



Wind Turbine Foundation Systems

- *Foundation Anchor Bolts*
- *Prestressed Ground Anchors*
- *High Strength Grouts*
- *Concrete Forming Accessories*



Anchor Bolt System

Williams Form Engineering pioneered the heavy duty thread forms present on the Grade 75 and 150 KSI anchor bolts three decades ago for use in the civil construction industry. The anchor bolts gained popularity due to the rugged nature of the thread form and concentric thread design. The wide thread pitch allows for fast hex nut engagement while still allowing precise adjustments when necessary. These factors contributed to designer acceptance of the Williams Grade 75 and 150 KSI threaded bars in the late 1990's as renewable energy started to gain wide range acceptance. Today each wind tower supported by a Williams foundation anchor bolt can be relied upon to perform flawlessly throughout the life of the turbine.

Advantages of Using Williams Anchor Bolts

- Extensive quality control and manufacturing program produces the highest quality bolts in the market.
- Eight manufacturing plants throughout North America allow for the most efficient distribution network and timely deliveries.
- Anchor bolts have been cold temperature tested to assure full load retention and reliability in harsh environments.
- Laboratory test results for all Williams anchor bolts show less than 2% load relaxation loss under tension.
- Advanced engineered components maintain strict tolerances to ensure the highest product standards.
- Leading anchor bolt manufacturer in the industry with over 20 years experience.
- Technically advanced sales staff and best customer service in the industry.
- Custom anchor diameters and grades available upon customer request.
- Shipments are custom packaged per customer's requirements.
- Anchor bolt bundles include bar code tags for positive US steel mill traceability
- Anchor bolts can be chamfered to assist tower installation.
- Anchor bolts can be color coded or include Q/C tag on bolt end for jobsite identification after installation.
- Grade 80 All-Thread Bar and special A193 B7 150 KSI High Impact Steel available upon request.

Grade 75 Anchor Bolts

Bar Designation & Nominal Diameter	Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Diameter	Part Number
#7 - 7/8" (22 mm)	5	0.60 in ² (387 mm ²)	60 kips (267 kN)	45 kips (200 kN)	2.0 lbs/ft (3.0 kg/m)	1" (25 mm)	R61-07
#8 - 1" (25 mm)	3-1/2	0.79 in ² (510 mm ²)	79 kips (351 kN)	59 kips (264 kN)	2.7 lbs/ft (3.9 kg/m)	1-1/8" (29 mm)	R61-08
#9 - 1-1/8" (29 mm)	3-1/2	1.00 in ² (645 mm ²)	100 kips (445 kN)	75 kips (334 kN)	3.4 lbs/ft (5.1 kg/m)	1-1/4" (32 mm)	R61-09
#10 - 1-1/4" (32 mm)	3	1.27 in ² (819 mm ²)	127 kips (565 kN)	95 kips (424 kN)	4.3 lbs/ft (5.5 kg/m)	1-3/8" (35 mm)	R61-10
#11 - 1-3/8" (36 mm)	3	1.56 in ² (1006 mm ²)	156 kips (694 kN)	117 kips (521 kN)	5.3 lbs/ft (7.9 kg/m)	1-1/2" (38 mm)	R61-11
#14 - 1-3/4" (43 mm)	3	2.25 in ² (1452 mm ²)	225 kips (1001 kN)	169 kips (750 kN)	7.65 lbs/ft (11.8 kg/m)	1-7/8" (48 mm)	R61-14

Grade 90 Anchor Bolts

Bar Designation & Nominal Diameter	Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Diameter	Part Number
#11 - 1-3/8" (35 mm)	3-1/2	1.56 in ² (1006 mm ²)	187 kips (832 kN)	140 kips (624 kN)	5.5 lbs/ft (8.2 kg/m)	1-9/16" (40 mm)	R91-11

150 KSI Anchor Bolts

Bar Designation & Nominal Diameter	Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Diameter	Part Number
1" (26 mm)	4	0.85 in ² (549 mm ²)	128 kips (567 kN)	102 kips (454 kN)	3.09 lbs/ft (4.6 kg/m)	1-1/8" (29 mm)	R71-08
1-1/4" (32 mm)	4	1.25 in ² (807 mm ²)	188 kips (834 kN)	150 kips (667 kN)	4.51 lbs/ft (6.7 kg/m)	1-7/16" (37 mm)	R71-10
1-3/8" (36 mm)	4	1.58 in ² (1019 mm ²)	237 kips (1054 kN)	190 kips (843 kN)	5.71 lbs/ft (8.5 kg/m)	1-9/16" (40 mm)	R71-11
1-3/4" (46 mm)	3-1/2	2.60 in ² (1664 mm ²)	390 kips (1734 kN)	312 kips (1388 kN)	9.06 lbs/ft (13.5 kg/m)	2" (51 mm)	R71-14





Anchor Bolt Accessories

All Williams fasteners exceed 100% of the bar's published ultimate strength and couplings will meet ACI 318 Section 25.5.7.1 for mechanical rebar connections. Tower Positioning Nuts are used to secure the bolt to the embedment ring during assembly and placement, or for leveling the template rings. They can not be substituted for full strength nuts. Hardware dimensions shown are for standard carbon steel and can be provided galvanized or uncoated.



Full Strength Hex Nuts



**Tower
Positioning Nuts**



Hardened Washers

Grade 75 Anchor Accessories

Bar Designation & Nominal Diameter	Full Strength Hex Nuts				Tower Positioning Nuts			Hardened Washers			
	Across Flats	Across Corners	Thickness	Part Number	Across Flats	Thickness	Part Number	Outside Diameter	Inside Diameter	Thickness	Part Number
#7 - 7/8" (22 mm)	1-7/16" (37 mm)	1.66" (42 mm)	1-1/4" (32 mm)	R63-07	1-1/4" (32 mm)	1/2" (13 mm)	R63-07TN	2" (51 mm)	1-1/16" (29 mm)	5/32" (4 mm)	R9F-08-436
#8 - 1" (25 mm)	1-5/8" (41 mm)	1.88" (48 mm)	1-3/8" (35 mm)	R63-08	1-7/16" (37 mm)	9/16" (14 mm)	R63-08TN	2-1/4" (57 mm)	1-3/16" (30 mm)	5/32" (4 mm)	R9F-09-436
#9 - 1-1/8" (29 mm)	1-7/8" (48 mm)	2.17" (55 mm)	1-1/2" (38 mm)	R63-09	1-5/8" (41 mm)	9/16" (14 mm)	R63-09TN	2-1/2" (64 mm)	1-3/8" (35 mm)	5/32" (4 mm)	R9F-10-436
#10 - 1-1/4" (32 mm)	2" (51 mm)	2.31" (59 mm)	2" (51 mm)	R63-10	1-3/4" (44 mm)	9/16" (14 mm)	R63-10TN	2-1/2" (64 mm)	1-3/8" (35 mm)	5/32" (4 mm)	R9F-10-436
#11 - 1-3/8" (36 mm)	2-1/4" (57 mm)	2.60" (66 mm)	2-1/8" (54 mm)	R63-11	1-7/8" (48 mm)	9/16" (14 mm)	R63-11TN	3" (76 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436
#14 - 1-3/4" (43 mm)	2-3/4" (70 mm)	3.18" (81 mm)	3" (76 mm)	R63-14	2-1/2" (65 mm)	3/4" (19 mm)	R63-14TN *	3-3/8" (86 mm)	1-7/8" (48 mm)	7/32" (6 mm)	R9F-14-436

* Rounded Collar Nut

Grade 90 Anchor Accessories

Bar Designation & Nominal Diameter	Full Strength Hex Nuts				Tower Positioning Nuts			Hardened Washers			
	Across Flats	Across Corners	Thickness	Part Number	Across Flats	Thickness	Part Number	Outside Diameter	Inside Diameter	Thickness	Part Number
#11 - 1-3/8" (35 mm)	2-1/4" (57 mm)	2.60" (66 mm)	2-13/32" (61 mm)	R93-11	2" (51 mm)	0.63" (16 mm)	R91-11TN	3" (76.2 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436

150 KSI Anchor Accessories

Bar Designation & Nominal Diameter	Full Strength Hex Nuts				Tower Positioning Nuts			Hardened Washers			
	Across Flats	Across Corners	Thickness	Part Number	Across Flats	Thickness	Part Number	Outside Diameter	Inside Diameter	Thickness	Part Number
1" (26 mm)	1-3/4" (44 mm)	2.0" (51 mm)	1-5/8" (41 mm)	R73-08	1-3/4" (44 mm)	9/16" (14 mm)	R73-08TN	2-1/4" (57 mm)	1-3/16" (30 mm)	5/32" (4 mm)	R9F-09-436
1-1/4" (32 mm)	2-1/4" (57 mm)	2.6" (66 mm)	1-7/8" (48 mm)	R73-10	2" (51 mm)	9/16" (14 mm)	R73-10TN *	2-3/4" (70 mm)	1-1/2" (38 mm)	5/32" (4 mm)	R9F-11-436
1-3/8" (36 mm)	2-1/2" (64 mm)	2.9" (73 mm)	2-1/8" (54 mm)	R73-11	2-1/4" (57 mm)	9/16" (14 mm)	R73-11TN *	3" (76 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436
1-3/4" (46 mm)	3" (76 mm)	3.5" (88 mm)	3-1/2" (89 mm)	R73-14	2-1/2" (64 mm)	5/8" (16 mm)	R73-14TN *	3-3/4" (95 mm)	2-1/8" (54 mm)	7/32" (6 mm)	R9F-16-436

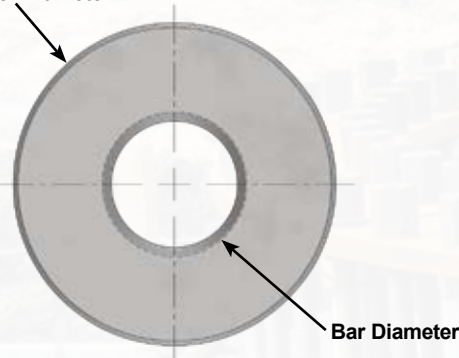
* Rounded Collar Nut

To achieve full strength of the system, hardened washers must be used with R73 hex nuts.



Threaded Bar Terminators

Terminator
Outer Diameter



Williams threaded terminators offer an economical alternative to the conventional approach of a plate between two hex nuts. With only a single component, they are more efficient to install and reduce congestion around the reinforcement. Since they are used with Williams threaded bars, they can be easily adjusted to the desired location and require no specialized equipment to install unlike other terminator systems.

Williams terminators meet the requirements of ASTM A970 Class HA. The dimensions shown for bar sizes up to #11 (1-3/8") exceed the requirements of ACI 318-19 Section 25.4.4, so can be used as headed reinforcement to reduce development length of a Williams threaded bar without the need for 90 degree bends or 180 degree hooks. Additionally, the nominal pullout strength of Williams terminators in 3000 psi concrete exceeds the specified tensile strength of the bar per ACI 318-19 Chapter 17. Other failure modes such as concrete breakout and side face blowout should be analyzed by the Engineer of Record.

For larger quantities, contact your Williams Representative to evaluate the cost saving design advantages of higher strength concrete.



150 KSI All-Thread-Bar Terminators

Bar Diameter	Minimum Thickness *	Terminator OD	Part Number
1" (26 mm)	1-5/8" (41 mm)	3" (76 mm)	R74-08-DN
1-1/4" (32 mm)	1-7/8" (48 mm)	3-3/4" (95 mm)	R74-10-DN
1-3/8" (36 mm)	2-1/8" (54 mm)	4-1/4" (108 mm)	R74-11-DN
1-3/4" (46 mm)	3-1/2" (89 mm)	5-1/4" (133 mm)	R74-14-DN
2-1/4" (57 mm)	3-3/4" (95 mm)	6-3/4" (171 mm)	R74-18-DN

Grade 75/80 Terminators

Bar Desig. & Nominal Dia.	Minimum Thickness *	Terminator OD	Part Number
#6 - 3/4" (19 mm)	1-1/8" (29 mm)	1-7/8" (48 mm)	R64-06-DN
#7 - 7/8" (22 mm)	1-1/4" (32 mm)	2-1/4" (57 mm)	R64-07-DN
#8 - 1" (25 mm)	1-3/8" (35 mm)	2-1/2" (64 mm)	R64-08-DN
#9 - 1-1/8" (29 mm)	1-1/2" (38 mm)	2-3/4" (70 mm)	R64-09-DN
#10 - 1-1/4" (32 mm)	2" (51 mm)	3-1/8" (79 mm)	R64-10-DN
#11 - 1-3/8" (36 mm)	2-1/8" (54 mm)	3-1/2" (89 mm)	R64-11-DN
#14 - 1-3/4" (43 mm)	2-1/2" (64 mm)	4-1/8" (105 mm)	R64-14-DN
#18 - 2-1/4" (57 mm)	3-3/4" (95 mm)	5-1/2" (140 mm)	R64-18-DN
#20 - 2-1/2" (64 mm)	3-3/4" (95 mm)	6-1/8" (156 mm)	R64-20-DN

Grade 60 Terminators

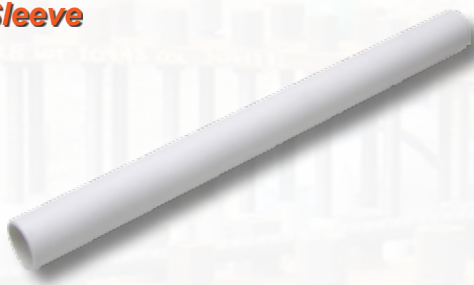
Bar Desig. & Nominal Dia.	Minimum Thickness *	Terminator OD	Part Number
#4 - 1/2" (13 mm)	7/8" (22 mm)	1-1/4" (32 mm)	R54-04-DN
#5 - 5/8" (16 mm)	1" (25 mm)	1-1/2" (38 mm)	R54-05-DN
#6 - 3/4" (19 mm)	1-1/8" (29 mm)	1-3/4" (45 mm)	R54-06-DN
#7 - 7/8" (22 mm)	1-1/4" (32 mm)	2" (51 mm)	R54-07-DN
#8 - 1" (25 mm)	1-3/8" (35 mm)	2-1/4" (57 mm)	R54-08-DN

* Actual thickness may vary due to material availability



Corrosion Protection

PVC Sleeve



Designation	Outer Diameter	Inner Diameter	Specification
1"	1.32" (34 mm)	1.19" (30 mm)	Class 200
1-1/4"	1.66" (42 mm)	1.50" (38 mm)	Class 200
1-1/2"	1.90" (48 mm)	1.72" (44 mm)	Class 200
2"	2.38" (61 mm)	2.15" (54 mm)	Class 200
2"	2.38" (61 mm)	2.06" (52 mm)	Schedule 40

R79T Tower End Cap

The Williams Tower End Cap was designed to protect the foundation anchor bolts from harsh weather conditions. This resilient cap is made from high impact resistant polypropylene with UV inhibitors and attaches to the bolt for a great fit. The caps include a rubber o-ring to positively seal the cap against the tower flange, and can accommodate up to 3 extra thick hardened washers if needed.

For proper installation, Williams recommends pushing the cap fully onto the anchor bolt, followed by turning in the direction of the threads to completely engage. Also recommended is the application of grease or some other corrosion inhibiting compound to the bolt prior to cap installation.

Williams Tower End caps are for protection of the tower foundation anchor bolts. With application of sufficient corrosion protective compound and proper installation, these caps will protect the foundation anchor bolt protrusion above the tower base from corrosion. However, these caps are not warranted against damage caused by falling sheet ice, extraordinary occurrence such as, but not limited to fire, improper installation methods, or destructive actions by humans or animals.

Maximum Anchor Bolt Projection	Anchor Bolt Type	Part Number
13" (330 mm)	#10 & #11 Grade 75 Rebar #11 Grade 90 Rebar 1-1/4" & 1-3/8" 150 KSI Bar M36 - M42 Bolts	R79T2413
15" (381 mm)		R79T2615
16" (406 mm)	#14 Grade 75 Rebar 1-3/4" 150 KSI Bar	R79T3216



Corrosion Protected Tower Anchor Bolts

When enhanced corrosion protection is required of wind turbine foundation anchors, Williams offers several types of corrosion protection options, see the Williams "Ground Engineering Systems" catalog for more details on corrosion resistance of our products.



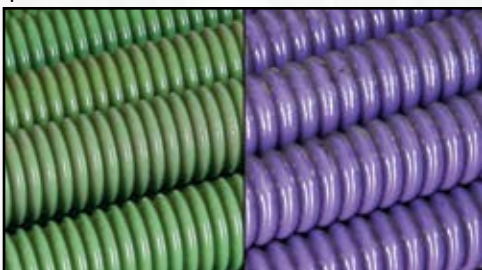
Pre-Grouted Bolts

with corrugated sleeves meet Post-Tensioning Institute standards for prestressed rock and soil anchors.



Hot Dip Galvanized Bolts

to ASTM A153 with oversize threaded full strength coated nuts.



Epoxy Coated Bolts

are fusion bonded to ASTM A775 or A934 and are available with oversize threaded full strength coated nuts.



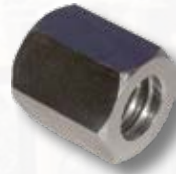
Pre-Greased Bolts

with Post-Tensioning Institute approved corrosion inhibitors are shipped within a smooth small diameter PVC sleeve.



Prestressed Ground Anchors

150 KSI All-Thread Bar

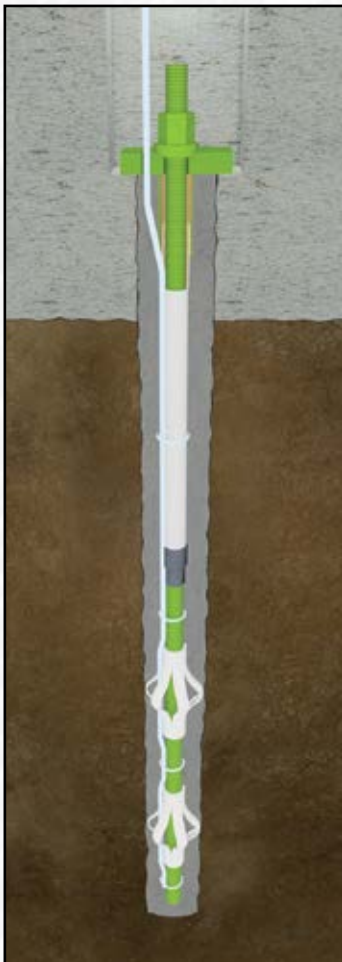


Nominal Bar Diameter	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	R73 Hex Nuts / R74 Collar Nuts			Part Number	R72 Stop-Type Couplings		
				Across Flats	OD/Across Corners	Thickness		Outside Diameter	Overall Length	Part Number
1-3/4" (46 mm)	2.60 in ² (1664 mm ²)	390 kips (1734 kN)	312 kips (1388 kN)	3" (76 mm)	3.5" (88 mm)	3-1/2" (89 mm)	R73-14	3" (76 mm)	8-1/2" (216 mm)	R72-14
2-1/4" (57 mm)	4.08 in ² (2632 mm ²)	613 kips (2727 kN)	490 kips (2181 kN)	3-3/4" (95 mm)	4.3" (109 mm)	3-3/4" (95 mm)	R73-18	3-1/2" (89 mm)	8-1/2" (216 mm)	R72-18
2-1/2" (65 mm)	5.19 in ² (3350 mm ²)	778 kips (3457 kN)	622 kips (2766 kN)	4-1/4" (108 mm)	4.9" (124 mm)	3-3/4" (95 mm)	R73-20	4-1/4" (108 mm)	8-5/8" (219 mm)	R72-20
3" (75 mm)	6.85 in ² (4419 mm ²)	1027 kips (4568 kN)	822 kips (3656 kN)	4-1/2" (114 mm)	OD 5" (127 mm)	5-1/2" (140 mm)	R74-24 *	5" (127 mm)	11-7/8" (302 mm)	R72-24

* Rounded collar nut

Wind turbine foundations situated on difficult geological grades such as very stiff coarse-grained soils or rock are often tied down to the earth with deep-embedded, grout bonded anchors. These large diameter rock or soil anchors are installed around the perimeter of the turbine foundation. They require less excavation and a substantial reduction in the amount of poured concrete versus traditional reinforced concrete spread footing foundations. Williams offers rock and soil anchors in various size high strength 150 KSI grade bars or 270 KSI multi-strand tendons. See the Williams "Ground Engineering Systems" catalog for more details.

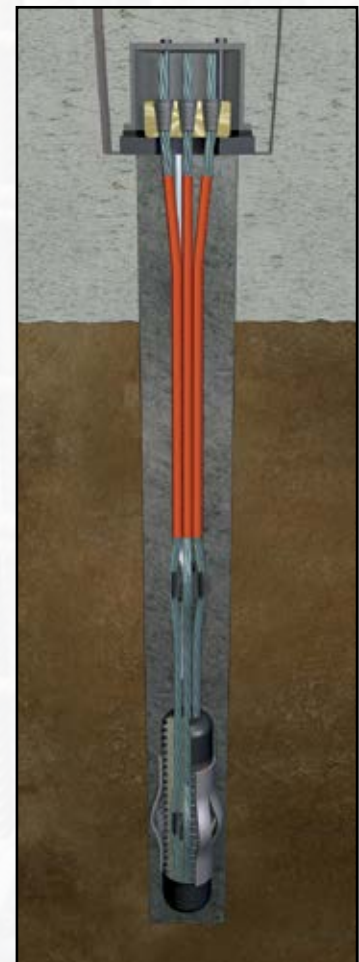
Simple Corrosion Protected Anchor



Enhanced Corrosion Protected Anchor



Multi-Strand Anchor





Concrete Accessories

Ultra-Bond Epoxy

Williams recommends Ultra-Bond Epoxy as an excellent choice when a high strength, fast setting adhesive is necessary. It is a two component (1:1 ratio) high modulus structural epoxy gel that provides maximum field reliability in a wide temperature (35° to 115° F) range with a minimum cure time. Talk to a Williams technical representative for more details concerning its use on wind turbine foundations.



Williams Wind Foundation Non-Shrink Grout

A high flow, high strength grout ideal for grouting wind tower foundations. Conforming to ASTM C-1107 with an ultimate average strength of 12,000 psi in 28 days and quick set times in temperatures as low as 35°F.

Williams Wind Foundation Epoxy Grout

A high performance, precision flowable epoxy grout engineered to meet the needs of the wind construction industry. Williams Wind Foundation Epoxy grout is an ideal product choice for turbine foundation grout pads when the schedule demands a quick turn around time. Average 24 hour strengths of 12,000 PSI and ultimate strengths up to 16,000 PSI means faster tower erection, quicker torque down time for foundation anchor bolts, greater dynamic loading, vibration dampening and reduced maintenance costs.

Chemicals

Williams distributes a full line of environmentally friendly construction chemicals, from VOC compliant high performance concrete sealers and curing compounds to biodegradable form-releases and evaporation retarders. All products are designed and supplied to meet today's jobsite environmental standards.

Concrete Forms

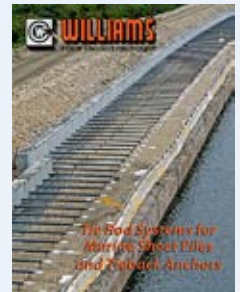
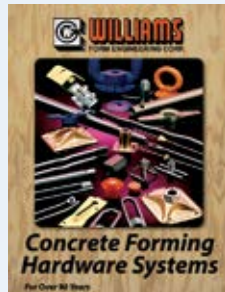
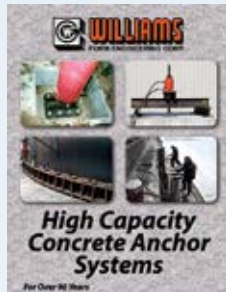
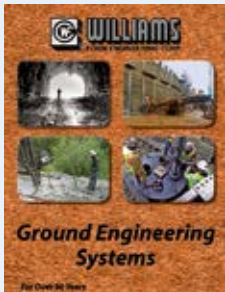
Williams Concrete Accessories Division can support a wide array of forming needs for today's foundation contractor, from custom steel pedestal forms to perimeter spread footing forms. Williams can provide a form package to keep your project on schedule. Our services include detailed drawings as well as forms for rental or purchase.

Additional Concrete Accessories

Additional items include a full line of concrete finishing tools, screeds, vibrators, mortar mixers, cold weather curing blankets, electric blankets and forming hardware.



Williams offers a full line of Ground Anchors, Concrete Anchors, Post-Tensioning Systems, Wind Turbine Foundation Systems, Marine Tieback Systems and Concrete Forming Hardware Systems for whatever your needs may be. Please visit our website for the most current information.



Also available from Williams are Rock & Soil Anchor Sample Specifications and High Capacity Concrete Anchor Sample Specifications



Please visit our website for the most current information

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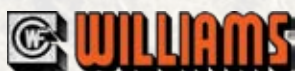
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