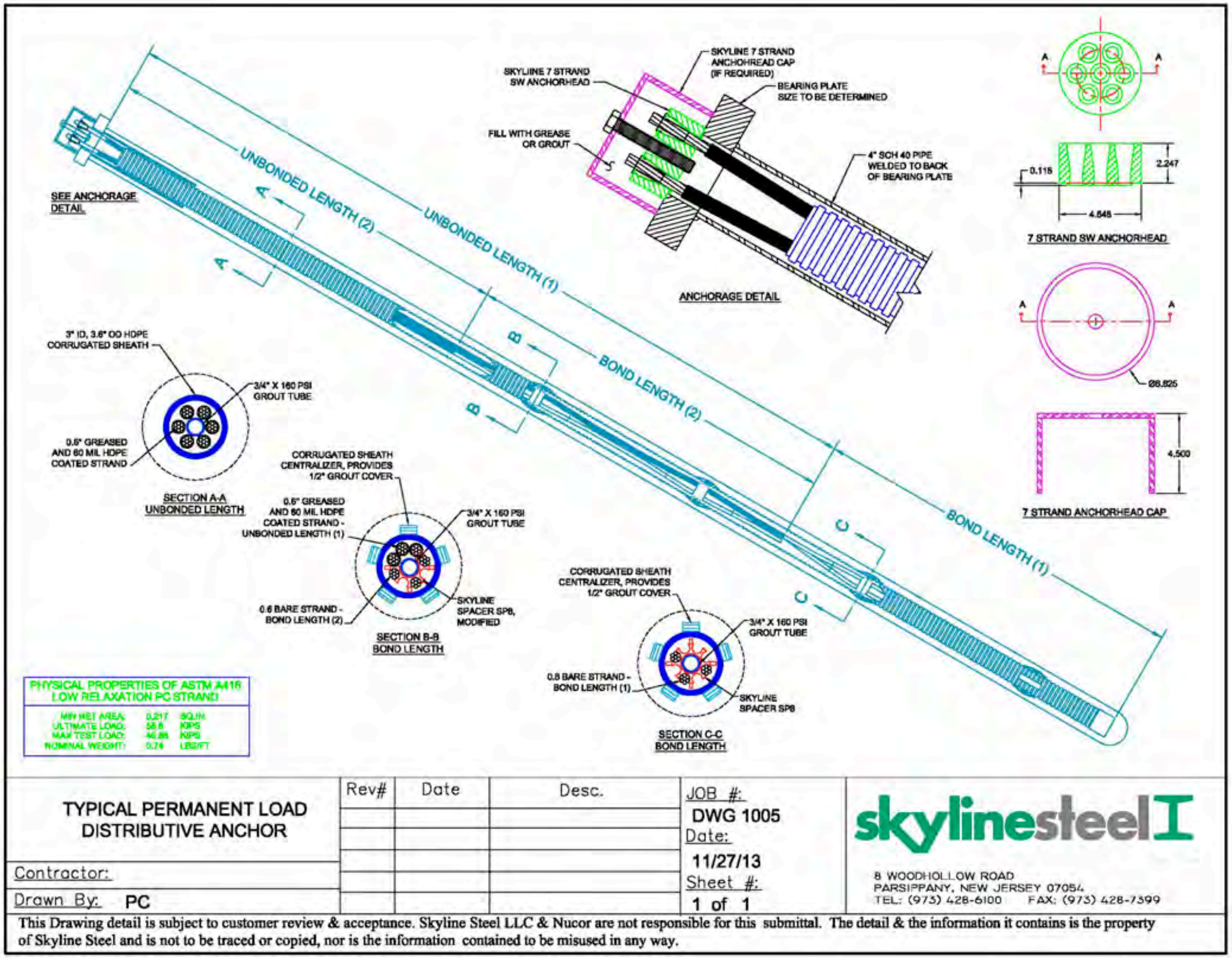
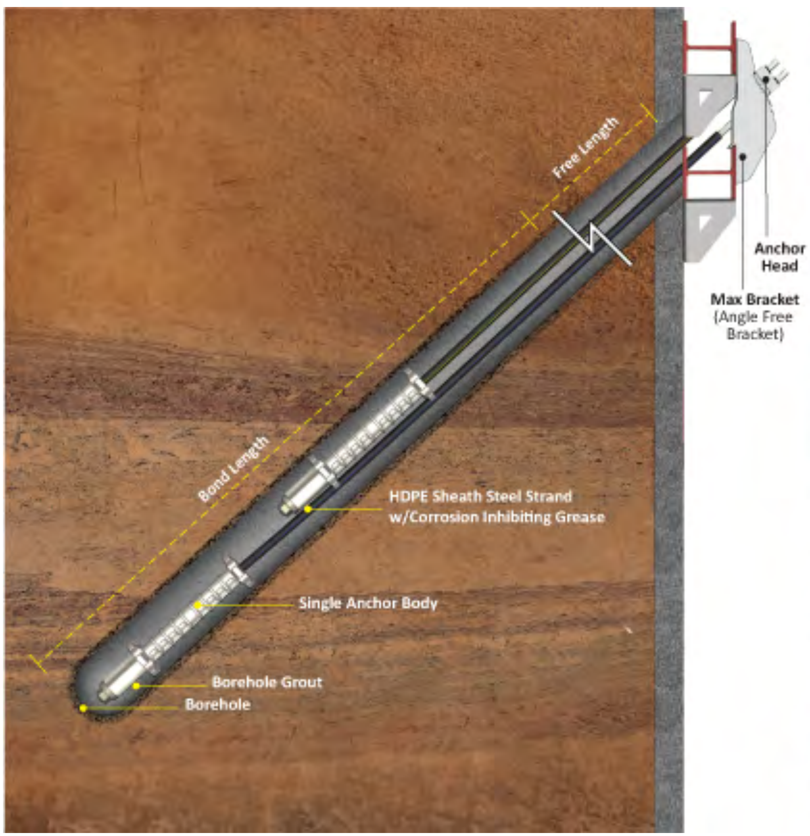
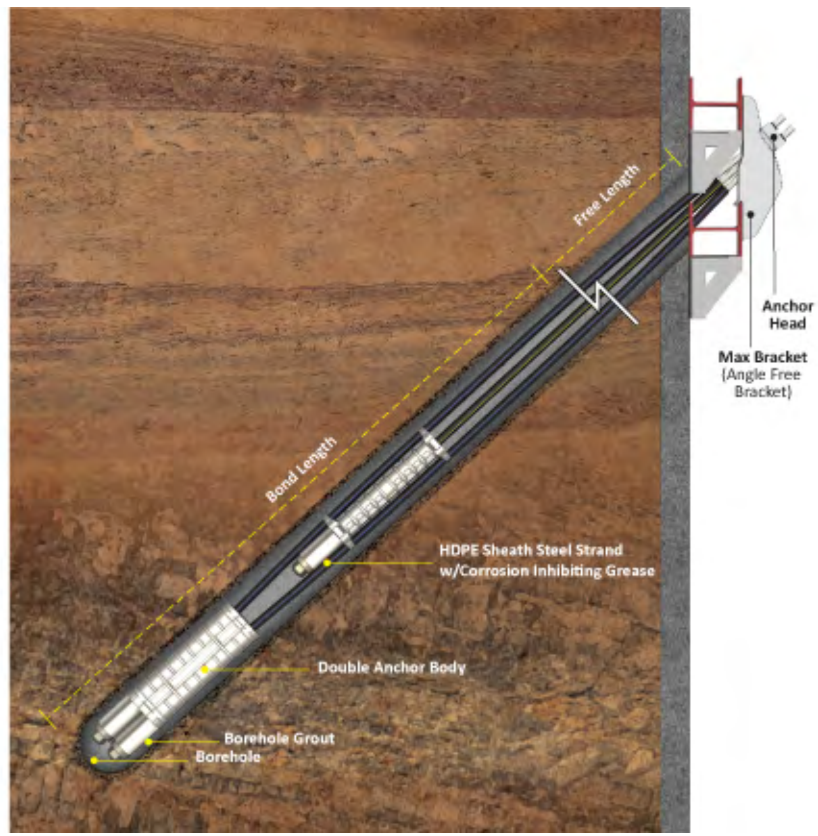
Load Distributive Tension Anchors



Load Distributive Compression Anchors (LDCA) Removable



Single Anchor Body



Double Anchor Body

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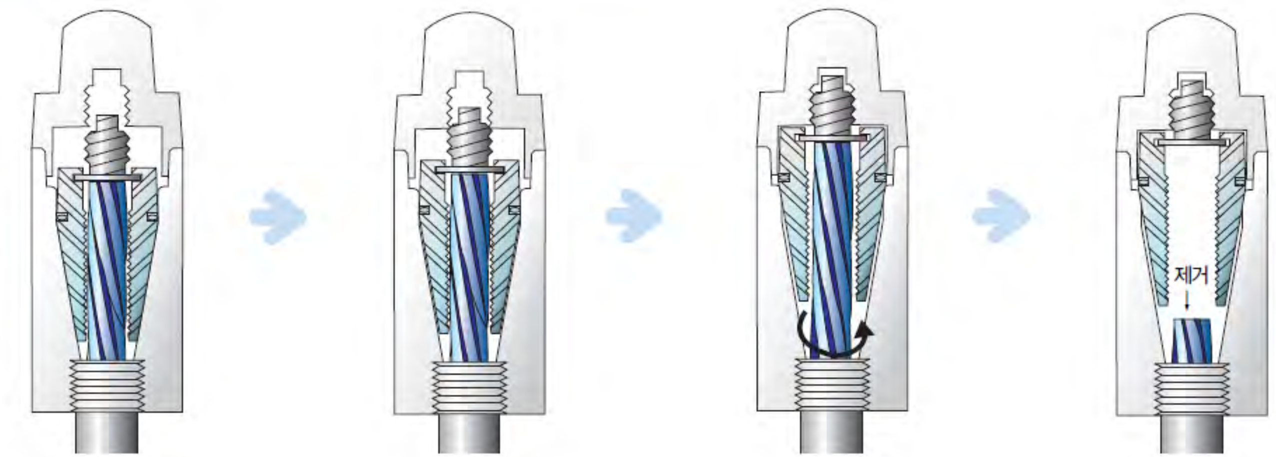
LDCA - Removable

Upgraded

- The newly developed corrosion-resistant aluminum die-casting anchor body
- Further improved part precision and bonding method
- Superb P.C strand protection structure and grout infiltration blocking effect



① Jacking and fixing

② Cutting wire, moving wedge

③ Rotating wire, opening wedge

④ Removing strand

Hollow Bar Systems

Domestic Production From Skyline Steel
Review Of Applications: Tiebacks, micropiles, soil-nail wall systems

Product Detail: Hollow Bar Systems

Hollow Bars

Hollow bars are fully threaded bars with a hollow core. A sacrificial drill bit is attached to one end of the hollow bar and advanced using rotary or rotary percussive drilling. Grout is continuously pumped through the hollow bar system while drilling, and the material is left in place when drilling depth is achieved. This process creates the steel reinforcing portion of an anchor or pile. Hollow bar products are a valuable and multi-functional addition to the geotechnical contractor's toolbox. They can be used as tie back or tie down anchors, rock anchors, soil nails and micropiles in a large array of challenging applications.

There are three basic types of drill bits for use with hollow bars: versatile cross cut bits in carbide or hardened steel, button bits for intact rock in carbide or hardened steel and steel stepped clay bits for cohesive soils. The selection of the drill bit type and size is based on the material that is being drilled through and the desired borehole diameter. A larger borehole diameter provides greater load carrying capacity and greater grout cover. Grout cover protects the anchor rod from corroding. Depending on the actual soil type, a 2.5" diameter bit can produce a 6" to 8" diameter grout column.

Production rates are increased dramatically through the use of hollow bar systems, as compared to traditional solid bar anchors. This is especially true when drilling through difficult conditions. In sites with low headroom, large scale drilling rigs and hole casing systems can be avoided. With drill rigs where "through the head grouting" is not available, grout swivels can be used to retrofit standard rotary percussion drills.

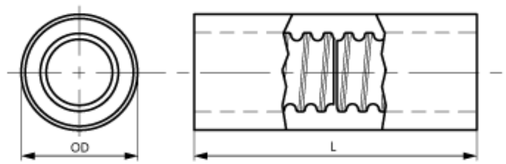
Roll Threading Custom Made
90 KSI Thick Walled Tube

Domestic Hollow Bar Production
Camp Hill, PA and Cartersville, GA

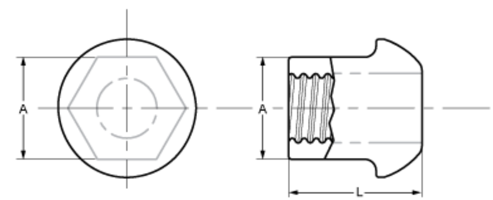
Domestic Hollow Bars & Accessories

"T" Threaded Hollow Bar*								
Bar Designation	**Nominal Outer Diameter** in	**Avg. Inner Diameter** in	**Avg. Cross Sectional Area** in^2	**Ultimate Load** kips	**Yield Load** kips	**Avg. Ultimate Tensile Stress** ksi	**Avg. Yield Stress** ksi	**Nominal Weight** lbs/ft
T40/16	1.57	0.63	1.36	148	118	109	86.7	4.7
T40/20	1.57	0.70	1.23	136	110	109	90.0	3.8
T52/26	2.05	1.03	2.07	227	179	110	86.9	6.7
T76N	3.00	2.10	2.90	319	252	110	86.9	10.2
T76S	3.00	1.77	3.80	418	330	110	86.9	13.2

* Meets "Buy America" requirements



"T" Threaded Hollow Bar Couplers			
Bar Designation	**OD** in	**L** in	**Weight** lbs
HBC 40	2.5	5.50	5.10
HBC 52	3.125	6.00	11.39
HBC 760	3.75	7.875	34.81



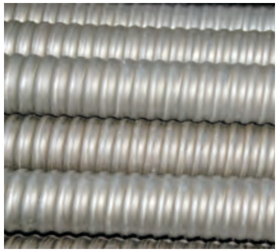
"T" Threaded Hollow Bar Anchor Hex Nuts			
Bar Designation	**A** in	**L** in	**Weight** lbs
HBAN 40	2.5	2.0	5.87
HBAN 52	3.35	3.0	10.04
HBAN 760	4.0	3.1	23.81

Hollow Bar Systems – Corrosion

Hollow Bar Corrosion Protection

The level of corrosion protection is dependent on the anticipated service life of the anchor, installation methods, and the corrosion potential (aggressiveness) of the environment. The FHWA has studied the effects of installation on both galvanized and epoxy coated bars as reported in FHWA CFL/TD10-002. **This study revealed epoxy coatings were both partially and completely removed at the leading edge of the thread profile and around the couplings.**

The installations were constructed using hollow bars as both the drill rod and reinforcement. The effects of the removal reduced the service life of the bar substantially by creating concentrated locations for potential corrosion. As such, the designer should evaluate all possibilities when determining the level of corrosion protection required.



Hot Dipped Galvanizing

Hot dipped galvanizing is a form of galvanization and is the process of coating a base metal such as steel with molten zinc. The zinc acts as a sacrificial material to the steel. The galvanized coating is manufactured in accordance with ASTM A 53 standards and is more resistant to handling than epoxy coatings.

Sacrificial Steel

Using sacrificial steel as a form of corrosion protection requires a geotechnical evaluation of the corrosivity of the soils. The estimated loss of steel thickness is calculated and then the hollow bar is designed with the additional increase in thickness.

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Hollow Bar Systems – Corrosion

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Shown here is an epoxy coated hollow bar post-installation. Note the stripped sections of epoxy coating, leaving exposed bare steel.

Photo courtesy of Schnabel Engineering and the FHWA

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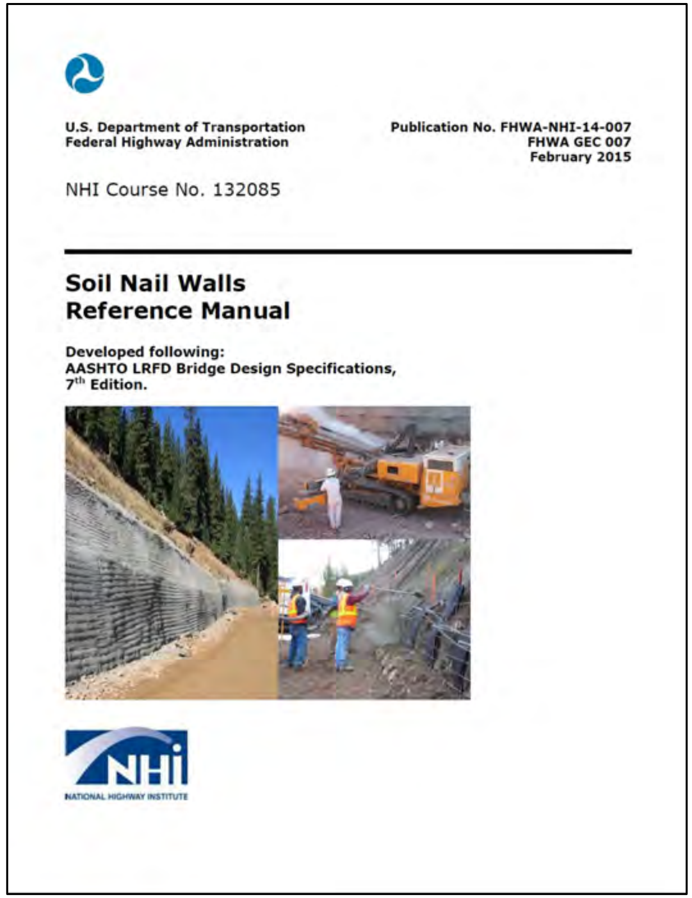

U.S. Department of Transportation
Federal Highway Administration

Publication No. FHWA-NHI-14-007
FHWA GEC 007
February 2015

NHI Course No. 132085

Soil Nail Walls
Reference Manual

Developed following:
AASHTO LRFD Bridge Design Specifications,
7th Edition.

NATIONAL HIGHWAY INSTITUTE

Hollow Bar Systems are specifically addressed in Chapter 10 (p.265) of the US FHWA Soil Nail Walls Reference Manual ed. GEC 7. For purposes of this manual they are called "HBSNs" *(Hollow Bar Soil Nails).* This manual is available for download for free at:

https://www.fhwa.dot.gov/engineering/geotech/pubs/nhi14007.pdf

New US Domestic Bits from Skyline Steel

Skyline Steel has began to produce US Domestic bits for the Hollow Bar System in select sizes and quantities. Pictured is a 100mm Ø (4”) Cross Cut Carbide bit suitable for use with T52 or T40 Skyline Steel hollow bars.

4”, 5”, 6”, 7”, and 8” bits in winged clay, cross cut (steel or carbide), and carbide button will be available in the coming months.

Bits are prototyped and tested before released for production

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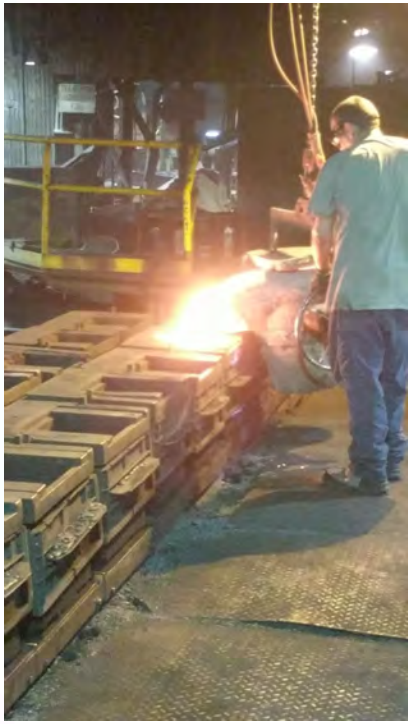
US Domestic Hollow Bar Production

- Skyline Steel continues to produce US domestic hollow bars to service the needs of projects compliant with Buy *America(n) provisions.*
- *All steel used in the manufacture* of bars, couplers, and nuts is with steel melted and manufactured here in the USA.
- Domestic drill bits are being developed and are available in select sizes.



CASE STUDY:

Hollow Bar Slope Stabilization

Project Partners

Owner: Questa Mine, New Mexico

Contractor: Nicholson Construction Company
Canonsbury, PA
Project Manager:
Paul Krumm, Operations Manager

Product

4,200 3-meter R38N hollow bar
600 3” cross cut carbide bits

Project Time Frame

September 2014

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CASE STUDY:

Hollow Bar Slope Stabilization

Problem

The schedule was extremely tight on this project. There were many difficult conditions on the project, including soil conditions and a crowded jobsite. The Nicholson team had the task of installing a multi-tiered wall and the additional challenges of using conventional drilling to install solid bar products and the unknown depths of competent materials.

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CASE STUDY:

Hollow Bar Slope Stabilization

Solution

Nicholson's design team chose Skyline Steel's hollow bar anchors because of the ease of their installation and improved speed to install. Another reason was the ability to drill the hollow bar anchors through varying depths of sub-surface conditions. Skyline Steel provided R38 hollow bar anchors, totaling over 4,200 galvanized, 3-meter bars. The design load of the hollow bar piles was 13.6 kips and was tested to 27.2 kips.

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Hollow Bar – West Village, NYC

Special thanks to New York Concrete

Skyline Steel Commercial Hollow Bar

- T76 and T52 Bars and Accessories

Hollow Bar – West Village, NYC

Skyline Steel Commercial Hollow Bar

- T76 and T52 Bars and Accessories

Special thanks to New York Concrete

CASE STUDY:

Hollow Bar Excavation Support

Project Partners

Owner

Rudin Management – New York, NY

Construction Manager

Turner Construction – New York, NY

Foundation/Excavation Contractor

Turner Construction – New York, NY

SOE Engineer

Langan Associates – New York, NY

Product

Hollow Bar

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CASE STUDY:

Hollow Bar Excavation Support

Problem

Upon being awarded the contract, New York Concrete Corporation (NYCC) was very concerned about meeting the tough demands of the owner. Their scope of work included the installation of seven separate foundations within a large city block.

CASE STUDY:

Hollow Bar Excavation Support

Solution

One of the areas that required an increase in productivity was the tiebacks for the support of excavation. NYCC decided to install hollow bars in lieu of traditional casing and solid bar tiebacks.

Skyline Steel turned to one of their newer products and was able to successfully supply the project with R51N and T76N hollow bars along with all of the complementary hardware.

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US Domestic Sizes Available

- T40/20, *110 kip yield*
- T40/16, *118 kip yield*
- T52/26, *179 kip yield*
- T76N, *252 kip yield*
- T76S, *330 kip yield*

Bar, couplers, and nuts designated 'US Domestic' meet Buy America provisions, melted and manufactured in the United States. Specifications subject to change. Subject to availability.

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Threaded Micropile Casing

- Available sizes & diameters
- Information on mill secondary and prime pipe
- New project highlights

MANUFACTURED BY SKYLINE STEEL

What is a Micropile?

- Small diameter pile, usually less than 14” Ø, smaller than a Drilled Shaft or CFA Pile.
- Typically installed with a small-bore drilling rig using a duplex drilling method with drill rod & drill bits or a down-hole hammer, and a “starter” casing with welded teeth or a cutting ring on the bottom
- Can be a Composite Pile System
  - Casing, grout, and threaded bar
- Depending on the type of micropile constructed, the capacity is developed through skin friction (the bond between grout and soil) but in Composite systems also relies upon the strength of the threaded bar
- End Bearing Micropiles socket into rock
- Ideal for use in areas with low headroom, restricted access, or vibration concerns

Micro Pile Project Update

Skyline Steel Micropile Casing used in Canada

- *7” x .408” wall casing*
- *Project for the Hospital Maisonneuve-Rosemont*
- *Micropiles were selected to reduce potential vibration, preventing disturbance of the hospital*

Merci, Petrifond!

Micropiles – Greenbrook NJ, Floodwall

Skyline Steel Micropile Casing

- *10-3/4” x .500 wall A252 GR3*
- *~4,500 LF of casing*
- *128 piles*

Special thanks to CMS

Micropiles – Breckenridge, Colorado

Skyline Steel Micropile Casing

- *7 5/8" x .500" wall*
- *5' sections for use in low headroom*
- *1,000 LF of casing*

Special thanks to Schnabel Foundation Company

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Micropiles – Breckenridge, Colorado

Skyline Steel Micropile Casing

- *7 5/8" x .500" wall*
- *5' sections for use in low headroom*
- *1,000 LF of casing*

Special thanks to Schnabel Foundation Company

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Micropiles – Reading, PA

Skyline Steel Micropile Casing & Cold Rolled Threadbar

- *7" x .408" wall*
- *#11 Gr 75 Cold-rolled Threadbar w/ centralizers*

Special thanks to Wagman

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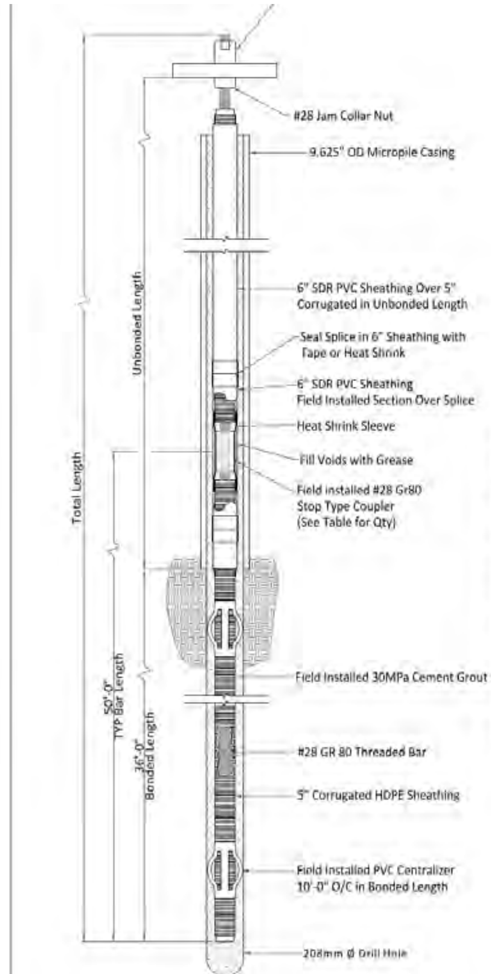
Composite Micro Pile
With Class I Corrosion Protected Threaded Bar



DCP Bar in Micropile
#28 Gr80 Threaded Bar

Micropile No.	Designation	Overall Length	Bonded Length	Unbonded Length	Qty of Couplers
M01	#28 Gr80 Threaded Bar	145'-0	36'-0	109'-0	2
M02		145'-0	36'-0	109'-0	2
M03		148'-0	36'-0	112'-0	2
M04		148'-0	36'-0	112'-0	2
M05		164'-0	36'-0	128'-0	3
M06		165'-0	36'-0	129'-0	3
M07		165'-0	36'-0	129'-0	3
M08		166'-0	36'-0	130'-0	3
M09		166'-0	36'-0	130'-0	3
M10		166'-0	36'-0	130'-0	3
M11		171'-0	36'-0	135'-0	3
M12		171'-0	36'-0	135'-0	3
M13		155'-0	36'-0	119'-0	3
M14		155'-0	36'-0	119'-0	3
M15		155'-0	36'-0	119'-0	3
M16		155'-0	36'-0	119'-0	3
M17		161'-0	36'-0	125'-0	3
M18		161'-0	36'-0	125'-0	3
M19		161'-0	36'-0	125'-0	3
M20		161'-0	36'-0	125'-0	3

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Micropile Tooling and Adaptors

Skyline Steel is proud to offer Casing Flange Adaptors and Duplex Drilling Adaptors for your Micro Pile Installation needs.

These critical parts were manufactured by Skyline Steel at Camp Hill, PA.

Flange and Duplex adaptors are custom made to order.

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Pipe Threading, Camp Hill PA

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Pin End With API Style Flush Threads
After Being Cut by a CNC Turret Lathe

Pin End Of Casing Gage Checked

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Skyline Steel Threaded Lengths, Starters, And Saver Subs

Micro pile Pipe

What is Mill Secondary? What is Prime?

Micro pile casing is steel pipe, usually N80 (80 ksi) steel pipe that was originally produced for the oil and gas industry.

Since the tolerances are extreme in that industry, a secondary use is to obtain the raw pipe that has been ‘rejected’ for use in the Oil & Gas fields (but still meet the requirements of a micro pile) and thread it for use in the Deep Foundation drilling industry as micro pile casing.

Typically lots of pipe are up for sale on the market with limited traceability as to the origin of the steel, hence the names “**Mill Secondary**” or “**Mill Surplus**”.

Routine testing of the integrity of the pipe is done via coupons and through origin letters obtained through the sale of the pipe.

Prime pipe is steel pipe for use in Micro pile applications that has been melted and manufactured here at Skyline Steel in the United States and fully complies with Buy America(n) provisions

CASE STUDY:

Micro piles with Threaded Bar

Problem

The PPL Center is built over the same lot where sinkholes wrecked the Corporate Plaza Building more than 17 years ago.

CASE STUDY:

Micro piles with Threaded Bar

Solution

Force Drilling installed over 1,700 micro piles, with depths ranging from 25’ to over 225’ in some very challenging karst ground conditions, with limestone rock formations and which have been prone to sink holes. Micro piles ranged in size from 9-5/8”, 7”, and 5-1/2” diameter steel casing, reinforced with a full length #18, #20 or #24 Grade 75 Skyline Steel threaded bar.

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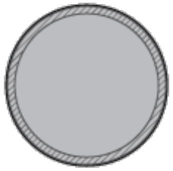
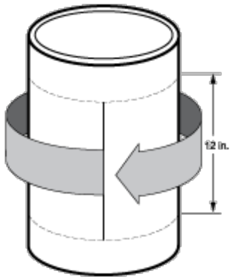
Threaded Casing for Micropiles

Micropile Casing									
Outside Diameter in	Thickness in	Inside Diameter in	Weight lb/ft	Cross Sectional Area in^2	Total Area of Shaft in^2	Internal Volume ft^3/ft	External Surface Area ft^2/ft	Moment of Inertia in^4	Section Modulus in^3
5.500	0.415	4.670	22.56	6.63	23.76	0.12	1.44	21.57	7.84
6.625	0.432	5.761	28.60	8.40	34.47	0.18	1.73	40.49	12.22
7.000	0.408	6.184	28.75	8.45	38.48	0.21	1.83	46.07	13.16
7.000	0.453	6.094	31.70	9.32	38.48	0.20	1.83	50.16	14.33
7.000	0.500	6.000	34.74	10.21	38.48	0.20	1.83	54.24	15.50
7.625	0.430	6.765	33.07	9.72	45.66	0.25	2.00	63.12	16.56
7.625	0.500	6.625	38.08	11.19	45.66	0.24	2.00	71.37	18.72
8.625	0.500	7.625	43.43	12.76	58.43	0.32	2.26	105.72	24.51
8.625	0.562	7.501	48.44	14.24	58.43	0.32	2.26	116.25	26.96
9.625	0.472	8.681	46.18	13.57	72.76	0.41	2.52	142.51	29.61
9.625	0.545	8.535	52.90	15.55	72.76	0.40	2.52	160.80	33.41
10.75	0.500	9.750	54.79	16.10	90.76	0.52	2.81	211.95	39.43
10.75	0.545	9.660	59.46	17.47	90.76	0.51	2.81	228.10	42.44
10.75	0.595	9.560	64.59	18.98	90.76	0.50	2.81	245.53	45.68
11.875	0.582	10.711	70.26	20.65	110.75	0.63	3.11	330.04	55.59
12.75	0.500	11.750	65.48	19.24	127.68	0.75	3.34	361.54	56.71
13.375	0.480	12.415	66.17	19.45	140.50	0.84	3.50	404.73	60.52
13.375	0.514	12.347	70.67	20.77	140.50	0.83	3.50	430.07	64.31

Cross Sectional Area



Total Area of Shaft



External Surface Area

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Thank You!

For More Information….

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