WILLIAMS®
FORM ENGINEERING CORP.

Ground Engineering Systems

100 YEARS

No. 125$_{u1}$

Using Williams Products

Readers of this catalog should independently verify the efficiency of any Williams products for the purpose intended by the user. The suitability of Williams products will depend upon field conditions, fabrications and user specifications which must be investigated and controlled by the user or its representatives. What follows are some suggestions for proper use of Williams products.

Proper Use is the Key

Williams Form Engineering Corporation provides a limited warranty on all of its products, as set forth in its quotations, acknowledgements and invoices furnished to each customer in connection with the sale of those products. Not withstanding this limited warranty, you should be aware that Williams products are intended for use by qualified and experienced workers. Serious accidents may result from misuse or improper supervision or inspection. Carefully field test any use not strictly conforming to normal practice before general adoption of the application. Carefully evaluate the product application, determine safe working loads and control all field conditions to prevent unsafe load applications. All safety factors shown are approximate, and in no case should they be exceeded.

IMPROPER USE OR INSTALLATION MAY RESULT IN SERIOUS INJURY OR DEATH. IF YOU HAVE THE SLIGHTEST DOUBT CONCERNING PROPER USE OR INSTALLATION, PLEASE CONSULT WITH OUR ENGINEERING DEPARTMENT.

You are Responsible for Any Modifications or Substitutions

Do not weld any casting, unless in the opinion of a qualified engineer such weld is in a no load, non-critical area. Welding causes carbides and extreme brittleness near the weld point, and destroys nearly all load value. Any welding or modifications to Williams products are the responsibility of the user, and as set forth in its limited warranty, Williams Form Engineering Corporation makes no representations or warranties concerning products altered, welded, bent or modified by others.

Many Williams products are manufactured, supplied and or designed as a system. Hence, we cannot guarantee that components from systems supplied by other manufacturers are interchangeable with our products. For best results, all parts of a system should consist of Williams products. From time to time, Williams Form Engineering Corporation may change product designs, safe working load ratings and product dimensions without prior notice to users. For the most current information concerning Williams products, please contact our engineering department, one of our technical representatives or see our web site.

Ongoing Inspection and Replacement are Essential

Each user should periodically inspect bolts and working hardware for wear and discard worn parts. Bent bolts, and bolts used at loads exceeding advertised yield strength should be discarded and replaced. A comprehensive inspection and replacement program should be instituted and followed, so that all bolts will be replaced after a predetermined number of uses, regardless of the apparent condition of the bolt.

All lifting hardware units displayed in this catalog are subject to wear, misuse, overloading, corrosion, deformation and other factors which may affect their safe working load. They should be regularly inspected to see if they may be used at the rated safe working load or removed from service. Frequency of inspection is dependent upon frequency and period of use, environment and other factors, and is best determined by an experienced user taking into account the actual conditions under which the hardware is used.

Ordering Procedure and Warranties

This catalog is intended to provide potential purchasers and users with general information about products offered by Williams Form Engineering Corporation. Prices, specifications, product descriptions and catalog items are subject to modification without prior notice. Any person desiring further information about products offered by Williams Form Engineering Corporation may contact the company or its authorized representatives. In appropriate cases, Williams will provide quotations for possible orders.

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Technical Assistance

Let Williams help save you thousands of dollars in start up costs by acting as an on-site advisor during your anchor bolt installation.

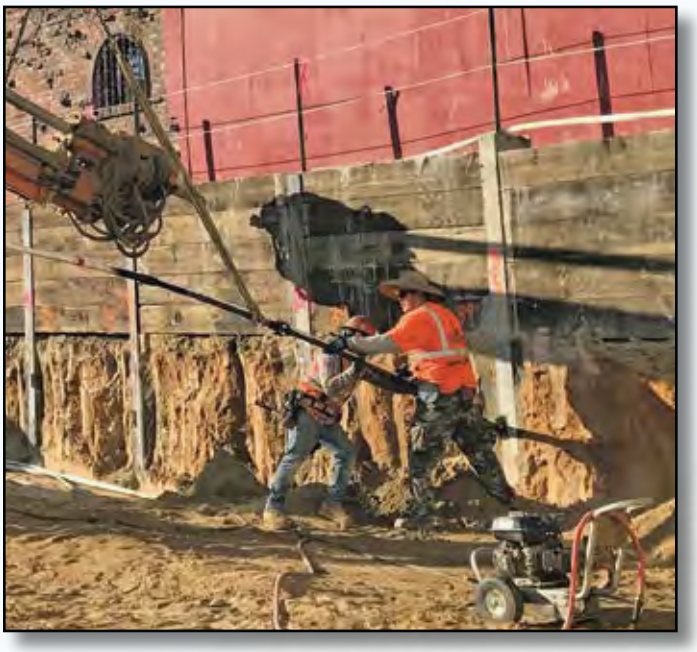
Our technician will work directly with your superintendent and crews to see they are prepared in terms of equipment needs, material coordination, and efficient installation procedures to yield the best productivity possible.

Our technicians are trained in most types of anchoring conditions and can often trim days off the bolting schedule by recommending efficient procedures. Technicians may also prove to be very beneficial in consulting with the design engineer to propose any last minute design changes to accommodate field conditions. Even the simplest anchoring job could have delays for an inexperienced crew. Take advantage of our expertise and be prepared to keep your project on schedule.

*Advance notification is requested. Contact your nearest Williams Representative for fee schedules.

Types of Earth Anchors

Williams Form Engineering is known throughout the world as one of the leaders in the manufacturing of ground anchor systems. With over 100 years of experience we are able to provide product and/or information for virtually any ground anchor application, and if necessary supply on-site technical assistance. Williams manufactures or distributes anchors in all four primary groups of ground anchor systems available on the market today. The four primary groups of ground anchors are as shown:



Cement Grout Bonded Anchors

Cement grout is used to develop a bond between the anchor and the soil or rock. Williams anchors can be made with several different types of steel grades.

Polyester Resin Anchors

Resin cartridges are used to develop anchorage between the anchor bar and the rock. Williams supplies All-Thread-Bars and threaded rebar for resin anchoring. Resin anchors often are a fast and economical solution for temporary rock support.

Mechanical Rock Anchors

A mechanical head assembly with an expansion shell and cone is used to develop a friction lock between the rock and head assembly.

Mechanical Soil Anchors

A pivoting plate such as the one used with the Manta Ray soil anchor shown above, is driven to a specified depth and rotated 90° to develop anchorage in the soil.

Types of Earth Anchors

Mechanical Rock Anchors

Advantages

1. No bond zone, so less drilling is necessary to develop the same shear cone as the bonded anchor system. Also, less grout is needed since there is less hole volume.
2. The installer can prestress and grout the anchor in the same day.
3. There is no cracking of the grout column, since the installer is prestressing the anchor before grouting.
4. The oversized drill hole provides for excellent grout coverage.

Disadvantages

1. The mechanical rock anchor should only be used in competent rock.
2. The maximum working load for Williams largest mechanical anchor, utilizing a 2:1 safety factor from the ultimate tensile steel capacity, is 180 kips.

Grout Bonded Rock & Soil Anchors

Advantages

1. Grout bonded anchors can be used in virtually all rock conditions and also in most soils.
2. The maximum working load with a single Williams bar anchor or multi-strand tendon can exceed 1,000 kips.

Disadvantages

1. The installer must wait for adequate compressive strength of the grout to be reached before prestressing the anchor.
2. A bond zone must be established, so deeper drilling is required to develop the design load in comparison to a mechanical anchor.
3. In weak rock or soils, a test program or sample borings should be used to determine drill hole diameter and anchor lengths.

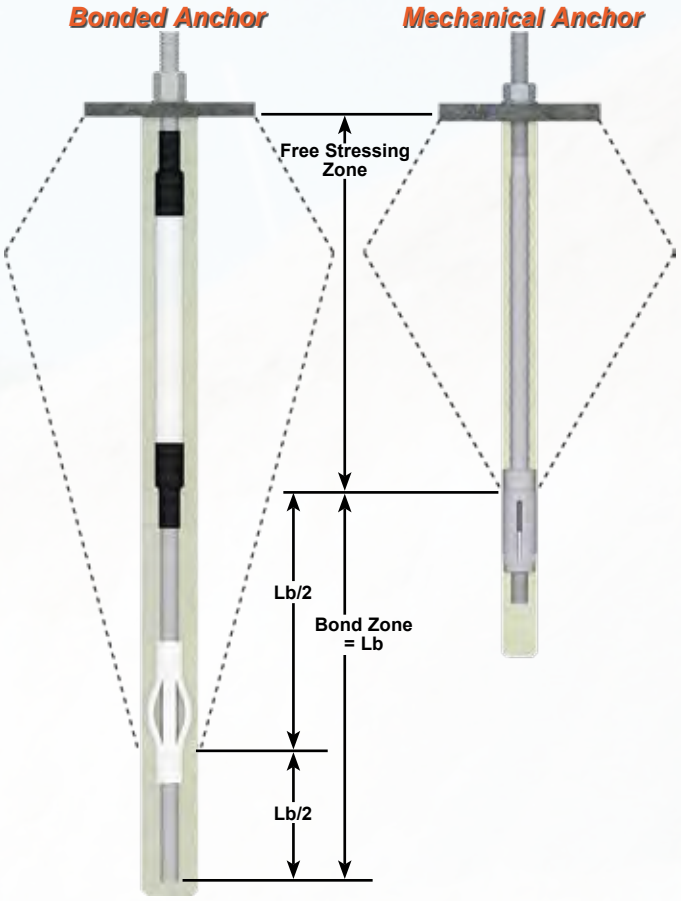
Mechanical Soil Anchors

Advantages

1. Problems associated with drilling anchor holes are eliminated because the anchor is driven into the soil.
2. All anchors are tested during installation and provide immediate anchorage. Actual holding capacity is determined during pull testing.
3. Time and expense associated with mixing and dispensing grout is eliminated.

Disadvantages

1. The anchors are designed to hold no more than a 50 kip maximum working load. Holding capacity can be limited by the bearing strength of the soil.
2. Corrosion protection is limited.
3. Rocks or other obstructions in the installation path can prevent adequate embedment.



Polyester Resin Rock Anchors

Advantages

1. Prestressing can be accomplished within minutes of the installation.
2. Resin bonded anchor bolts are one of the most economical temporary rock anchor systems available.
3. Resin anchoring is successful in most rock types.

Disadvantages

1. Resin anchors are difficult to protect against corrosion. They require tight drill holes for propermixing of cartridges, resulting in only a thin resin cover. In addition, resin anchors cannot be centered in the drill hole, which allows the bolt to rest on the bottom or side of the hole. Resin is placed into the drill hole in a pre-measured amount which does not account for resin loss into rock seams and cracks. Loss of resin creates unprotected gaps along the anchor, essentially reducing the safety factor of the system.
2. Resin anchors with lengths over 25 feet are difficult to install because resin gel time often requires speedy installations. Couplings cannot be used with full column resin anchors because their outer diameter is too large relative to the drill hole diameter.
3. Water presence can greatly reduce the holding capacity of the anchor or cause the anchors to be susceptible to creep.
4. Temperature affects set and cure times of the resin.

Choosing an Appropriate Rock Anchor

START

ROCK

Will the anchor be in competent rock?
(RQD values and core recovery samples should be evaluated to determine rock competence. Often, RQD values greater than 75% and rock unconfined compressive strengths greater than 2500 psi will indicate competent rock.)

YES

NO

Is the full anchor length estimated to be less then 75 feet?

YES

NO

Is the anchor working load greater than 180 kips?

YES

Is the anchor working load less then 580 kips?

NO

Can the working load be reduced and the number of anchors increased?

YES

NO

Option:
A multi-strand anchor system

NO

Is the anchor permanent?

YES

NO

Is the anchor less then 30 feet?

NO

Is the anchor prestressed?

YES

NO

Is the anchor prestressed?

YES

NO

Options:
1. Polyester resin rock dowel.
2. Cement grouted rock dowel using Grade 75 or Grade 150 All Thread-Bar.

Options:
Grout bond Grade 75 or Grade 150 All-Thread-Bar rock dowel. If corrosion protection is important, epoxy coat or galvanize the anchor system.

Options:
1. Hollow-Core Spin-Lock mechanical rock anchor. This allows for the installer to prestress and grout the anchor in the same day. Mechanical rock anchors are shorter in length than bonded rock anchors. This system also provides an excellent barrier against corrosion.
2. Multi-strand anchors with class 1 corrosion protection.

Options:
1. Polyester resin utilizing a a Grade 75 or Grade 150 All Thread-Bar. A fast set resin can be placed in the bond zone and a slow set resin in the free-stressing length.
2. A temporary Spin-Lock mechanical anchor, which allows for a shorter length.
3. Hollow bar anchors

Is corrosion protection essential?

NO

YES

Is the anchor prestressed?

NO

YES

Options:
Grade 60, Grade 75 or 150 KSI All-Thread-Bar cement grouted dowels.

Options:
1. MCP I utilizing a Grade 75 or Grade 150 All-Thread-Bar depending on the load.
2. Hollow bar anchors
3. Multi-strand anchors with class 2 protection

Is the anchor prestressed?

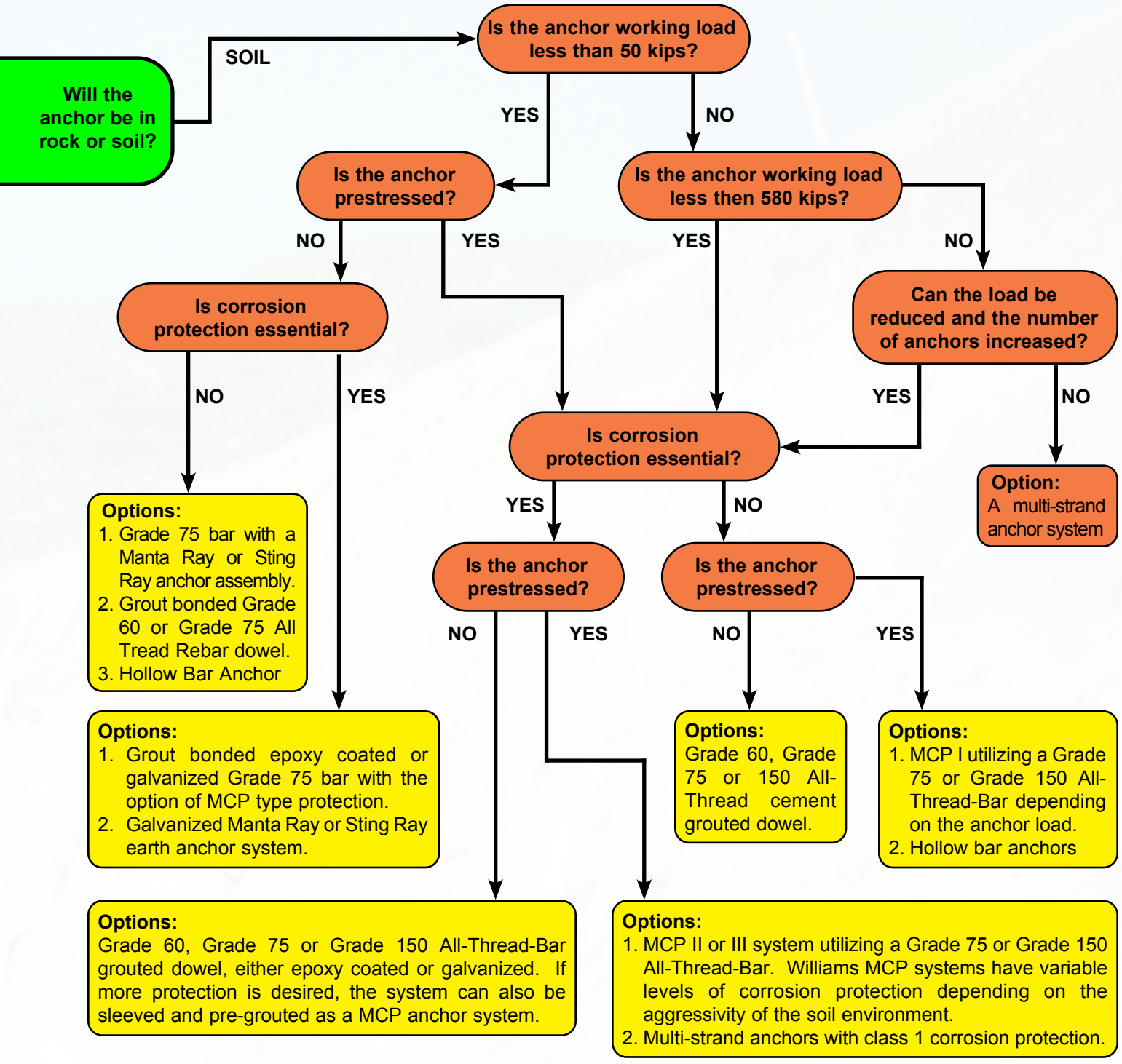
YES

NO

Options:
Cement grout bonded anchors using Grade 60, Grade 75 or Grade150 All-Thread-Bar, epoxy coated or galvanized. If more protection is desired the system can also be MCP protected.

Options:
1. MCP II or III system utilizing a Grade 75 or Grade 150 All Thread-Bar, depending on the design load. If the ground is extremely aggressive, the designer may consider galvanizing or epoxy coating the bar used with the MCP system.
2. Multi-strand system with class 1 corrosion protection.

Choosing an Appropriate Soil Anchor



Notes:

This flow chart is meant to be a quick reference. A designer should consider that flow charts such as this can not incorporate every variable relevant to the design of earth anchors. For additional help in choosing an anchor system please contact your nearest Williams representative.

1. Certain rock strata may require consolidation grouting prior to rock anchor installation in order to minimize the difficulties associated with grouting anchors in fractured rock.
2. For low temperature and high impact applications, Williams can manufacture Spin-Lock anchors using ASTM A193 grade B7 material or an ASTM A320 grade L7 material.
3. The term MCP refers to Williams (M)ultiple (C)orrosion (P)rotection anchor systems,
4. Most of Williams All-Thread Bars come in stock lengths of 50 ft. For longer anchors, Williams Stop-Type Couplings are often used for a mechanical connection between bars. Williams couplers develop 100% of the bars ultimate strength.
5. Williams can manufacture anchors using stainless steel bars if anchoring into highly aggressive rock or soil.

Prestressed Earth Anchors

The prestressing of a rock or soil anchor is done by one of two methods. The preferred and most accurate way to prestress an anchor is to use a hollow ram hydraulic jack which couples directly to the end of the anchor with a pull rod assembly. The jack frame typically bears against the steel plate while the hydraulic ram transfers a direct tension load to the anchor. When the prestress load is reached, the anchor nut is turned tightly against the anchor bearing plate, and the load from the jack is released. The anchor nut prevents the steel from relaxing back to its original length, therefore, the anchor has been pre-stressed. Once the anchor is put into service, additional elongation in the anchor rod only occurs if the applied load exceeds the prestress load.

The second method of prestressing is to use a torque tension method. Unlike some competing products, Williams full, concentric, rolled threads allow for torque tensioning when applicable. This is accomplished by simply turning the anchor nut against the anchor bearing plate with a torque wrench. By using a "torque tension relationship" provided by Williams, the installer can approximate the torque reading to a corresponding anchor tension load. Although not as accurate as direct tensioning, it is often used for fast, economical installations in areas where hydraulic jacks would be cumbersome or difficult to utilize. Torque tensioning is recommended to be done using a high-pressure lubricant under the hex nut to resist frictional resistance.

Prestressed earth anchors are often used for resisting cyclic or dynamic loading caused by wind or fluctuating water tables. They are also used to limit or restrict structural movement due to anchor steel elongation. Common applications for prestressed earth anchors are tower foundations, tie back walls, slope and dam stability, and tunnel bolting. Non-tensioned anchors or passive dowels are often used for temporary support, resisting shear loads, static loading, or for applications with low consequences of failure.

Benefits of a Prestressed Anchor

Pre-tested - By prestressing an anchor, each bolt is essentially "pre-tested", assuring it will hold its design load prior to final construction.

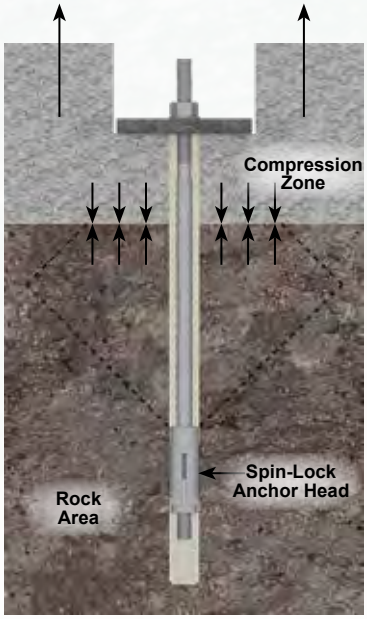
Eliminate Fatigue Stress - Fatigue failure is minimized since the service load must exceed the prestressed load of the bolt to cause additional steel elongation. Therefore, the periodic stretching and relaxing that causes fatigue failure is eliminated.

Eliminate Uplift - Prestressing can eliminate a "floating" condition of a foundation due to the natural hydraulic pressures or uplift loads caused by wind or other overturning moments.

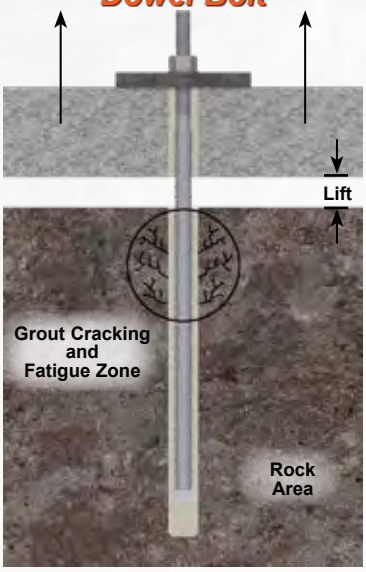
Negligible Bond Stress Relief - In cases where the earth anchor free-stress length is grouted after prestress, the grout hardens around the deformations of the bar and bonds to the rock in the drill hole to help prevent stress relief in the bolt.

Corrosion Protection - A prestressed earth anchor will not elongate through the grout column in the free-stressing length. Elongation breaks down and cracks the grout, opening the door to corrosion and eventual failure. This is a common problem with passive or "non-tensioned" rock dowels.

Prestressed Bolt



Dowel Bolt



Effects of Non-Tensioned Dowels

Not Pre-Tested - Any application of load onto the bolt will cause the grout to crack in the first several inches of drill hole depth.

Floating Condition - Allows floating of foundation or uplift of the structure due to steel elongation.

Possible Fatigue Failure - Bolt can stretch and relax as the load varies.

Possible Corrosion Problem - Bolt elongation will crack protective grout cover.

With a non-tensioned dowel, anchorage starts at the surface and actually breaks down and cracks the grout as the load transfers deeper along the length of the bolt. Over time the total anchorage may be lost due to these recurring grout breakdowns.

Free Body Diagrams

These diagrams are shown to help illustrate what happens to a prestressed anchor when an external load is applied. The external load must exceed the prestressed amount before affecting the original load.

1
Prestress load of 1000 lbs.

When a prestress load is applied and locked off, the anchorage load is equal to the force carried by the hex nut or the load bearing against the anchor plate.

2
External load of 700 lbs. is applied to the anchor

When an external force is applied to a prestressed anchor, the force on the bearing plate is reduced by the same amount as the external load. However, the anchor load is still unchanged unless the external load exceeds the prestress load.

3
External load of 1500 lbs. is applied

If the external load exceeds the prestress load, the nut is no longer holding a load. Then the anchorage load will be the same as the external load until anchor or rock/soil failure occurs.

Determining Proper Anchor Length

The length and load capacity of rock and soil anchor systems is dependent on many variables. Some of these variables are rock or soil properties, installation methods, underground or overhead obstructions, existing structures, right of way and easement limitations, anchor material strength and anchor type. Topics such as these should be evaluated during an anchor feasibility study prior to final anchor design. Final embedment depths should be determined on a project to project basis after reviewing rock or soil samples, previous experience and geological data. On-site anchor tests are generally the best way to accurately determine anchor lengths and capacities for the given geological conditions.

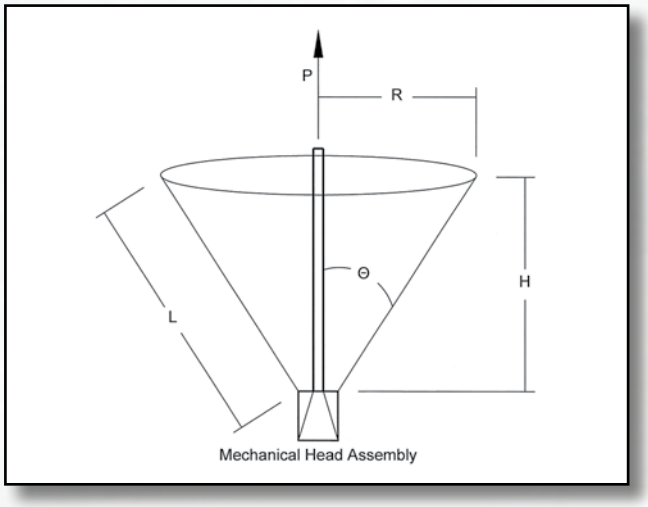
Free-Stress Length

Prestressed or post-tensioned earth anchors must be designed with a free-stress length. This is the portion of the anchor length that does not provide anchorage to the soil or rock during the stressing procedure. The purpose of the free-stress length is to allow the installer to transfer an immediate anchor load directly to a specific location in the soil or rock. For instance, when designing tie back anchors, the free-stress length should be long enough to transfer the prestress load behind the predicted failure plane of the soil or rock mass. The free-stress length also helps to minimize load loss due to movement at the anchor head during load transfer from the stressing jack. The Post Tensioning Institute recommends that for prestressed rock or soil anchors utilizing steel bars, the free-stress length shall be a minimum of 10 feet, and for steel strand a minimum of 15 feet due to greater seating losses. PTI recommendations on free-stress length are based on anchors utilizing high strength post-tension steel and often have relatively high design loads. Lighter load prestressed mechanical rock anchors have been successfully designed and installed with overall lengths shorter than 10 feet in high quality rock.

Mechanical Rock Anchor Lengths

One method that is used to estimate the embedment depth for mechanical rock anchors such as Williams Spin-Lock system is based on rock mass pullout capacity. The mass of rock mobilized in uplift is approximately conical in shape and often is angled outward from the longitudinal axis of the rock anchor between 15 and 60 degrees depending on the site's structural geology. The pullout capacity of the cone is a function of the weight of the cone and the shear resistance of the rock along the surface of the cone. Rock anchors are typically designed with embedments deep enough to ensure ductile failure of the steel bar. Mathematically, by setting the anchors ultimate steel capacity equal to the pull out capacity of the rock failure cone and applying necessary safety factors, a designer can estimate anchor embedment depth. Some designers neglect shear resistance and only use the weight of the cone for rock mass pullout resistance. This will typically provide a conservative anchor design.

The length of a mechanical rock anchor can be shorter than a cement grout or resin bond system since the load is being transferred by a mechanical head assembly rather than a grout or resin bond length. Therefore, the free-stress length plus the length of the mechanical head assembly makes up the embedment depth of the mechanical rock anchor. When anchors require couplers for longer lengths, Williams recommends the use of a hollow bar Spin-Lock for ease of grouting. Williams lists useful mechanical anchor property charts on pages 55-58 which tabulate anchor steel capacity based on corresponding anchor diameters and recommended safety factors. This section also reviews installation procedure and provides detailed information on Spin-Lock accessories and components.



R = Radius of cone base
H = Height of cone
L = Incline length of cone
V = Volume of cone (right angle cone)= (1/3)(p)(R^2)(H)
S = Rock shear resistance multiplied by the rock cone interface surface area
FS = Factor of Safety (.5 for a 2:1 Safety Factor)
Y = Unit weight of rock (approximately 150 pcf dry)
U = Ultimate tensile strength of anchor rod
q = Cone angle
P = Applied Design Load
π = 3.14

[(V) (Y) + S] > P < [(U) (FS)]

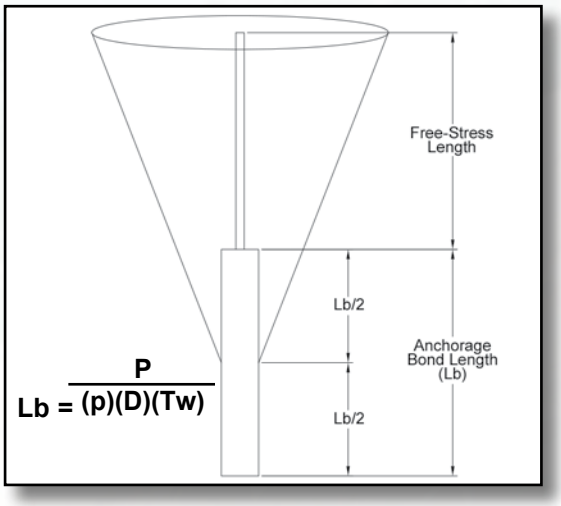
Mechanical Soil Anchor Lengths

Williams Form Engineering offers the Manta Ray and Stingray mechanical soil anchors. Both types of anchors are dependent on soil properties and the size of the head assembly for actual holding capacity. Their main advantage is ease of installation as no drilling or grouting is required. The anchor is simply driven into the soil with a driving hammer and pulled back to rotate the Manta Ray or Sting Ray head perpendicular. Holding capacities for the Manta Ray anchors are shown on pages 73-74.

Determining Proper Anchor Length

Bonded Rock Anchor Lengths

Embedment depths for prestressed resin or cement grout bonded rock anchors are often determined by using the rock cone method as described under *Mechanical Rock Anchor Lengths*. However, unlike the mechanical anchor, the bonded anchor must also include a bond length in the embedment depth. The bond length allows the applied tensile load to be transferred to the surrounding rock. Therefore the embedment depth of a prestressed bonded rock anchor is made up of the free-stress length and the bond length. When using the rock cone method, a conservative approach would be to assume the pullout cone starts at the top of the bond zone. The bond length can be estimated by using the following equation, however test anchors are generally the best way to determine anchor embedments and capacities. Typical values shown below are from the Post-Tensioning Institute. They are not meant to be used for final design. Final bond stresses should be determined after the review of sample cores, previous experience and geological data. A development length analysis should always be performed between the deformed steel tendon and grout, using a working bond stress of 250 psi between the nominal outside diameter of the steel tendon to confirm whether the grout to ground or grout to steel bond controls the bond length design.



$$Lb = \frac{P}{(p)(D)(Tw)}$$

Ultimate Grout/Bond Stress Estimates For Various Rock

Granite and Basalt	250-450 psi
Dolomitic Limestone	200-300 psi
Soft Limestone	150-200 psi
Slated and Hard Shales	120-200 psi
Soft Shales	30-120 psi
Sandstones	120-250 psi
Concrete	200-400 psi

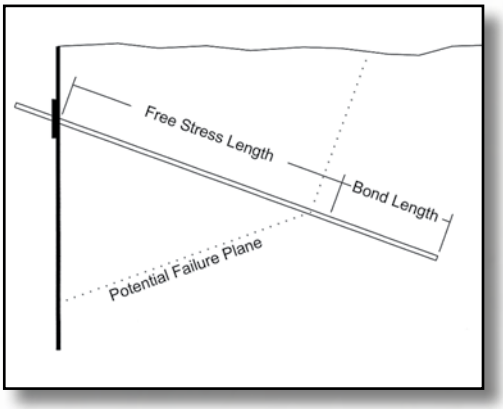
(Bond stress taken from PTI)

P = Design load for the anchor
p = 3.14
D = Diameter of the drill hole
Lb = Bond length
Tw = Working bond stress along the interface between the rock and grout (The working bond stress is normally 50 percent or less of the ultimate bond stress.)

Note - The ultimate bond stress between the rock and the anchor grout is estimated by a value of 10% of the unconfined compressive strength of the rock, but not more than 600 psi (4.2 MPa).

Bonded Soil Anchor Lengths

Embedments for prestressed soil anchors consist of a 10 foot minimum free-stress lengths for bar anchors, 15 foot minimum free-stress lengths for strand anchors and typical bond lengths ranging from 15 to 40 feet. Anchor drilling and grouting methods can have significant impact on soil bond stress values therefore final bond lengths are often determined by specialty anchor contractors. Shown below is a chart that can be used to estimate anchor bond length. This chart is for straight shaft anchors installed in small diameter holes using low grout pressure. However, final anchor capacity should be determined from field testing the anchors. For further guidance and recommendation on the design of prestressed bonded soil and rock anchors, refer to the Post-Tensioning Institutes manual on rock and soil anchors. Also refer to AASHTO for applicable publications.



Estimated Average Ultimate Bond Stress for Determining Soil/Grout Bond Lengths (taken from PTI)

Cohesive Soil		Cohesionless Soil	
Anchor Type	**Average Ultimate Bond Stress at Soil/Grout Interface (psi)**	**Anchor Type**	**Average Ultimate Bond Stress at Soil/Grout Interface (psi)**
Gravity Grouted Anchors (straight shaft)	5-10	Gravity Grouted Anchors (straight shaft)	10-20
Pressure Grouted Anchors (straight shaft)		Pressure Grouted Anchors (straight shaft)	
- Soft silty clay	5 - 10	- Fine-medium sand, medium dense - dense	12 - 55
- Silty clay	5 - 10	- Medium coarse sand (w/ gravel), medium dense	16 - 95
- Stiff clay, medium to high plasticity	5 - 10	- Medium coarse sand (w/ gravel), dense - very dense	35 - 140
- Very stiff clay, medium to high plasticity	10 - 25	- Silty sands	25 - 60
- Stiff clay, medium plasticity	15 - 35	- Dense glacial till	43 - 75
- Very stiff clay, medium plasticity	20 - 50	- Sandy gravel, medium dense - dense	31 - 200
- Very stiff sandy silt, medium plasticity	40 - 55	- Sandy gravel, dense - very dense	40 - 200

Note: Actual values for pressure grouted anchors depend on the ability to develop pressures in each type of soil.

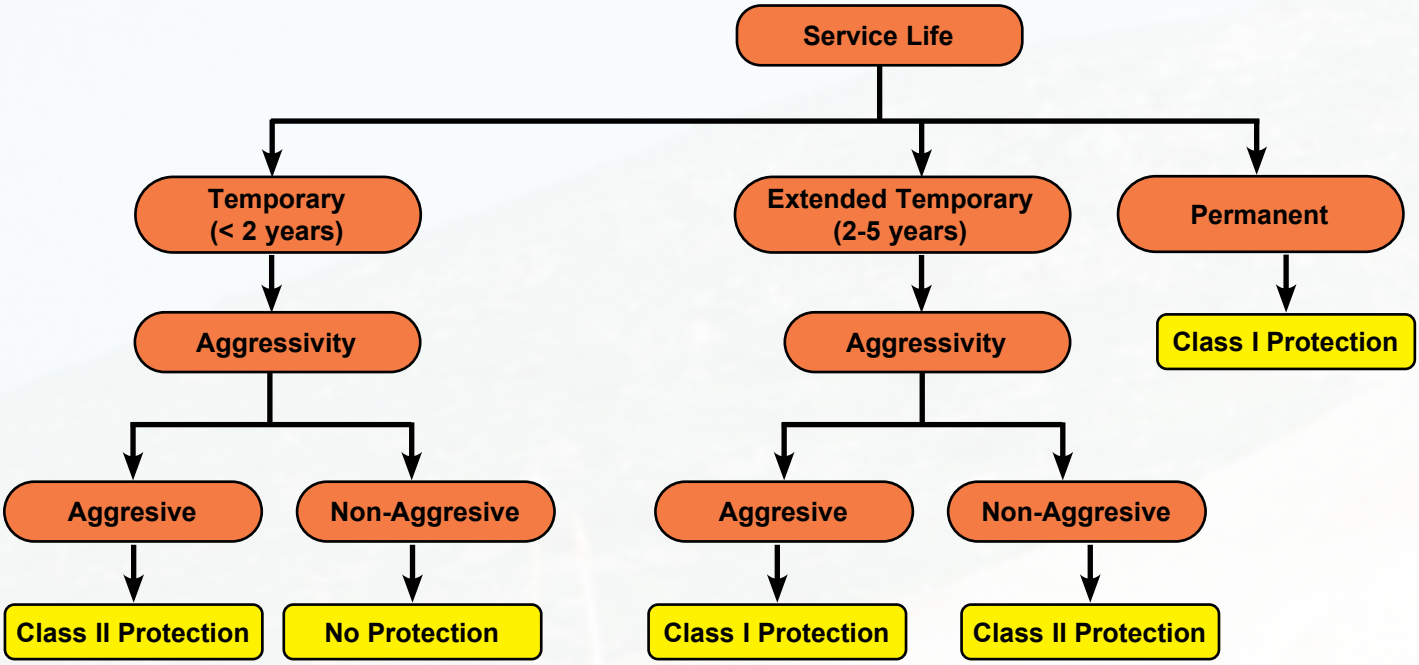
Corrosion Protection

The level of corrosion protection for an earth anchor is primarily dependent on the service life of the anchor, the aggressivity of the environment, installation methods and consequences of failure. An anchor with a service life greater than 24 months is generally considered permanent. Permanent anchors should always have some type of corrosion protection incorporated into their design.

Ground aggressivity is generally influenced by the following:

1. Electrical resistivity of the soil (Soil is aggressive if resistance is less than 2000 ohm-cm.)
2. pH value of the soil (Soil is aggressive if less than 5.5)
3. Chemical characteristics of the ground water, rock, or soil (salt water, slag fill, industrial waste, organic fill etc.)
4. Moisture
5. Presence of oxygen
6. Stray electrical currents

Governing Specifications for each anchor application may specify different protection schemes and these specifications should always be followed in designing the appropriate corrosion protection level. The following "Decision Tree" published in the PTI Recommendations for Prestressed Rock and Soil Anchors, assists designers in following a logical approach to corrosion protection selection:



Grout Bonded Rock or Soil Anchors

The standard permanent grout bonded rock or soil anchor consists of an epoxy coated or galvanized anchor rod, grouted in an oversized drill hole. Centralizers should be used to assure good grout cover (approximately 25 mm) around the bar. Additional corrosion protection may be desired if the rock or soil is considered to be aggressive, consequences of failure are high or anchoring into material where good grout cover is difficult to achieve. Williams Multiple Corrosion Protection (MCP) systems offer increasing barriers against corrosion attack. Williams MCP systems allow the anchor bar to be encapsulated in a pre-grouted poly-corrugated tube. Protective end caps may also be used to seal the nut and washer from the environment when the outer end of the anchorage will not be encased in concrete.

Grout Bonded Multi-Strand Anchors

Williams also offers permanent and temporary multi-strand ground anchors. Williams strand anchors are offered with a corrosion inhibiting compound under an extruded high density polyethylene/polyproplyne in the anchor unbonded length. The permanent anchors are protected with corrugated high density polyethylene/polyproplyne (HDPE/PP) over the entire length of the anchor excluding the stressing tail. The corrugated (HDPE/PP) offers one level of corrosion protection while the field grouting operation inside the corrugated (HDPE/PP) offers an additional level of protection. Temporary anchors are not manufactured with the corrugated (HDPE/PP) over the anchor bond and unbonded lengths.

Corrosion Protection

Mechanical Rock Anchors

Williams Spin-Lock mechanical rock anchors are used when anchoring into competent rock. The standard Williams Spin-Lock anchor relies on cement grout for corrosion protection. Williams Spin-Locks can be specified with a hollow anchor bar, allowing the system to be grouted from the lowest gravitational point in both up and down bolting applications. This provides a solid grout cover surrounding the anchor rod. Unlike the bonded rock anchor, the Spin-lock is grouted after the anchor is stressed so cracking of the grout column due to prestressing is eliminated. Spin-Lock anchors have been in service since 1959 and in most cases have relied strictly on cement grout for corrosion protection. If so desired, additional corrosion protection can be provided by step drilling a larger diameter drill hole, which provides additional grout cover, or by galvanizing the steel anchor rod. Protective end caps may also be used to seal the nut and washer from the environment when the outer end of the anchorage will not be encased in concrete.

Anchor Head Protection

The most important section of a ground anchor that needs adequate corrosion protection is the portion of the anchor exposed to air/oxygen. This is typically defined as the “anchor head”, which generally consists of a steel bearing plate, a hex nut and washer for a bar system, or a wedge plate and wedges for a strand system. For permanent ground anchors it is best to galvanize the hex nut and plates even if the bar is epoxy coated. Galvanized components, if scratched during shipping, are less likely to cause corrosion concerns than scratched epoxy coated components. The end of the steel bar protruding out from the hex nut is often protected by the use of a plastic or steel end cap packed with grease or cement grout. Williams offers several different types of PVC and metal end caps to provide corrosion protection at otherwise exposed anchor ends.

Screw On Fiber Reinforced Nylon Cap

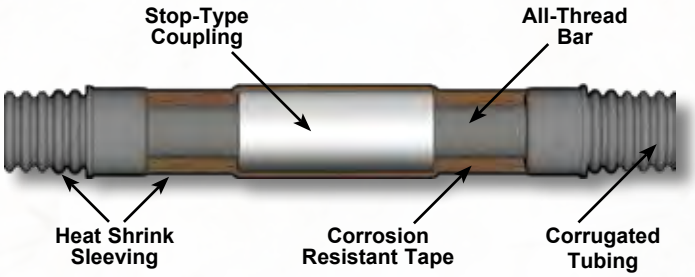
Strand End Cap

Steel Tube welded on Flange with Threaded Screw Connections

Screw-On PVC Cap

Field Splice for Bars

Continuous corrosion protection can even be accomplished for the MCP Pregrouted anchors manufactured from Williams Form Engineering. To achieve the equivalent levels of corrosion protection the coupled sections of bar anchors can be wrapped in a grease impregnated tape that is further protected with heat shrink sleeving. This scheme is acceptable by most governing agencies and is specified in the PTI Recommendations for Prestresed Rock and Soil Anchors.



Methods of Corrosion Protection

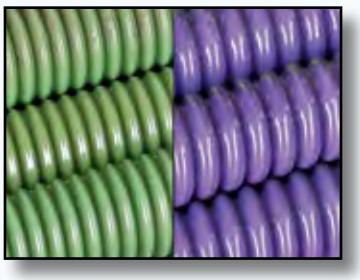
Corrosion Protection Method	Abrasion Resistance (4 = best)	Typical Thickness	Relative Cost (4 = highest)	Production Lead Time	Can be Applied to Accessories?	Can be Applied in the Field?
Hot Dip Galvanizing	4	3-4 mils	2	2-4 weeks	yes	no
Epoxy Coating	1	12-15 mils	1	2-3 weeks	yes	no
Pre-Grouted Bars	3	2”, 3” or 4” tubing	3	2 weeks	no	yes
Extruded Polyethylene/Polyproplyne Coating	2	60 mils	1	2-4 weeks	no	no
Corrosion Inhibiting Compound	2	N.A.	2	2-4 weeks	yes	yes

- Other thicknesses can be applied, contact a Williams representative for issues regarding threadability of fasteners
- Combination of protection methods are available (i.e. epoxy bar with a pregrout section, galvanizing with epoxy)
- Field patch kits are available for galvanized and epoxy coated products
- Field procedures are available for coupling (2) pregrouted anchors
- Contact Williams for more information regarding the appropriate corrosion protection level and corresponding governing reference specifications/documents.

Corrosion Protection

Pre-Grouted Bars

Cement Grout filled corrugated polyethylene tubing is often used to provide an additional barrier against corrosion attack in highly aggressive soils. These anchors are often referred to as MCP or Multiple Corrosion Protection anchors. The steel bars are wrapped with an internal centralizer then placed inside of the polyethylene tube where they are then factory pre-grouted. When specifying couplings with MCP ground anchors, verify coupling locations with a Williams representative.



Epoxy Coating

Fusion bonded epoxy coating of steel bars to help prevent corrosion has been successfully employed in many applications because of the chemical stability of epoxy resins. Epoxy coated bars and fasteners should be done in accordance with ASTM A775 or ASTM A934. Epoxy coated bars and components are subject to damage if dragged on the ground or mishandled. Heavy plates and nuts are often galvanized even though the bar may be epoxy coated since they are difficult to protect against abrasion in the field. Epoxy coating patch kits are often used in the field for repairing nicked or scratched epoxy surfaces.

Hot Dip Galvanizing

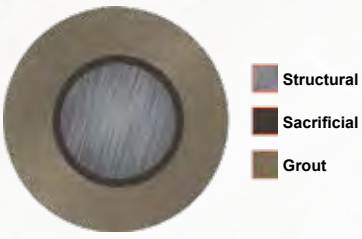
Zinc serves as a sacrificial metal corroding preferentially to the steel. Galvanized bars have excellent bond characteristics to grout or concrete and do not require as much care in handling as epoxy coated bars. However, galvanization of anchor rods is more expensive than epoxy coating and often has greater lead time. Hot dip galvanizing bars and fasteners should be done in accordance with ASTM A153. Typical minimum galvanized coating thickness for steel bars and components is between 3 and 4 mils. However, actual coating thickness will be much greater and may prevent full length threadability of fasteners unless methods to control thickness are used. Typically 1 to 2 feet of workable thread is provided on galvanized bar unless specified otherwise.

Extruded Polyethylene/Polypropylene

Williams strand tendons contain an extruded high density polyethylene/polyproplyne sheathing around each individual strand in the free-stressing portion of the anchorage. The sheathing is minimum 60 mils thick and applied once the 7-wire strand has been coated with a corrosion inhibiting compound. Extruded polyethylene/polyproplyne sheathing provides a moisture tight barrier for corrosion protection and allows the strand to elongate freely throughout the free-stressing length during the prestressing operation.

Corrosion Inhibiting Grease, Gel or Wax with Sheath

Williams corrosion inhibiting compounds can be placed in the free stressing sleeves, in the end caps, or in the trumpet areas. Most commonly bars are greased and PVC is slipped over the grease bar prior to shipping. Each of the options Williams offers are of an organic compound that provide the appropriate moisture displacement and have corrosion inhibiting additives with self- healing properties. They can be pumped or applied manually. Grease and Gel stay permanently viscous, while wax is solid at normal temperatures and must be heated to liquify and facilitate pumping. Each compound is chemically stable, and non-reactive with the prestressing steel, duct materials, or grout, and all meet PTI standards for Corrosion Inhibiting compounds.



Sacrificial Steel

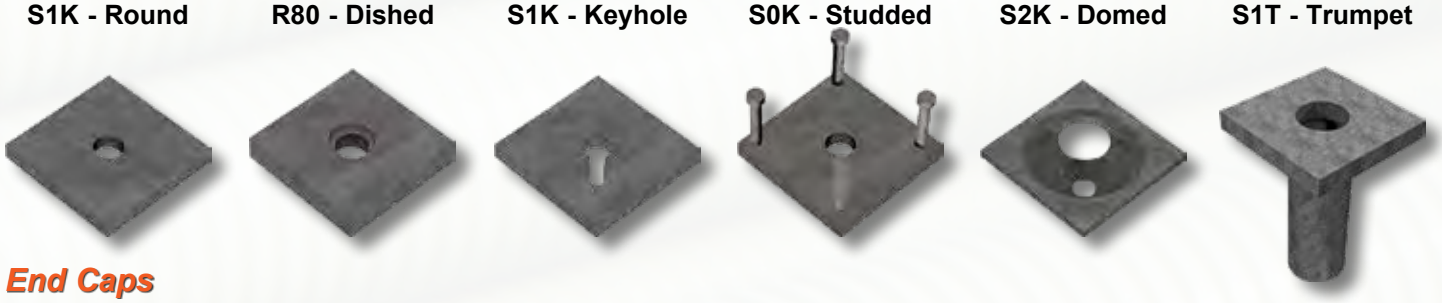
Sacrificial steel as a means of corrosion protection has become widely accepted in use for soil nails and micropiles. It involves the allowance of a calculated amount of steel on the outer perimeter of the tendon to be consumed by corrosion. The area of sacrificial steel is deducted from the total cross-sectional area of the tendon when determining the required tendon size, and often results in increasing the bar diameter to the next larger size. The sizing and design life of the anchor tendons can be determined based upon Section 10.4.2 of FHWA Geocircular No. 7 or Section 4.3 of The UK Department of Transport's TRR-380. This method of corrosion protection should only be used in known non-aggressive ground conditions.

Plates, End Caps, Centralizers & Eye Nuts

Bearing Plates

Williams steel bearing plates are standard with a round hole for non-grouted ground anchors. Also available are dished plates for use with spherical hex nuts and keyhole plates which provide free access for grout tube entry. Bearing plates are customized for each application. Plate dimensions should be specified around the parameters of the project. In addition, corrosion protection should be considered along with specifying hole diameter and bar angle.

S1K - Round **R80 - Dished** **S1K - Keyhole** **S0K - Studded** **S2K - Domed** **S1T - Trumpet**



End Caps

Williams offers several different types end caps to provide corrosion protection at otherwise exposed anchor ends. Most often the caps are packed with corrosion inhibiting grease. Caps made from steel are used in exposed impact areas.

Screw-on Fiber Reinforced Nylon Cap **Steel Tube welded on Flange with Threaded Screw Connections** **Steel Tube with Jam Nut** **Screw-on PVC Cap** **Slip-on PVC Cap w/ Plastic Nut**

Centralizers

The Williams Centralizers are used to center the anchor assembly in the drill hole. They are usually spaced 10 to 15 feet along the bar. To order, specify drill hole diameter, bar size or the outer diameter of sleeve when used over bar.

Eye Nuts

Williams Eye Nuts may be used as lifting eyes for forms, concrete blocks, concrete cylinders, machinery or equipment. The large base on three of the models makes them excellent for anchoring guy wires. Safety factors and working loads based on the ultimate strength of the Eye Nuts should be determined for the specific application by the project design engineer.

E1N **E1N1C** **E1N3** **E1N4**

Eye Nut Designation	Minimum Inside Width	Inside Height	Ring Diameter	Overall Height	Taps Available				SWL (3:1 FS) **	SWL (5:1 FS) **	Blank Part Number
					UNC & Coil Tie Rods	Grade 60 Grade 75	150 KSI All-Thread	B7X Hollow			
E1N * Cast Steel	1-1/2" (38 mm)	2-1/2" (64 mm)	7/8" (22 mm)	5-1/8" (130 mm)	1/2" to 1" (13 to 25 mm)	#4 to #8	-	-	23 kips (104 kN)	14 kips (62 kN)	E1M-00-E1N
E1N1C Forged Steel	2" (51 mm)	2-1/2" (64 mm)	1.15"Oval (29 mm)	5-1/2" (140 mm)	1" to 1-1/8" (25 to 29 mm)	#8 to #9	1" (26 mm)	32 mm	41 kips (182 kN)	25 kips (109 kN)	E1M-00-E1N1C
E1N3 Forged Steel	2" (51 mm)	3" (76 mm)	1-3/4" (45 mm)	8" (203 mm)	1-1/8" to 1-3/8" (29 to 35 mm)	#10 to #11	1" to 1-3/8" (26 to 36 mm)	38 mm	87 kips (386 kN)	52 kips (231 kN)	E1M-00-E1N3
E1N4 Forged Steel	2-1/2" (64 mm)	3-3/4" (95 mm)	2-3/16" (56 mm)	10" (254 mm)	1-3/4" to 2" (45 to 51 mm)	#14 to #18	1-3/4" (46 mm)	51 mm	137 kips (608 kN)	82 kips (365 kN)	E1M-00-E1N4
E1N4C Forged Steel	3" (76 mm)	5-3/4" (146 mm)	2" (51 mm)	11-1/2" (292 mm)	1-1/4" to 2" (32 to 51 mm)	#10 to #18	1-3/8" to 1-3/4" (36 to 46 mm)	51 mm	124 kips (550 kN)	74 kips (330 kN)	E1M-00-E1N4C
E1N5C * Forged Steel	4-1/4" (108 mm)	4-1/2" (114 mm)	2-5/8" (67 mm)	12" (305 mm)	-	#18 to #20	2-1/4" to 2-1/2" (57 to 65 mm)	76 mm	204 kips (907 kN)	122 kips (544 kN)	E1M-00-E1N5C

* Non-Domestic

** SWL based on straight tension loading only. Angled loading should be considered with caution, as it will significantly reduce Eyenut capacity. Contact your Williams representative for more information.

150 KSI All-Thread-Bar

R71 150 KSI All-Thread-Bar

Nominal Bar Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Prestressing Force			Nominal Weight	Approx. Thread Major Dia.	Part Number
			0.80*f* pu A	0.70*f* pu A	0.60*f* pu A			
1" - 4 (26 mm)	0.85 in² (549 mm²)	128 kips (567 kN)	102 kips (454 kN)	89.3 kips (397 kN)	76.5 kips (340 kN)	3.09 lbs/ft (4.6 kg/m)	1-1/8" (29 mm)	R71-08
1-1/4" - 4 (32 mm)	1.25 in² (807 mm²)	188 kips (834 kN)	150 kips (667 kN)	131 kips (584 kN)	113 kips (500 kN)	4.51 lbs/ft (6.7 kg/m)	1-7/16" (37 mm)	R71-10
1-3/8" - 4 (36 mm)	1.58 in² (1019 mm²)	237 kips (1054 kN)	190 kips (843 kN)	166 kips (738 kN)	142 kips (633 kN)	5.71 lbs/ft (8.5 kg/m)	1-9/16" (40 mm)	R71-11
1-3/4" - 3-1/2 (46 mm)	2.60 in² (1664 mm²)	390 kips (1734 kN)	312 kips (1388 kN)	273 kips (1214 kN)	234 kips (1041 kN)	9.06 lbs/ft (13.5 kg/m)	2" (51 mm)	R71-14
2-1/4" - 3-1/2 (57 mm)	4.08 in² (2632 mm²)	613 kips (2727 kN)	490 kips (2181 kN)	429 kips (1909 kN)	368 kips (1636 kN)	14.1 lbs/ft (20.8 kg/m)	2-1/2" (64 mm)	R71-18
2-1/2" - 3 (65 mm)	5.19 in² (3350 mm²)	778 kips (3457 kN)	622 kips (2766 kN)	545 kips (2422 kN)	467 kips (2074 kN)	18.2 lbs/ft (27.1 kg/m)	2-3/4" (70 mm)	R71-20
3" - 3 (75 mm)	6.85 in² (4419 mm²)	1027 kips (4568 kN)	822 kips (3656 kN)	719 kips (3198 kN)	616 kips (2740 kN)	24.1 lbs/ft (35.8 kg/m)	3-1/8" (80 mm)	R71-24

Steel Quality

Williams 1" through 1-3/4" 150 KSI bars are widely available as cold-stressed and stress relieved in strict compliance with ASTM A722 and AASHTO M275 Highway Specifications. While the 2-1/4" through 3" 150 KSI bars are exclusively available as alloy steel that is quenched and tempered to meet the prescribed tensile properties of ASTM A722, all sizes are available and occasionally supplied using this process.

Thorough inspection and traceability are carried out during all phases of manufacturing to assure the highest standards of quality.

Properties

Williams 150 KSI bars are manufactured in 7 diameters from 1" (26 mm) through 3" (75 mm). All diameters are available in continuous lengths up to 50' (15.2 m).

Williams 150 KSI bars are high in strength yet ductile enough to exceed the specified elongation and reduction of area requirements. Selected heats can also pass the 135° supplemental bend test when required. Testing has shown Williams 150 KSI All-Thread-Bars to meet or exceed post tensioning bar and rock anchoring criteria as set by the Post Tensioning Institute including dynamic test requirements beyond 500,000 cycles of loading.

Tensile Strength & Working Loads

Per PTI recommendations for anchoring, anchors should be designed so that the design load is not more than 60% of the specified minimum tensile strength of the prestressing steel. The lock-off load should not exceed 70% of the specified minimum tensile strength of the prestressing steel. The maximum test load should not exceed 80% of the specified minimum tensile strength of the prestressing steel. The maximum test load and the maximum factored design load must not exceed the yield strength of ANY steel element.

Threads

All-Thread-Bars are cold rolled threaded to close tolerances under continuous monitoring procedures for quality control. Threads for Williams 150 KSI bar are specially designed with a rugged thread pitch wide enough to be fast under job site conditions and easy to assemble. They also have a smooth, wide, concentric, surface suitable for torque tensioning. This combination offers tremendous installation savings over inefficient, hot rolled, non-concentric thread forms. Threads are standard left-hand for diameters up to 1-3/8" and right-hand for diameters over 1-3/4", with any direction available on special request.

Williams All-Thread-Bars are threaded around the full circumference enabling the load transfer from the bar to the fasteners to occur efficiently without eccentric point loading. Williams fasteners easily meet the allowable load transfer limitations set forth by the Post Tensioning Institute. Williams 150 KSI All-Thread-Bars and fasteners are machined to tight tolerances for superior performance and mechanical lock. Precision machining greatly reduces concern of fastener loosening or detensioning. Williams 150 KSI bars exceed the deformation requirements of ASTM A722. Williams special thread deformation pattern projects ultra high relative rib area, much greater than conventional rebar. This provides for superior bond performance in grout or concrete.

Cutting (No Welding)

Williams 150 KSI All-Thread-Bar should not be subjected to the heat of a torch, welding or used as a ground. Field cutting should be done with an abrasive wheel or band saw.

Stress Relaxation

Currently ASTM A722 does not include prescribed maximum relaxation thresholds. However, Williams can provide 150 KSI bars that meet project specific relaxation values. Consult your WFEC rep for more information.

150 KSI All-Thread-Bar Accessories

Hex Nut

Round Collar Nut

All Couplings and Hex/Collar Nuts exceed 100% of the bar's published ultimate strength and couplings will meet ACI 318 Section 25.5.7.1 for mechanical rebar connections.

R73 Hex Nuts / R74 Collar Nuts

Bar Diameter	Across Flats	OD/Across Corners	Thickness	Part Number
1" (26 mm)	1-3/4" (44 mm)	2.0" (51 mm)	1-5/8" (41 mm)	R73-08
1-1/4" (32 mm)	2-1/4" (57 mm)	2.6" (66 mm)	1-7/8" (48 mm)	R73-10
1-3/8" (36 mm)	2-1/2" (64 mm)	2.9" (73 mm)	2-1/8" (54 mm)	R73-11
1-3/4" (46 mm)	3" (76 mm)	3.5" (88 mm)	3-1/2" (89 mm)	R73-14
2-1/4" (57 mm)	3-3/4" (95 mm)	4.3" (109 mm)	3-3/4" (95 mm)	R73-18
2-1/2" (65 mm)	4-1/4" (108 mm)	4.9" (124 mm)	3-3/4" (95 mm)	R73-20
3" * (75 mm)	4-1/2" (114 mm)	OD 5" (127 mm)	5-1/2" (140 mm)	R74-24

* Rounded Collar Nut

R72 Stop-Type Couplings

Bar Diameter	Outside Diameter	Overall Length	Part Number
1" (26 mm)	1-3/4" (44 mm)	4" (102 mm)	R72-08
1-1/4" (32 mm)	2-1/8" (54 mm)	4-1/2" (114 mm)	R72-10
1-3/8" (36 mm)	2-3/8" (60 mm)	5" (127 mm)	R72-11
1-3/4" (46 mm)	3" (76 mm)	8-1/2" (216 mm)	R72-14
2-1/4" (57 mm)	3-1/2" (89 mm)	8-1/2" (216 mm)	R72-18
2-1/2" (65 mm)	4-1/4" (108 mm)	8-5/8" (219 mm)	R72-20
3" (75 mm)	5" (127 mm)	11-7/8" (302 mm)	R72-24

Couplings are available as tap thru upon request

Provides up to 5° angle when used with a dished plate.

R9F Hardened Washers

Bar Diameter	Outside Diameter	Inside Diameter	Thickness	Part Number
1" (26 mm)	2-1/4" (57 mm)	1-3/16" (30 mm)	5/32" (4 mm)	R9F-09-436
1-1/4" (32 mm)	2-3/4" (70 mm)	1-1/2" (38 mm)	5/32" (4 mm)	R9F-11-436
1-3/8" (36 mm)	3" (76 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436
1-3/4" (46 mm)	3-3/4" (95 mm)	2-1/8" (54 mm)	7/32" (6 mm)	R9F-16-436
2-1/4" (57 mm)	4-1/2" (114 mm)	2-5/8" (67 mm)	9/32" (7 mm)	R9F-20-436
2-1/2" (65 mm)	5" (127 mm)	2-7/8" (73 mm)	9/32" (7 mm)	R9F-22-436
3" (75 mm)	6" (152 mm)	3-3/8" (86 mm)	9/32" (7 mm)	R9F-26-436

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

R88 Spherical Hex Nuts

Bar Diameter	Across Flats	Thickness	Outside Dome	Part Number
1" (26 mm)	1-3/4" (44 mm)	2-1/4" (57 mm)	2-1/2" (64 mm)	R88-08
1-1/4" (32 mm)	2-1/4" (57 mm)	2-3/4" (70 mm)	3-1/8" (80 mm)	R88-10
1-3/8" (36 mm)	2-1/2" (64 mm)	3-1/4" (83 mm)	3-5/8" (90 mm)	R88-11
1-3/4" (46 mm)	3" (76 mm)	3-1/2" (89 mm)	4" (102 mm)	R88-14
2-1/4" * (57 mm)	3-3/4" (95 mm)	5-1/4" (133 mm)	5-1/2" (140 mm)	R73-18 R81-18
2-1/2" * (65 mm)	4-1/4" (108 mm)	5-1/2" (140 mm)	6" (152 mm)	R73-20 R81-20
3" ** (75 mm)	4-1/4" (108 mm)	7-1/2" (191 mm)	7" (178 mm)	R74-24 R81-24

* Standard Nut with Spherical Washer assembly
** Rounded Collar Nut with Spherical Washer assembly

Hex Jam Nut

Round Collar Jam Nut

Jam Nuts can not be substituted for full strength nuts. Larger diameters will be a rounded collar jam nut, with special order machined hex available.

R73/R74-JN Jam Nuts

Bar Diameter	Across Flats	OD/Across Corners	Thickness	Part Number
1" (26 mm)	1-3/4" (44 mm)	2.0" (51 mm)	0.41" (10 mm)	R73-08JN
1-1/4" * (32 mm)	1-7/8" (48 mm)	OD 2-1/8" (54 mm)	0.47" (12 mm)	R74-10JN
1-3/8" * (36 mm)	2-1/8" (54 mm)	OD 2-3/8" (60 mm)	0.53" (14 mm)	R74-11JN
1-3/4" * (46 mm)	2-3/4" (70 mm)	OD 3" (76 mm)	0.88" (22 mm)	R74-14JN
2-1/4" * (57 mm)	3-1/4" (83 mm)	OD 3-1/2" (89 mm)	0.94" (24 mm)	R74-18JN
2-1/2" * (65 mm)	4" (102 mm)	OD 4-1/4" (108 mm)	0.94" (24 mm)	R74-20JN
3" * (75 mm)	4-1/4" (108 mm)	OD 5" (127 mm)	2" (51 mm)	R74-24JN

*Round Collar Jam Nut

R8M Beveled Washers

Bar Diameter	Degree of Bevel	Outside Diameter	Inside Diameter	Maximum Thickness	Minimum Thickness	Part Number
1" (26 mm)	10°	2-27/32" (72 mm)	1-7/16" (37 mm)	7/8" (22 mm)	3/8" (10 mm)	R8M-08-10
1-1/4" (32 mm)	15°	3-3/8" (86 mm)	1-9/16" (40 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-12-15
1-3/8" (36 mm)	15°	3-1/2" (89 mm)	1-3/4" (44 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-13-15
1-3/4" (46 mm)	15°	5-1/4" (133 mm)	2-1/4" (57 mm)	1-5/8" (41 mm)	3/8" (10 mm)	R8M-16-15
2-1/4" (57 mm)	10°	6-1/2" (165 mm)	3" (76 mm)	1-7/8" (48 mm)	3/4" (19 mm)	R8M-18-10
2-1/2" (65 mm)	10°	7-1/2" (190 mm)	3-1/2" (89 mm)	2-5/16" (59 mm)	1" (25 mm)	R8M-21-10
3" (75 mm)	10°	8" (203 mm)	3-5/8" (92 mm)	2-7/16" (62 mm)	1" (25 mm)	R8M-25-10

To achieve full strength of the system, beveled washers must be used in conjunction with a hardened washer

Grade 75 & Grade 80 All-Thread Rebar

Threads

Williams All-Thread Rebar has a cold rolled, continuous, rounded course thread form. Williams special thread (deformation) pattern projects ultra high relative rib area at 3 times that of conventional rebar. This provides for superior bond performance in concrete. Because of the high thread pitch and the full 360 degree concentric thread form, Williams All-Thread Rebar should only be bent under special provisions using larger bend diameters than typical ACI minimums. As an alternative to bending, Williams recommends use of a steel plate or a threaded terminator disc to reduce development length. Threads are available in both right and left hand. Grades up to 100 are available upon request.

Sizes

All-Thread Rebar is available in 12 diameters from #6 through #32. Diameters #6 to #24 are available in continuous lengths up to 50-foot, larger diameters up to 40-foot.

Welding

Welding of All-Thread Rebar should be approached with caution since no specific provisions have been included to enhance its weldability. Refer to ANSI/AWS D1.4 for proper selections and procedures.

R61 Grade 75 & Grade 80 All-Thread Rebar

ASTM A615*

Bar Designation & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Grade 75 Minimum Yield Strength	Grade 80 Minimum Yield Strength	Nominal Weight	Approx. Thread Major Diameter	Part Number
#6 - 5 (19 mm)	0.44 in² (284 mm²)	44 kips (196 kN)	33 kips (147 kN)	35 kips (156 kN)	1.5 lbs/ft (2.4 kg/m)	7/8" (22 mm)	R61-06
#7 - 5 (22 mm)	0.60 in² (387 mm²)	60 kips (267 kN)	45 kips (200 kN)	48 kips (214 kN)	2.0 lbs/ft (3.0 kg/m)	1" (25 mm)	R61-07
#8 - 3-1/2 (25 mm)	0.79 in² (510 mm²)	79 kips (351 kN)	59 kips (264 kN)	63 kips (280 kN)	2.7 lbs/ft (3.9 kg/m)	1-1/8" (29 mm)	R61-08
#9 - 3-1/2 (29 mm)	1.00 in² (645 mm²)	100 kips (445 kN)	75 kips (334 kN)	80 kips (356 kN)	3.4 lbs/ft (5.1 kg/m)	1-1/4" (32 mm)	R61-09
#10 - 3 (32 mm)	1.27 in² (819 mm²)	127 kips (565 kN)	95 kips (424 kN)	102 kips (454 kN)	4.3 lbs/ft (6.4 kg/m)	1-3/8" (35 mm)	R61-10
#11 - 3 (36 mm)	1.56 in² (1006 mm²)	156 kips (694 kN)	117 kips (521 kN)	125 kips (556 kN)	5.3 lbs/ft (7.9 kg/m)	1-1/2" (38 mm)	R61-11
#14 - 3 (43 mm)	2.25 in² (1452 mm²)	225 kips (1001 kN)	169 kips (750 kN)	180 kips (801 kN)	7.7 lbs/ft (11.4 kg/m)	1-7/8" (48 mm)	R61-14
#18 - 3 (57 mm)	4.00 in² (2581 mm²)	400 kips (1780 kN)	300 kips (1335 kN)	320 kips (1423 kN)	13.6 lbs/ft (20.2 kg/m)	2-7/16" (62 mm)	R61-18
#20 - 2-3/4 (64 mm)	4.91 in² (3168 mm²)	491 kips (2184 kN)	368 kips (1637 kN)	393 kips (1748 kN)	16.7 lbs/ft (24.8 kg/m)	2-3/4" (70 mm)	R61-20
#24 - 2-3/4 (76 mm) *	6.82 in² (4400 mm²)	682 kips (3034 kN)	512 kips (2277 kN)	546 kips (2429 kN)	24.0 lbs/ft (35.8 kg/m)	3-3/16" (81 mm)	R61-24
#28 - 2-3/4 (89 mm) *	9.61 in² (6200 mm²)	961 kips (4274 kN)	720 kips (3206 kN)	769 kips (3421 kN)	32.7 lbs/ft (48.6 kg/m)	3-3/4" (95 mm)	R61-28
#32 - 2-3/4 (102 mm) *	12.56 in² (8103 mm²)	1256 kips (5587 kN)	942 kips (4190 kN)	1004 kips (4466 kN)	43.0 lbs/ft (64.0 kg/m)	4-1/4" (108 mm)	R61-32

* Bars size #24 and larger are not covered under ASTM A615.
#32 Bar availability may be limited. Please contact Williams for specific lead times.

All Couplings and Hex/Collar Nuts exceed 100% of the bar's published ultimate strength and couplings will meet ACI 318 Section 25.5.7.1 for mechanical rebar connections.

Hex Nut

Round Collar Nut

R62 Stop-Type Couplings

Bar Desig. & Nominal Dia.	Outside Diameter	Overall Length	Part Number
#6 - 3/4" (19 mm)	1-1/4" (32 mm)	3-1/2" (89 mm)	R62-06
#7 - 7/8" (22 mm)	1-3/8" (35 mm)	4" (102 mm)	R62-07
#8 - 1" (25 mm)	1-5/8" (41 mm)	4-1/2" (114 mm)	R62-08
#9 - 1-1/8" (29 mm)	1-7/8" (48 mm)	5" (127 mm)	R62-09
#10 - 1-1/4" (32 mm)	2" (51 mm)	5-1/2" (140 mm)	R62-10
#11 - 1-3/8" (36 mm)	2-1/4" (57 mm)	6" (152 mm)	R62-11
#14 - 1-3/4" (43 mm)	2-7/8" (73 mm)	6" (152 mm)	R62-14
#18 - 2-1/4" (57 mm)	3-1/2" (89 mm)	7-1/8" (181 mm)	R62-18
#20 - 2-1/2" (64 mm)	4" (102 mm)	8" (203 mm)	R62-20
#24 - 3" (76 mm)	5" (127 mm)	9-3/4" (248 mm)	R62-24
#28 - 3-1/2" (89 mm)	5-1/2" (140 mm)	12" (305 mm)	R62-28
#32 - 4" (102 mm)	5-3/4" (146 mm)	12-1/2" (318 mm)	R62-32

Couplings are available as tap thru upon request

R63 Hex Nuts / R64 Collar Nuts

Bar Desig. & Nominal Dia.	Across Flats	OD/Across Corners	Thickness	Part Number
#6 - 3/4" (19 mm)	1-1/4" (32 mm)	1.44" (37 mm)	1-1/8" (29 mm)	R63-06
#7 - 7/8" (22 mm)	1-7/16" (37 mm)	1.66" (42 mm)	1-1/4" (32 mm)	R63-07
#8 - 1" (25 mm)	1-5/8" (41 mm)	1.88" (48 mm)	1-3/8" (35 mm)	R63-08
#9 - 1-1/8" (29 mm)	1-7/8" (48 mm)	2.17" (55 mm)	1-1/2" (38 mm)	R63-09
#10 - 1-1/4" (32 mm)	2" (51 mm)	2.31" (59 mm)	2" (51 mm)	R63-10
#11 - 1-3/8" (36 mm)	2-1/4" (57 mm)	2.60" (66 mm)	2-1/8" (54 mm)	R63-11
#14 - 1-3/4" (43 mm)	2-3/4" (70 mm)	3.18" (81 mm)	3" (76 mm)	R63-14
#18 - 2-1/4" (57 mm)	3-3/4" (95 mm)	4.33" (110 mm)	3-3/4" (95 mm)	R63-18
#20 - 2-1/2" (64 mm)	4" (102 mm)	4.62" (117 mm)	3-3/4" (95 mm)	R63-20
#24 - 3" (76 mm) *	4-1/2" (114 mm)	OD 5" (127 mm)	4-3/8" (111 mm)	R64-24
#28 - 3-1/2" (89 mm) *	5-1/2" (140 mm)	OD 6" (152 mm)	5-1/2" (140 mm)	R64-28
#32 - 4" (102 mm) *	5-3/4" (146 mm)	OD 6.25" (159 mm)	6" (152 mm)	R64-32

* Round Collar Nut

Grade 75 & Grade 80 All-Thread Rebar

R81 Spherical Washers

Bar Desig. & Nominal Dia.	Thickness	Outside Dome	Part Number
#6 - 3/4" (19 mm)	35/64" (14 mm)	2" (51 mm)	R81-0675
#7 - 7/8" (22 mm)	39/64" (15 mm)	2-1/4" (57 mm)	R81-0775
#8 - 1" (25 mm)	5/8" (16 mm)	2-1/2" (64 mm)	R81-0875
#9 - 1-1/8" (29 mm)	3/4" (19 mm)	2-3/4" (70 mm)	R81-0975
#10 - 1-1/4" (32 mm)	53/64" (21 mm)	3" (76 mm)	R81-1075
#11 - 1-3/8" (36 mm)	29/32" (23 mm)	3-1/4" (83 mm)	R81-1175
#14 - 1-3/4" (43 mm)	1-7/64" (28 mm)	3-3/4" (95 mm)	R81-1475
#18 - 2-1/4" (57 mm)	1-13/32" (36 mm)	5" (127 mm)	R81-1875
#20 - 2-1/2" (64 mm)	1-1/2" (38 mm)	5-1/4" (133 mm)	R81-2075
#24 - 3" (76 mm)	1-7/8" (48 mm)	6-1/2" (165 mm)	R81-2475
#28 - 3-1/2" (89 mm)	1-1/2" (38 mm)	7" (178 mm)	R81-2875
#32 - 4" (102 mm)	-	-	-

Provides up to 5˚ angle when used with a dished plate.

R9F Hardened Washers

Bar Desig. & Nominal Dia.	Outside Diameter	Inside Diameter	Thickness	Part Number
#6 - 3/4" (19 mm)	1-3/4" (44 mm)	15/16" (24 mm)	5/32" (4 mm)	R9F-07-436
#7 - 7/8" (22 mm)	2" (51 mm)	1-1/16" (29 mm)	5/32" (4 mm)	R9F-08-436
#8 - 1" (25 mm)	2-1/4" (57 mm)	1-3/16" (30 mm)	5/32" (4 mm)	R9F-09-436
#9 - 1-1/8" (29 mm)	2-1/2" (64 mm)	1-3/8" (35 mm)	5/32" (4 mm)	R9F-10-436
#10 - 1-1/4" (32 mm)	2-1/2" (64 mm)	1-3/8" (35 mm)	5/32" (4 mm)	R9F-10-436
#11 - 1-3/8" (36 mm)	3" (76 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436
#14 - 1-3/4" (43 mm)	3-3/8" (86 mm)	1-7/8" (48 mm)	7/32" (6 mm)	R9F-14-436
#18 - 2-1/4" (57 mm)	4-1/2" (114 mm)	2-5/8" (67 mm)	9/32" (7 mm)	R9F-20-436
#20 - 2-1/2" (64 mm)	5" (127 mm)	2-7/8" (73 mm)	9/32" (7 mm)	R9F-22-436
#24 - 3" (76 mm)	6" (142 mm)	3-3/8" (86 mm)	9/32" (7 mm)	R9F-26-436
#28 - 3-1/2" (89 mm)	7" (178 mm)	3-7/8" (98 mm)	9/32" (7 mm)	R9F-30-436
#32 - 4" (102 mm)	7-3/4" (197 mm)	4-3/8" (111 mm)	5/16" (8 mm)	R9F-34-436

Hex Jam Nut

Round Collar Jam Nut

Jam Nuts can not be substituted for full strength nuts. Larger diameters will be a rounded collar jam nut, with special order machined hex available.

R63/R64-JN Jam Nuts

Bar Desig. & Nominal Dia.	Across Flats	OD/Across Corners	Thickness	Part Number
#6 - 3/4" (19 mm)	1-1/4" (32 mm)	1.44" (37 mm)	9/16" (14 mm)	R63-06JN
#7 - 7/8" (22 mm)	1-7/16" (37 mm)	1.66" (42 mm)	5/8" (16 mm)	R63-07JN
#8 - 1" (25 mm)	1-5/8" (41 mm)	1.88" (48 mm)	11/16" (17 mm)	R63-08JN
#9 - 1-1/8" (29 mm)	1-7/8" (48 mm)	2.17" (55 mm)	3/4" (19 mm)	R63-09JN
#10 - 1-1/4" (32 mm)	2" (51 mm)	2.31" (59 mm)	15/16" (24 mm)	R63-10JN
#11 - 1-3/8" (36 mm)	2-1/4" (57 mm)	2.60" (66 mm)	1" (25 mm)	R63-11JN
#14 - 1-3/4" (43 mm) *	2-5/8" (67 mm)	OD 2.88" (73 mm)	1-3/16" (30 mm)	R64-14JN
#18 - 2-1/4" (57 mm) *	3-1/4" (83 mm)	OD 3.5" (89 mm)	1-11/16" (43 mm)	R64-18JN
#20 - 2-1/2" (64 mm) *	3-3/4" (95 mm)	OD 4" (102 mm)	1-11/16" (43 mm)	R64-20JN
#24 - 3" (76 mm) *	4-1/2" (114 mm)	OD 5" (127 mm)	2" (51 mm)	R64-24JN
#28 - 3-1/2" (89 mm) *	5" (127 mm)	OD 5.5" (140 mm)	2-1/4" (57 mm)	R64-28JN
#32 - 4" (102 mm) *	5-3/4" (146 mm)	OD 6.25" (159 mm)	2-1/2" (64 mm)	R64-32JN

*Round Collar Jam Nut

R8M Beveled Washers

Bar Desig. & Nominal Dia.	Degree of Bevel	Outside Diameter	Inside Diameter	Maximum Thickness	Minimum Thickness	Part Number
#6 - 3/4" (19 mm)	15°	2-1/16" (52 mm)	1" (25 mm)	3/4" (19 mm)	1/4" (6 mm)	R8M-08-15
#7 - 7/8" (22 mm)	15°	2-1/16" (52 mm)	1" (25 mm)	3/4" (19 mm)	1/4" (6 mm)	R8M-08-15
#8 - 1" (25 mm)	15°	2-13/16" (71 mm)	1-5/16" (33 mm)	1" (25 mm)	5/16" (8 mm)	R8M-09-15
#9 - 1-1/8" (29 mm)	15°	2-13/16" (71 mm)	1-5/16" (33 mm)	1" (25 mm)	5/16" (8 mm)	R8M-09-15
#10 - 1-1/4" (32 mm)	15°	3-3/8" (86 mm)	1-9/16" (40 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-12-15
#11 - 1-3/8" (36 mm)	15°	3-1/2" (89 mm)	1-3/4" (44 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-13-15
#14 - 1-3/4" (43 mm)	15°	4-1/2" (114 mm)	2-1/8" (54 mm)	1-5/8" (41 mm)	15/32" (12 mm)	R8M-14-15
#18 - 2-1/4" (57 mm)	15°	5" (127 mm)	3" (76 mm)	1-5/8" (41 mm)	11/32" (9 mm)	R8M-18-15
#20 - 2-1/2" (64 mm)	10°	5-1/2" (140 mm)	3" (76 mm)	1-23/32" (44 mm)	3/4" (19 mm)	R8M-20-10
#24 - 3" (76 mm)	10°	7" (178 mm)	3-5/8" (92 mm)	2" (51 mm)	3/4" (19 mm)	R8M-24-10
#28 - 3-1/2" (89 mm)	10°	8" (203 mm)	4-1/4" (108 mm)	2-5/16" (59 mm)	7/8" (22 mm)	R8M-28-10
#32 - 4" (102 mm)	10°	9" (229 mm)	4-3/4" (121 mm)	2-19/32" (66 mm)	1" (25 mm)	R8M-32-10

To achieve full strength of the system, beveled washers must be used in conjunction with a hardened washer

Grade 100 All-Thread Rebar

Threads

Williams Grade 100 All-Thread Rebar has a cold rolled, continuous, rounded course thread form. Because of the full 360° concentric thread form, Williams All-Thread Rebar should only be bent under special provisions. Williams special thread (deformation) pattern projects ultra high relative rib area at 3 times that of conventional rebar. This provides for superior bond performance in concrete. Threads are available in both right and left hand.

R31 Grade 100 All-Thread Rebar

ASTM A615

Bar Designation Nominal Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Dia.	Part Number
#14 - 1-3/4" - 3-1/4 (43 mm)	2.25 in² (1452 mm²)	258 kips (1148 kN)	225 kips (1001 kN)	8.18 lbs/ft (12.2 kg/m)	1-7/8" (48 mm)	R31-14
#18 - 2-1/4" - 3-1/4 (57 mm)	4.00 in² (2581 mm²)	460 kips (2046 kN)	400 kips (1779 kN)	13.6 lbs/ft (19.6 kg/m)	2-3/8" (60 mm)	R31-18
#20 - 2-1/2" - 3 (64 mm)	4.91 in² (3168 mm²)	564 kips (2509 kN)	491 kips (2184 kN)	16.7 lbs/ft (24.8 kg/m)	2-5/8" (67 mm)	R31-20

Contact your Williams representative for other size availability.

Sizes

Grade 100 All-Thread Rebar is available in 3 diameters from #14 (43 mm) through #20 (64 mm). Other diameters can be provided upon special order. All diameters are available in continuous lengths up to 50' (15.2 m). Check with your local WFEC Technical Rep for information on availability and lead times.

Welding

Welding of Grade 100 All-Thread Rebar should be approached with caution since no specific provisions have been included to enhance its weldability. Refer to ANSI/AWS D1.4 for proper selections and procedures.

All Couplings and Hex Nuts exceed 100% of the bar's published ultimate strength.

R32 Stop-Type Couplings

Bar Desig. & Nominal Dia.	Outside Diameter	Thickness	Part Number
#14 - 1-3/4" (43 mm)	2-3/4" (70 mm)	6-1/2" (165 mm)	R32-14
#18 - 2-1/4" (57 mm)	3-1/2" (89 mm)	8" (203 mm)	R32-18
#20 - 2-1/2" (64 mm)	4" (102 mm)	8-1/2" (216 mm)	R32-20

R33 Hex Nuts

Bar Desig. & Nominal Dia.	Across Flats	Across Corners	Thickness	Part Number
#14 - 1-3/4" (43 mm)	2-3/4" (70 mm)	3.18" (81 mm)	3" (76 mm)	R33-14
#18 - 2-1/4" (57 mm)	3-3/4" (95 mm)	4.04" (103 mm)	3-3/4" (95 mm)	R33-18
#20 - 2-1/2" (64 mm)	4" (102 mm)	4.62" (117 mm)	3-3/4" (95 mm)	R33-20

Round Collar Jam Nut

Jam Nuts can not be substituted for full strength nuts. Standard rounded collar jam nut, with special order machined hex available.

Hardened Washers

Bar Desig. & Nominal Dia.	Outside Diameter	Inside Diameter	Thickness	Part Number
#14 - 1-3/4" (43 mm)	3-3/8" (86 mm)	1-7/8" (48 mm)	7/32" (5.6 mm)	R9F-14-436
#18 - 2-1/4" (57 mm)	4-1/2" (114 mm)	2-5/8" (67 mm)	9/32" (7.1 mm)	R9F-20-436
#20 - 2-1/2" (64 mm)	5" (127 mm)	2-7/8" (73 mm)	9/32" (7.1 mm)	R9F-22-436

R34-JN Jam Nuts

Bar Desig. & Nominal Dia.	Across Flats	Outer Diameter	Thickness	Part Number
#14 - 1-3/4" (43 mm)	2-3/4" (70 mm)	3" (76 mm)	1.44" (37 mm)	R34-14JN
#18 - 2-1/4" (57 mm)	3-1/4" (83 mm)	3-1/2" (89 mm)	1.56" (40 mm)	R34-18JN
#20 - 2-1/2" (64 mm)	3-3/4" (95 mm)	4" (102 mm)	1.75" (45 mm)	R34-20JN

Stainless Steel All-Thread Bar

Presented below are four different stainless steel options for All-Thread-Bar anchoring. Generally, the Stainless 304 B8 Class 1 and the Stainless 316 B8M Class I bars are the least expensive and most readily available of the Stainless Steels. The Stainless 304 B8 Class II bar boasts the highest strength among the Stainless Steels, while the 316 B8M Class II provides the combination of high strength and the highest level of corrosion resistance. Check with your local WFEC Technical Rep for information on availability and lead times.

Stainless Steel Threaded Bar - 304 & 316 Class 1

ASTM A193 304 B8 Class 1 & ASTM A193 316 B8M Class I

Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Part Number
1/2" - 13 (13 mm)	0.142 in² (91.6 mm²)	10.6 kips (47.3 kN)	4.26 kips (18.9 kN)	0.5 lbs/ft (0.8 kg/m)	B8U-04-S4C1 B8U-04-S6C1
5/8" - 11 (16 mm)	0.226 in² (146 mm²)	16.9 kips (75.2 kN)	6.78 kips (30.2 kN)	0.8 lbs/ft (1.3 kg/m)	B8U-05-S4C1 B8U-05-S6C1
3/4" - 10 (19 mm)	0.334 in² (216 mm²)	25.1 kips (111 kN)	10.0 kips (44.6 kN)	1.2 lbs/ft (1.8 kg/m)	B8U-06-S4C1 B8U-06-S6C1
1" - 8 (25 mm)	0.606 in² (391 mm²)	45.5 kips (202 kN)	18.2 kips (80.9 kN)	2.1 lbs/ft (3.2 kg/m)	B8U-08-S4C1 B8U-08-S6C1
1-1/4" - 7 (32 mm)	0.969 in² (625 mm²)	72.7 kips (323 kN)	29.1 kips (129 kN)	3.4 lbs/ft (5.0 kg/m)	B8U-10-S4C1 B8U-10-S6C1
1-1/2" - 6 (38 mm)	1.41 in² (906 mm²)	105 kips (469 kN)	42.2 kips (188 kN)	5.1 lbs/ft (7.5 kg/m)	B8U-12-S4C1 B8U-12-S6C1

Structural Properties

Diameter Range	Yield Stress	Ultimate Stress	Elongation in 4 Bar Diameters	Reduction of Area
All Diameters	30 KSI (207 MPa)	75 KSI (517 MPa)	30% min.	50% min.

Stainless Steel Threaded Bar - 304 Class 2

ASTM A193 304 B8 Class II

Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Part Number
1/2" - 13 (13 mm)	0.142 in² (91.6 mm²)	17.7 kips (78.9 kN)	14.2 kips (63.1 kN)	0.5 lbs/ft (0.8 kg/m)	B8U-04-S4C2
5/8" - 11 (16 mm)	0.226 in² (146 mm²)	28.2 kips (126 kN)	22.6 kips (101 kN)	0.8 lbs/ft (1.3 kg/m)	B8U-05-S4C2
3/4" - 10 (19 mm)	0.334 in² (216 mm²)	41.8 kips (186 kN)	33.4 kips (149 kN)	1.2 lbs/ft (1.8 kg/m)	B8U-06-S4C2
1" - 8 (25 mm)	0.606 in² (391 mm²)	69.7 kips (310 kN)	48.5 kips (216 kN)	2.1 lbs/ft (3.2 kg/m)	B8U-08-S4C2
1-1/4" - 7 (32 mm)	0.969 in² (625 mm²)	102 kips (453 kN)	63.0 kips (280 kN)	3.4 lbs/ft (5.0 kg/m)	B8U-10-S4C2
1-1/2" - 6 (38 mm)	1.41 in² (906 mm²)	141 kips (625 kN)	70.2 kips (312 kN)	5.1 lbs/ft (7.5 kg/m)	B8U-12-S4C2

Structural Properties

Diameter Range	Yield Stress	Ultimate Stress	Elongation in 4 Bar Diameters	Reduction of Area
Up to 3/4" (to 19 mm)	100 KSI (690 MPa)	125 KSI (862 MPa)	12% min.	35% min.
1" (25 mm)	80 KSI (552 MPa)	115 KSI (793 MPa)	15% min.	35% min.
1-1/4" (32 mm)	65 KSI (448 MPa)	105 KSI (724 MPa)	20% min.	35% min.
1-1/2" (38 mm)	50 KSI (375 MPa)	100 KSI (670 MPa)	28% min.	45% min.

Stainless Steel Threaded Bar - 316 Class 2

ASTM A193 316 B8M Class II

Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Part Number
1/2" - 13 (13 mm)	0.142 in² (91.6 mm²)	15.6 kips (69.4 kN)	13.6 kips (60.6 kN)	0.5 lbs/ft (0.8 kg/m)	B8U-04-S6C2
5/8" - 11 (16 mm)	0.226 in² (146 mm²)	24.9 kips (110 kN)	21.7 kips (96.5 kN)	0.8 lbs/ft (1.3 kg/m)	B8U-05-S6C2
3/4" - 10 (19 mm)	0.334 in² (216 mm²)	36.7 kips (163 kN)	32.1 kips (143 kN)	1.2 lbs/ft (1.8 kg/m)	B8U-06-S6C2
1" - 8 (25 mm)	0.606 in² (391 mm²)	60.6 kips (269 kN)	48.5 kips (216 kN)	2.1 lbs/ft (3.2 kg/m)	B8U-08-S6C2
1-1/4" - 7 (32 mm)	0.969 in² (625 mm²)	92.0 kips (409 kN)	63.0 kips (280 kN)	3.4 lbs/ft (5.0 kg/m)	B8U-10-S6C2
1-1/2" - 6 (38 mm)	1.41 in² (906 mm²)	126 kips (562 kN)	70.2 kips (312 kN)	5.1 lbs/ft (7.5 kg/m)	B8U-12-S6C2

Structural Properties

Diameter Range	Yield Stress	Ultimate Stress	Elongation in 4 Bar Diameters	Reduction of Area
Up to 3/4" (to 19 mm)	96 KSI (662 MPa)	110 KSI (759 MPa)	15% min.	45% min.
1" (25 mm)	80 KSI (552 MPa)	100 KSI (670 MPa)	20% min.	45% min.
1-1/4" (32 mm)	65 KSI (448 MPa)	95 KSI (655 MPa)	25% min.	45% min.
1-1/2" (38 mm)	50 KSI (375 MPa)	90 KSI (621 MPa)	30% min.	45% min.

UNC Threaded Bars

R6J Grade 60 Solid Rebar

Our R6J Grade 60 Rebar is most often used in resin bolting or for anchor dowels. Depending on the application it may be more economical than Williams R61 Grade 75 All-Thread Rebar, however, the installer does not have the flexibility of a continuous workable thread. Williams offers threaded end rebar in the following sizes.

R6J Grade 60 Solid Rebar

ASTM 615

Bar Designation Nominal Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Dia.	Part Number
#4 - 1/2" - 13 UNC (13 mm)	0.142 in² (91.6 mm²)	11.3 kips (50.5 kN)	8.52 kips (37.9 kN)	0.67 lbs/ft (1.0 kg/m)	1/2" (13 mm)	R6J-04
#5 - 5/8" - 11 UNC (16 mm)	0.226 in² (146 mm²)	18.1 kips (80.4 kN)	13.6 kips (60.3 kN)	1.0 lbs/ft (1.6 kg/m)	5/8" (16 mm)	R6J-05
#6 - 3/4" - 10 UNC (19 mm)	0.334 in² (216 mm²)	26.7 kips (119 kN)	20.0 kips (89.1 kN)	1.5 lbs/ft (2.2 kg/m)	3/4" (19 mm)	R6J-06
#7 - 7/8" - 9 UNC (22 mm)	0.462 in² (298 mm²)	37.0 kips (164 kN)	27.7 kips (123 kN)	2.0 lbs/ft (3.0 kg/m)	7/8" (22 mm)	R6J-07
#8 - 1" - 8 UNC (25 mm)	0.606 in² (391 mm²)	48.5 kips (216 kN)	36.4 kips (162 kN)	2.7 lbs/ft (4.0 kg/m)	1" (25 mm)	R6J-08
#9 - 1-1/8" - 7 UNC (29 mm)	0.763 in² (492 mm²)	61.0 kips (271 kN)	45.8 kips (200 kN)	3.4 lbs/ft (5.1 kg/m)	1-1/8" (29 mm)	R6J-09
#10 - 1-1/4" - 7 UNC (32 mm)	0.969 in² (625 mm²)	77.5 kips (345 kN)	58.1 kips (259 kN)	4.3 lbs/ft (6.4 kg/m)	1-1/4" (32 mm)	R6J-10
#11 - 1-3/8" - 8 UN (36 mm)	1.23 in² (794 mm²)	98.6 kips (439 kN)	73.8 kips (328 kN)	5.3 lbs/ft (7.9 kg/m)	1-3/8" (34.9 mm)	R6J-11
#14 - 1-3/4" - 5 UNC (43 mm) *	1.90 in² (1226 mm²)	149 kips (663 kN)	110 kips (489 kN)	7.7 lbs/ft (11.4 kg/m)	1-3/4" (45 mm)	R6J-14
#18 - 2-1/4"- 4-1/2 UNC (57 mm) *	3.25 in² (2097 mm²)	255 kips (1134 kN)	189 kips (841 kN)	13.6 lbs/ft (20.2 kg/m)	2-1/4" (57 mm)	R6J-18

* The #14 and #18 diameters are made from 400W rebar from Canada.

B8V Grade B7 High Impact Bar

Williams ground anchors can be specified using our high impact Grade B7 material. This product may be desireable in extremely cold temperatures or where rock fall may impact the anchor head. The following diameters are available.

B8V Grade B7 High Impact Bar

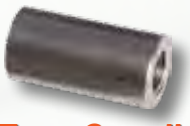
ASTM A193

Bar Diameter & Pitch	Minimum Net Area Thru Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Dia.	Part Number
3/8" - 16 UNC (9.5 mm)	0.078 in² (50.2 mm²)	9.69 kips (43.1 kN)	8.14 kips (36.2 kN)	0.29 lbs/ft (0.4 kg/m)	3/8" (9.5 mm)	B8V-03
1/2" - 13 UNC (12 mm)	0.142 in² (91.6 mm²)	17.8 kips (79.0 kN)	14.9 kips (66.3 kN)	0.53 lbs/ft (0.8 kg/m)	1/2" (13 mm)	B8V-04
5/8" - 11 UNC (16 mm)	0.226 in² (146 mm²)	28.3 kips (126 kN)	23.7 kips (106 kN)	0.84 lbs/ft (1.3 kg/m)	5/8" (16 mm)	B8V-05
3/4" - 10 UNC (20 mm)	0.334 in² (215 mm²)	41.8 kips (186 kN)	35.0 kips (156 kN)	1.2 lbs/ft (1.8 kg/m)	3/4" (19 mm)	B8V-06
7/8" - 9 UNC (22 mm)	0.462 in² (298 mm²)	57.8 kips (257 kN)	48.5 kips (216 kN)	1.7 lbs/ft (2.5 kg/m)	7/8" (22 mm)	B8V-07
1" - 8 UNC (25 mm)	0.606 in² (391 mm²)	75.8 kips (337 kN)	63.6 kips (283 kN)	2.1 lbs/ft (3.2 kg/m)	1" (25 mm)	B8V-08
1-1/8" - 7 UNC (29 mm)	0.763 in² (492 mm²)	95.4 kips (424 kN)	80.1 kips (356 kN)	2.7 lbs/ft (4.0 kg/m)	1-1/8" (29 mm)	B8V-09
1-1/4" - 7 UNC (32 mm)	0.969 in² (625 mm²)	121 kips (539 kN)	102 kips (453 kN)	3.4 lbs/ft (5.1 kg/m)	1-1/4" (32 mm)	B8V-10
1-3/8" - 8 UN (35 mm)	1.23 in² (794 mm²)	154 kips (684 kN)	129 kips (575 kN)	4.2 lbs/ft (6.2 kg/m)	1-3/8" (35 mm)	B8V-11
1-1/2" - 6 UNC (38 mm)	1.41 in² (909 mm²)	176 kips (784 kN)	148 kips (658 kN)	5.1 lbs/ft (7.5 kg/m)	1-1/2" (38 mm)	B8V-12
1-3/4" - 5 UNC (45 mm)	1.90 in² (1226 mm²)	238 kips (1056 kN)	200 kips (887 kN)	6.5 lbs/ft (9.6 kg/m)	1-3/4" (45 mm)	B8V-14
2" - 6 UN (51 mm)	2.65 in² (1710 mm²)	331 kips (1473 kN)	278 kips (1237 kN)	9.0 lbs/ft (13.4 kg/m)	2" (51 mm)	B8V-16

UNC Threaded Accessories

H1F Heavy Duty Hex Nuts

Bar Diameter	Across Flats	Across Corners	Thickness	Part Number
3/8" (9.5 mm)	11/16" (18 mm)	0.79" (20 mm)	23/64" (9 mm)	H1FN-03
1/2" (13 mm)	7/8" (22 mm)	1.0" (26 mm)	31/64" (12 mm)	H1FN-04
5/8" (16 mm)	1-1/16" (27 mm)	1.2" (31 mm)	39/64" (16 mm)	H1FN-05
3/4" (19 mm)	1-1/4" (32 mm)	1.4" (37 mm)	47/64" (19 mm)	H1FN-06
7/8" (22 mm)	1-7/16" (36.6 mm)	1.7" (42 mm)	55/64" (22 mm)	H1FN-07
1" (25 mm)	1-5/8" (41 mm)	1.9" (48 mm)	63/64" (25 mm)	H1FN-08
1-1/8" (29 mm)	1-13/16" (46 mm)	2.1" (53 mm)	1-7/64" (28 mm)	H1FN-09
1-1/4" (32 mm)	2" (51 mm)	2.3" (59 mm)	1-7/32" (31 mm)	H1FN-10
1-3/8" (36 mm)	2-3/16" (56 mm)	2.5" (64 mm)	1-11/32" (34 mm)	H1FU-11
1-1/2" (38 mm)	2-3/8" (60 mm)	2.7" (70 mm)	1-15/32" (37 mm)	H1FN-12
1-3/4" (43 mm)	2-3/4" (70 mm)	3.2" (81 mm)	1-23/32" (44 mm)	H1FN-14
1-7/8" (48 mm)	2-15/16" (75 mm)	3.4" (86 mm)	1-27/32" (47 mm)	H1FU-15
2" (51 mm)	3-1/8" (79 mm)	3.6" (92 mm)	1-31/32" (50 mm)	H1FU-16
2-1/4" (57 mm)	3-1/2" (89 mm)	4.0" (103 mm)	2-1/4" (57 mm)	H1FN-18



C2T & C2V Stop-Type Couplings

Bar Diameter	Outside Diameter	Overall Length	Standard Part Number	Grade B7 Part Number
3/8" (9.5 mm)	3/4" (19 mm)	1-1/2" (38 mm)	C2TN-03	C2VN-03
1/2" (13 mm)	3/4" (19 mm)	1-1/2" (38 mm)	C2TN-04	C2VN-04
5/8" (16 mm)	1" (25 mm)	1-3/4" (45 mm)	C2TN-05	C2VN-05
3/4" (19 mm)	1-1/8" (29 mm)	2" (51 mm)	C2TN-06	C2VN-06
7/8" (22 mm)	1-1/4" (32 mm)	2-1/4" (57 mm)	C2TN-07	C2VN-07
1" (25 mm)	1-1/2" (38.1 mm)	3" (76 mm)	C2TN-08	C2VN-08
1-1/8" (29 mm)	1-5/8" (41 mm)	3-1/2" (89 mm)	C2TN-09	C2VN-09
1-1/4" (32 mm)	1-7/8" (48 mm)	3-3/4" (95 mm)	C2TN-10	C2VN-10
1-3/8" (35 mm)	2-1/8" (54 mm)	4" (102 mm)	C2TU-11	C2VU-11
1-1/2" (38 mm)	2-1/4" (57 mm)	5" (127 mm)	C2TN-12	C2VN-12
1-3/4" (45 mm)	2-1/2" (64 mm)	5-1/2" (140 mm)	C2TN-14	C2VN-14
1-7/8" (48 mm)	2-7/8" (73 mm)	6" (152 mm)	C2TU-15	C2VU-15
2" (51 mm)	3" (76 mm)	6" (152 mm)	C2TU-16	C2VU-16
2-1/4" (57 mm)	3-1/2" (89 mm)	8" (203 mm)	C2TN-18	C2VN-18

Note: C2V couplers must be used when coupling Grade B7 bars to develop full strength and maintain impact properties.

R9F Hardened Washers

Bar Diameter	Outside Diameter	Inside Diameter	Thickness	Part Number
3/8" (9.5 mm)	1" (25 mm)	7/16" (11 mm)	5/64" (2 mm)	R9F-03-436
1/2" (13 mm)	1-1/16" (27 mm)	17/32" (14 mm)	9/64" (3.6 mm)	R9F-04-436
5/8" (16 mm)	1-5/16" (33 mm)	11/16" (17 mm)	9/64" (3.6 mm)	R9F-05-436
3/4" (19 mm)	1-7/16" (37 mm)	13/16" (21 mm)	9/64" (3.6 mm)	R9F-06-436
7/8" (22 mm)	1-3/4" (45 mm)	15/16" (24 mm)	5/32" (4 mm)	R9F-07-436
1" (25 mm)	2" (51 mm)	1-1/16" (29 mm)	5/32" (4 mm)	R9F-08-436
1-1/8" (29 mm)	2-1/4" (57 mm)	1-3/16" (30 mm)	5/32" (4 mm)	R9F-09-436
1-1/4" (32 mm)	2-1/2" (64 mm)	1-3/8" (35 mm)	5/32" (4 mm)	R9F-10-436
1-3/8" (36 mm)	2-3/4" (70 mm)	1-1/2" (38 mm)	5/32" (4 mm)	R9F-11-436
1-1/2" (38 mm)	3" (76 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436
1-3/4" (43 mm)	3-3/8" (86 mm)	1-7/8" (48 mm)	7/32" (6 mm)	R9F-14-436
1-7/8" (48 mm)	3-3/4" (95 mm)	2-1/8" (54 mm)	7/32" (6 mm)	R9F-16-436
2" (51 mm)	3-3/4" (95 mm)	2-1/8" (54 mm)	7/32" (6 mm)	R9F-16-436
2-1/4" (57 mm)	4" (102 mm)	2-3/8" (60 mm)	9/32" (7 mm)	R9F-18-436

R8M Beveled Washers

Bar Diameter	Degree of Bevel	Outside Diameter	Inside Diameter	Maximum Thickness	Minimum Thickness	Part Number
3/8" (9.5 mm)	14°	1-1/4" (32 mm)	9/16" (14 mm)	7/16" (11 mm)	1/8" (3 mm)	R8M-03-14
1/2" (13 mm)	14°	1-1/4" (32 mm)	9/16" (14 mm)	7/16" (11 mm)	1/8" (3 mm)	R8M-04-14
5/8" (16 mm)	11°	1-9/16" (40 mm)	13/16" (21 mm)	1/2" (13 mm)	3/16" (5 mm)	R8M-06-11
3/4" (19 mm)	11°	1-9/16" (40 mm)	13/16" (21 mm)	1/2" (13 mm)	3/16" (5 mm)	R8M-06-11
7/8" (22 mm)	15°	2-1/16" (52 mm)	1" (25 mm)	3/4" (19 mm)	1/4" (6 mm)	R8M-08-15
1" (25 mm)	15°	2-1/16" (52 mm)	1" (25 mm)	3/4" (19 mm)	1/4" (6 mm)	R8M-08-15
1-1/8" (29 mm)	15°	2-13/16" (71 mm)	1-5/16" (33 mm)	1" (25 mm)	5/16" (8 mm)	R8M-09-15
1-1/4" (32 mm)	15°	3-3/8" (86 mm)	1-9/16" (40 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-12-15
1-3/8" (36 mm)	15°	3-3/8" (86 mm)	1-9/16" (40 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-12-15
1-1/2" (38 mm)	15°	3-1/2" (89 mm)	1-3/4" (45 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-13-15
1-3/4" (43 mm)	5°	3-9/16" (91 mm)	2-1/16" (52 mm)	13/16" (21 mm)	1/2" (13 mm)	R8M-16-5
1-7/8" (48 mm)	5°	3-9/16" (91 mm)	2-1/16" (52 mm)	13/16" (21 mm)	1/2" (13 mm)	R8M-16-5
2" (51 mm)	5°	3-9/16" (91 mm)	2-1/16" (52 mm)	13/16" (21 mm)	1/2" (13 mm)	R8M-16-5
2-1/4" (57 mm)	-	-	-	-	-	-

To achieve full strength of the system, beveled washers must be used in conjunction with a hardened washer.

Geo-Drill Injection Anchor System

The Williams Geo-Drill Injection Anchor System is today's solution for a fast and efficient anchoring system into virtually any type of soil. The system has historically been known as a "self-drilling anchoring" because the hollow fully-threaded bar serves as both the drill string and the grouted anchor, thus installation is performed in a single operation. The sacrificial drill bit is threaded onto the end of the Hollow Injection Bar and left in place following drilling. The drilling fluid (air, water, or grout) is introduced through the hollow bar and allows the spoils to flush from the borehole.

The Geo-Drill System is particularly suitable for soils that do not allow for open-hole drilling (i.e. granular soils that are collapsible in nature). In such cases, drilling with a grout fluid serves the purpose of flushing spoils from the borehole and prevents looser, surrounding material from collapsing due to the higher relative density of the grout. Williams Geo-Drill Injection Anchor System should be considered on any project requiring fast production that would otherwise need to involve a casing system in order to maintain borehole stability.

Advantages of the Williams Geo-Drill Injection Anchor System

- Fast, single-step anchoring system with simple equipment.
- Eliminates the need for a cased borehole in collapsing soils.
- Efficient installation since drilling and grouting can be performed in a single operation, saving both time and money.
- Continuously drilling and grouting under high pressure causes the grout to permeate into looser soils and creates a bulb-effect for increased bond capacity.
- Suitable for working in limited space and areas of difficult access.
- Multiple ranges of drill bits suitable for most soil conditions.
- Installed with standard track drill (top hammer) or compact hollow bar drilling heads, eliminating the need for larger casing rigs.
- Continuously threaded bar pattern can be cut and coupled anywhere along its length.
- Domestic available in 10' or 20' lengths, non-domestic available in 3 meter lengths only.
- Corrosion protection systems available upon request.
- FHWA approved for use as a micropile or soil nail (Domestic Hollow Injection Bar only)

B7X1 Domestic Hollow Injection Bar

Bar Diameter	Average Inner Diameter	Minimum Net Area Through Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Part Number
32 mm (1-1/4")	0.787" (20.0 mm)	0.556 in² (359 mm²)	58.4 kips (260 kN)	47.2 kips (210 kN)	2.1 lbs/ft (3.1 kg/m)	B7X1-032N
32S mm (1-1/4")	0.626" (15.9 mm)	0.776 in² (501 mm²)	81.5 kips (363 kN)	66.0 kips (294 kN)	2.7 lbs/ft (4.0 kg/m)	B7X1-032S
38 mm (1-1/2")	0.830" (21.1 mm)	1.067 in² (688 mm²)	112 kips (498 kN)	90.7 kips (404 kN)	3.76 lbs/ft (5.6 kg/m)	B7X1-038N
51 mm (2")	1.187" (30.1 mm)	1.795 in² (1158 mm²)	188 kips (837 kN)	152 kips (677 kN)	6.26 lbs/ft (9.3 kg/m)	B7X1-051N
76 mm (3")	1.890" (48.0 mm)	3.880 in² (2503 mm²)	407 kips (1811 kN)	329 kips (1466 kN)	13.79 lbs/ft (20.5 kg/m)	B7X1-076N

B7Y1 Non-Domestic Hollow Injection Bar

Bar Designation & Outer Diameter	Average Inner Diameter	Minimum Net Area Through Threads	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Part Number
T30S - 30 mm (1.18")	11 mm (0.43")	0.662 in² (427 mm²)	71.9 kips (320 kN)	58.5 kips (260 kN)	2.42 lbs/ft (3.6 kg/M)	B7Y1-030S
T40N - 40 mm (1.57")	20 mm (0.79")	1.046 in² (675 mm²)	121 kips (539 kN)	96.7 kips (430 kN)	4.23 lbs/ft (6.3 kg/M)	B7Y1-040N
T40S - 40 mm (1.57")	16 mm (0.63")	1.222 in² (788 mm²)	148 kips (660 kN)	118 kips (525 kN)	4.84 lbs/ft (7.2 kg/M)	B7Y1-040S
T52N - 52 mm (2.05")	24 mm (0.94")	1.874 in² (1209 mm²)	209 kips (929 kN)	164 kips (730 kN)	6.92 lbs/ft (10.3 kg/M)	B7Y1-052N
* T64 - 64 mm (2.52")	40 mm (1.57")	2.4 in² (1548 mm²)	261 kips (1160 kN)	209 kips (930 kN)	8.74 lbs/ft (13 kg/M)	B7Y1-064N
* T73N - 73 mm (2.87")	53 mm (2.08")	2.5 in² (1615 mm²)	260 kips (1160 kN)	218 kips (970 kN)	8.9 lbs/ft (13.2 kg/M)	B7Y1-073N *
T76S - 76 mm (2.99")	45 mm (1.77")	3.891 in² (2510 mm²)	427 kips (1900 kN)	337 kips (1500 kN)	13.23 lbs/ft (19.7 kg/M)	B7Y1-076S
* T103N - 103 mm (4.06")	78 mm (3.07")	4.87 in² (3140 mm²)	510 kips (2270 kN)	405 kips (1800 kN)	17.0 lbs/ft (25.3 kg/M)	B7Y1-103N *
* T130N - 130 mm (5.12")	60 mm (2.36")	16.2 in² (10452 mm²)	1785 kips (7940 kN)	1180 kips (5250 kN)	50.4 lbs/ft (78 kg/M)	B7Y1-130N *

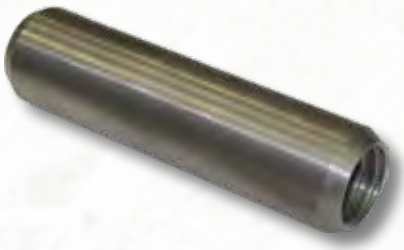
* Diameter available on special order. Contact your Williams representative for fastener and drill bit information.

Accessories

Thread Profile of Domestic Bar

The Domestic Hollow Injection Bar is a high strength, impact resistant heavy wall steel tubing continuously threaded over its entire length with a heavy duty left hand thread/deformation pattern. The thread form (similar for all diameters) is a unique Williams feature that provides a lower thread pitch angle to provide easier coupling disengagement without "locking up", versus conventional rope threads during drilling operations. This thread form provides more surface area and thread/deformations per unit length for superior bond capabilities over that of competitive drill steel thread forms. The Geo-Drill Injection Anchor system is available with enhanced corrosion protection with hot-dip galvanized/epoxy coated bars and components. Installation adapters for the Geo-Drill Injection Anchors are available for all drill rigs.

Couplings



The Domestic Hollow Injection Bar Couplings have a unique tapered center stop which seals the Injection Bar connection to minimize grout leakage during simultaneous grouting and drilling operations. The internal stop design also assures a full positive thread connection in both Injection Bar ends while providing a matching end bearing between bars that reduces percussion energy loss to the drill bit. The couplings provide 100% ultimate tensile or compression strength capacity of the installed anchorage. The coupling OD is tapered on both ends to allow drill cuttings and grout displacement during drilling while the ID has internal chamfers to assist alignment and connection of the bars. The Non-Domestic Hollow Injection Bar Couplings do not contain a tapered center stop, but instead have an o-ring gasket to minimize grout leakage.

Bar	Outside Diameter	Overall Length	Part Number
32 mm	1-5/8" (41 mm)	6-1/4" (159 mm)	B7X2-032
38 mm	2" (51 mm)	7-5/8" (194 mm)	B7X2-038
51 mm	2-5/8" (67 mm)	8-1/2" (216 mm)	B7X2-051
76 mm	3-7/8" (98 mm)	9-7/8" (251 mm)	B7X2-076
T30	1-1/2" (38 mm)	4-1/8" (105 mm)	B7Y2-030
T40	2-1/8" (54 mm)	5-1/2" (140 mm)	B7Y2-040
T52	2-3/4" (70 mm)	6-1/4" (159 mm)	B7Y2-052
T64	3.15" (80 mm)	7.09" (180 mm)	B7Y2-064
T76	3-3/4" (95 mm)	8-5/8" (219 mm)	B7Y2-076

Hex Nuts

The Hex Nuts designed exclusively for the Geo-Drill Injection Anchor system are a full 100% ultimate tension or compression strength component.

Nominal Bar Diameter	Across Flats	Across Corners	Thickness	Part Number
32 mm (1-1/4")	1-3/4" (45 mm)	2.0" (51 mm)	1-3/4" (44 mm)	B7X3-032
38 mm (1-1/2")	2" (51 mm)	2.3" (59 mm)	2" (51 mm)	B7X3-038
51 mm (2")	3" (76 mm)	3.5" (89 mm)	3-1/2" (89 mm)	B7X3-051
76 mm (3")	4-1/4" (108 mm)	4.9" (125 mm)	3-3/4" (95 mm)	B7X3-076
T30	1-7/8" (46 mm)	2.2" (59 mm)	1-3/8" (35 mm)	B7Y3-030
T40	2-1/2" (65 mm)	2.9" (73 mm)	2" (51 mm)	B7Y3-040
T52	3-1/8" (80 mm)	3.6" (92 mm)	2-3/4" (70 mm)	B7Y3-052
T64	3.35" (85 mm)	3.9" (99 mm)	2.76" (70 mm)	B7Y3-064
T76	4" (102 mm)	4.6" (117 mm)	3-1/8" (80 mm)	B7Y3-076

R8M Beveled Washers

Bar	Degree of Bevel	Outside Diameter	Inside Diameter	Maximum Thickness	Minimum Thickness	Part Number
32 mm & T30	15°	2-13/16" (71 mm)	1-5/16" (33 mm)	1" (25 mm)	5/16" (8 mm)	R8M-09-15
38 mm	15°	3-3/8" (86 mm)	1-3/4" (44 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-38-15
T40	15°	3-1/2" (89 mm)	1-3/4" (44 mm)	1-1/4" (32 mm)	3/8" (10 mm)	R8M-13-15
51 mm & T52	15°	5-1/4" (133 mm)	2-1/4" (57 mm)	1-5/8" (41 mm)	3/8" (10 mm)	R8M-16-15
T64	10°	5-1/2" (140 mm)	3" (76 mm)	1-23/32" (44 mm)	3/4" (19 mm)	R8M-20-10
76 mm & T76	15°	6" (152 mm)	3-1/2" (89 mm)	2-7/64" (54 mm)	1/2" (13 mm)	R8M-76-15

To achieve full strength of the system, beveled washers must be used in conjunction with a hardened washer

R9F Hardened Washers

Bar	Outside Diameter	Inside Diameter	Thickness	Part Number
32 mm & T30	2-1/2" (64 mm)	1-3/8" (35 mm)	5/32" (4 mm)	R9F-10-436
38 mm & T40	3" (76 mm)	1-5/8" (41 mm)	5/32" (4 mm)	R9F-12-436
51 mm & T52	3-3/4" (95 mm)	2-1/8" (54 mm)	7/32" (6 mm)	R9F-16-436
T64	4-1/2" (114 mm)	2-5/8" (67 mm)	9/32" (7 mm)	R9F-20-436
76 mm & T76	5-1/2" (140 mm)	3-1/8" (80 mm)	9/32" (7 mm)	R9F-24-436

B7XC Centralizers

The bar can be centralized in the drill hole on 10' centers by attaching a steel centralizer in front of the coupling during the drilling operation. Available plain or hot dip galvanized to ASTM A123. State drill hole diameter and bar size when ordering.

Accessories

B7XB Drill Bits

HC Hardened Bit
Hardened cross cut drill bit, suitable for the majority of applications including narrow bands of soft rock.
Soil Types: Fills and Medium Dense Gravels

CC Carbide Bit
Tungsten carbide cross-cut drill bit. Excellent choice for majority of granular soils with mixed hard formations.
Soil Types: Fills, Gravels, Shale & Seamy Rock Formations

SB Sand/Clay Bit
Two stage cross cut drill bit, suitable for loose to medium dense ground and fills.
Soil Types: Sand, Clay and Light Gravels

BB Button Bit
Tungsten carbide hemispherical button drill bit for moderately strong to strong rock, boulders and rubble.
Rock Types: Mudstone, Limestone, and Granite

CB Cobble Bit
Offset face cross cut drill bit suitable for drilling in cobbles with silt and gravel as well as sedimentary bedrock material.

Bit Adapters
Williams offers Bit Adapters for the Geo-Drill Anchor system to transition from a lager bar to a bit that is tapped for a different size bar.

Nominal Bar Diameter	Available Drill Bit Diameters				
	HC	CC	SB	BB	CB
32 mm (1-1/4")	2" (51 mm)	2" (51 mm)	5" (127 mm)	2-1/2" (65 mm)	4" (102 mm)
	2-1/2" (65 mm)	2-1/2" (65 mm)		3" (76 mm)	
	3" (76 mm)	3" (76 mm)		3-1/2" (89 mm)	
	3-1/2" (89 mm)	3-1/2" (89 mm)		4" (102 mm)	
	4" (102 mm)	4" (102 mm)			
38 mm (1-1/2") T30 T40	2-1/2" (65 mm)	2-1/2" (65 mm)	5" (127 mm)	2-1/2" (65 mm)	4" (102 mm)
	3" (76 mm)	3" (76 mm)		3" (76 mm)	
	3-1/2" (89 mm)	3-1/2" (89 mm)		3-1/2" (89 mm)	
	4" (102 mm)	4" (102 mm)	6" (152 mm)	4" (102 mm)	
	4-1/2" (114 mm)	5" (127 mm)		5" (127 mm)	
51 mm (2")	-	3" (76 mm)	6" (152 mm)	3" (76 mm)	4-3/4" (121 mm)
		3-1/2" (90 mm)		3-1/2" (90 mm)	
		4" (102 mm)			
		4-1/2" (114 mm)	8" (203 mm)	4" (102 mm)	6" (152 mm)
		5" (127 mm)		5" (127 mm)	
		6" (152 mm)			
T52	-	4" (102 mm)	7" (178 mm)	-	-
T64 76 mm (3") T76	-	5" (125 mm)	7" (178 mm)	5" (125 mm)	-
		6" (152 mm)			
		7" (175 mm)	10" (254 mm)	6" (152 mm)	
		8" (203 mm)			

Applications

Soil Nails

Soil Nails are non-tensioned, in-situ reinforcement for the stability of excavations and embankments in top-down construction. The Williams Geo-Drill Injection Anchor System is an ideal choice for soil nailing in difficult soils as it offers high installation rates. Hollow bar soil nails have been used extensively on private and select DOT permanent soil nail walls for years. With the 2015 edition of the *FHWA Geotechnical Engineering Circular #7*, hollow bar soil nails are specifically addressed and allowed for use in non-corrosive ground conditions. Consult your Williams' Technical Representative for more information.

Micropiles

Williams Hollow Injection Bar offer an excellent choice for micropiles in difficult ground conditions where open-hole drilling isn't possible. The continuously threaded bar profile lends itself perfectly for restricted headroom applications because the bar can be cut and coupled at any length. The FHWA has approved hollow bar anchors for permanent use in micropile applications.

Prestressed Ground Anchors

Williams Geo-Drill Injection Anchors can be used as a choice for pre-tensioned anchors in loose or collapsing soils without the need for a casing. A free length must be installed onto the anchor if the project specifications call for a pre-tension load to be applied from the bond length. Please consult with a Williams specialist for suggestions to properly attach a free length sleeve. Note to Designer: Consult with Williams for an appropriate level of corrosion protection if prestressed ground anchors are intended to be used for a permanent application.

Tunnel Spiles and Forepoling

The Geo-Drill Injection Anchor System is often used for spiling in NATM tunneling. Spiles are continuously drilled and grouted pre-support reinforcement to enable the heading of a tunnel to advance without the risk of falling debris. The anchors can also be used as face stabilization of portals.

Limitations of System

In general, Williams recommends using the Geo-Drill Injection Anchor System in difficult soils that do not allow for open-hole drilling. Ground conditions featuring large voids or the presence of an artesian water condition are generally not suitable for a drilled and grouted hollow bar. In hard rock, conventional DTH (Down the Hole Hammers) in open-hole drilling offer a more efficient alternative. In all such cases, Williams offers solutions in their complete line of solid bar anchor systems and multi-strand tendon systems.

Project Photos

Project: SunZia Transmission
Contractor: Crux Subsurface.
Location: Arizona & New Mexico

Project: Private Residence
Contractor: GeoStabilization International
Location: Colorado

Project: Wastewater Treatment Plant
Contractor: Spartan Specialties
Location: Muskegon, MI

Project: National War Memorial Park
Contractor: Ancor Loc New Zealand
Location: Wellington, New Zealand

Project: Telluride Airport
Contractor: Mays Construction Specialties
Location: Telluride, CO

Project: Seward Highway Rehabilitation
Contractor: Southeast Roadbuilders
Location: Moose Pass, AK

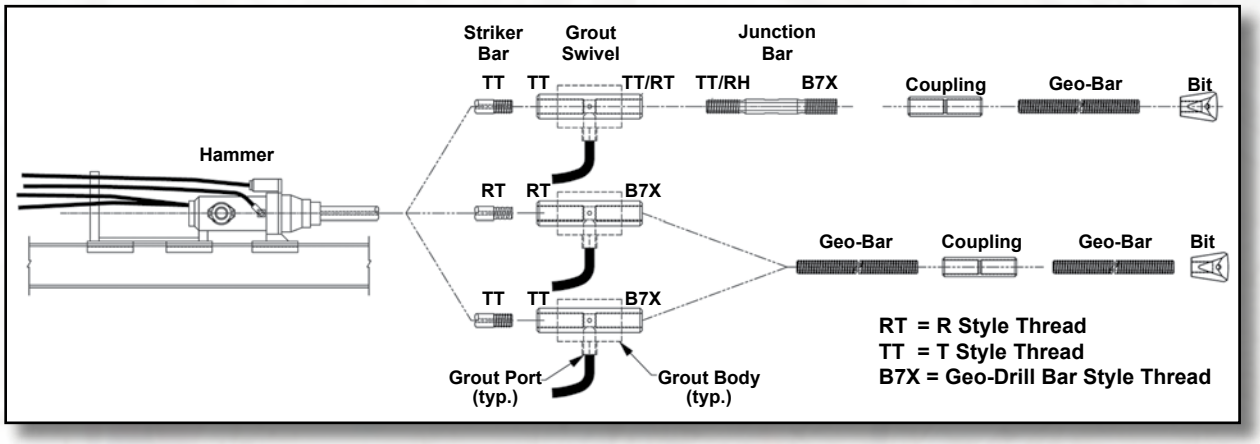
Installation

The Williams Geo-Drill Injection Anchor System is optimally used in poor or very poor ground conditions ranging from inconsistent fill, boulders, rubble and weathered rock to sand and gravel. Generally the system is installed with rotary percussive drilling and continuous grouting. The thickness of grout can be varied depending on susceptibility of the borehole to collapse, however a grout mixture of 0.4 water to cement ratio is recommended in poor, collapsible soils to ensure a high enough density to support the annulus. In all cases, a final grout mixture of 0.40 w/c should be used for adequate in-situ structural capacity. Williams recommends mixing the grout in a colloidal (shear type) mixer, so once pumped, the fine grout particles are fully able to disperse into the small voids of the surrounding soil. This well mixed grout exits the side ports of the drill bit under pressure to flush and remove the softer parts of the soil while penetrating into the firmer material for increased bond capacity. Williams recommends to partially withdraw each fully drilled section up the drill mast prior to attaching new sections, this way the drilling can begin in a plunging type action to even further improve grout penetration. Utilizing proper drilling and grouting techniques is important as the system would generally fail between the soil/anchor interface, not the grout/anchor interface.

In all cases the hollow bar system should be drilled slow enough to ensure rotation through the soil as opposed to excessive percussion and feed pressure with limited rotation. Such practice will provide the formation of a true borehole with consistent grout cover. Grouting pressure should be sufficient to maintain circulation at all times with a small amount of grout return visible at the mouth of the borehole. In permeable ground, this can result in an increase in the grout column diameter by several inches. Consult a Williams Representative for more detailed information on what to expect based on your specific geotechnical report. Normal drilling rotation is in the range of 40 and 100 RPM.

Drill Rigs

The preferred method of installation for the Williams Geo-Drill Injection Anchor System is rotary percussion drilling, as this method offers good directional stability and high rates of production. Hand-held drill rigs can be used to install 32 mm (1-1/4") bars. Hand-held equipment works best when used in conjunction with a jackleg or within a slideframe arrangement.



Grout-Swivel System for Rig Installation

For simultaneous drilling and grouting installations a grout-swivel system is required. The grout-swivel consists of a Grout Body and Grout Shank. The Grout Shank fits within the Grout Body and contains grout inlet ports. One end of the shank attaches to the striker bar while the other end attaches to the hollow bar anchor. The Grout Body contains an inlet pipe to allow grout to enter into the shank and down the hollow bar. The body remains stationary while the shank spins with the rotary action of the drill. To hold the body into position and prevent spinning with the rotary action of the drill, it is necessary to attach a locator frame from the body to the drifter.

We recommend water or grout flush (not air) be used with the grout-swivel system. In all cases, grease should be applied to the grout-swivel system prior to use.

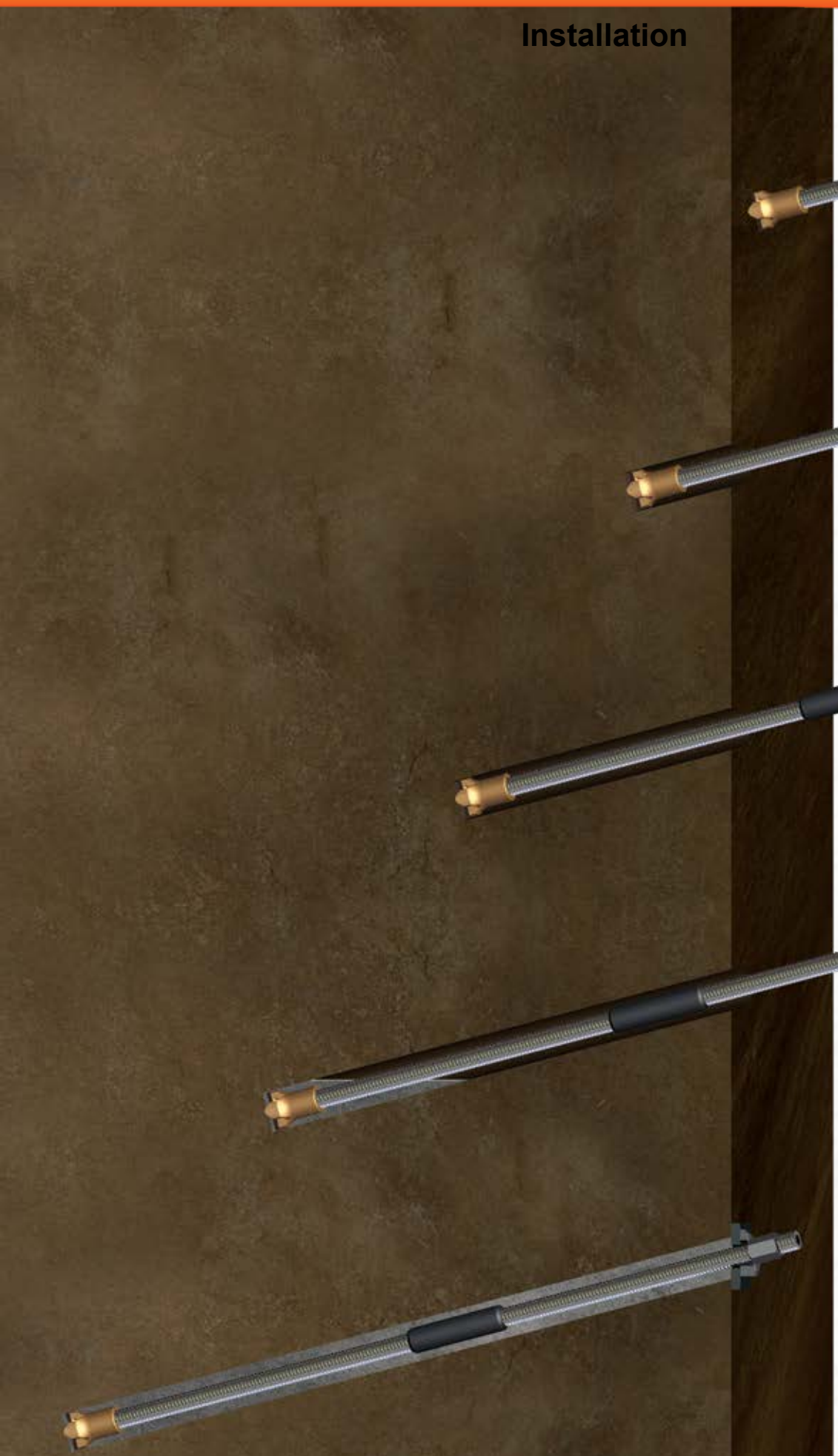
Junction Bar

When using a grout shank with a T or R type thread, Williams recommends the use of a Junction Bar to transition between the Grout Shank and the Geo-Drill Bar. Coming out the anchor end of the Junction Bar would either be a Geo-Drill Coupling or Coupling Adapter. All disengagement during drilling to add sections or move to another anchor location would be done from below the Junction Bar and not at the Grout Shank, thus prolonging the life of the Grout Swivel.

Coupling Adapter

A Coupling Adapter is a machined and case hardened adapter, which is usually located just below the drill hammer and is used to connect the striker bar to the hollow bar. Sizes are available in any striker bar thread type to connect to any Hollow Injection Bar size. Generally a Coupling Adapter would be used in place of a grout-swivel during an air flush installation.

Installation



1. Williams Geo-Drill Injection Anchor set into position for installation.

2. Installation begins with rotary percussive drilling and either grout, water or air flushing.

3. Once the first 10 foot section is installed, drilling stops long enough to add the second section.

4. Raise the anchor high enough to get visible evidence of flush return from the mouth of the bore hole and begin drilling again in a normal fashion.

5. Add sections in the manner noted in step four until anchor reaches final depth. Completely flush all drilling grout and debris with competent compressive strength grout.

Strand Anchor System

Williams Strand Anchors utilize a high density extruded polyethylene sheath over corrosion inhibiting compound in the unbonded zone. Williams has the most technologically advanced extrusion equipment for the manufacture of permanent and temporary anchors. The state of the art equipment allows for precise extruded lengths in the unbonded zone and high quality manufacturing.

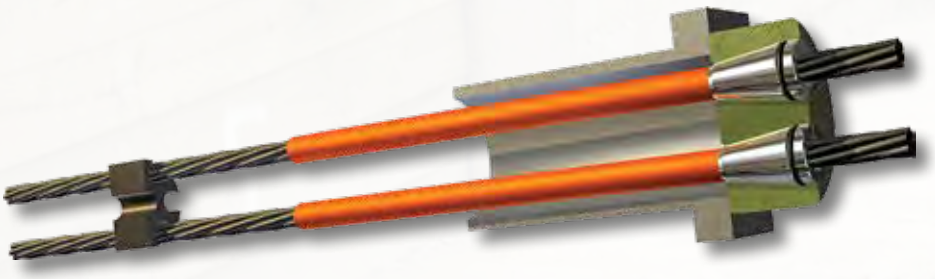
Williams Strand Anchors are typically produced from 0.6" diameter, 7 wire strand (fpu = 270 ksi, 1862 N/mm^2) meeting ASTM A416 and are manufactured in accordance with the Post-Tensioning Institute's *Recommendations for Prestressed Rock and Soil Anchors*.

Advantages of Williams Grout Bonded Strand Anchors

- High capacity - Anchors utilize a 0.6" dia. 270 KSI (ultimate stress) strand. The number of strands per anchor dictate the load carrying capacity of the anchor.
- Lightweight - For a Class I protected anchor, the corrugated duct is grouted in the field, greatly reducing the weight of the anchor. There is more load carrying capacity per pound of 7-wire 270 KSI strand than solid bar.
- Anchors arrive to the jobsite fully fabricated and packaged in coils to allow for installation in areas where there are clearance issues or bench width constraints.
- Unlike bar systems, strand can be produced in any length.
- All Williams strand anchors utilize a small diameter greased filled extruded high density polyethylene sheathing, allowing for a greater number of individual strands to be contained in a given drill hole size. Manual greasing and sheathing of individual strands require a larger free stressing sheath.
- Stringent quality control of manufacturing is maintained because Williams' engineering department provides shop drawings for each production order showing customer preference details and specific contract requirements.

Applications

- Dam Tie-Downs
- Temporary Excavation Support
- Landslide Mitigation
- Permanent Tieback Systems
- Slope Surface Stabilization
- Foundations



Corrosion Protection

The anchor system can be produced to meet the Post-Tensioning Institute's *Recommendations for Prestressed Rock and Soil Anchors*. Williams Strand Anchors are supplied with the following classes of Corrosion Protection:

PTI Class I - Encapsulated Tendon:
Anchorage: Wedge Plate, Bearing Plate w/ Trumpet and End Cap (where exposed).
Free Stressing Length: Corrosion inhibiting compound filled HDPE/PP sheath encased in grout filled corrugated sheathing.
Bond Length: Grout filled encapsulated corrugated sheathing.

PTI Class II - Grout Protected:
Anchorage: Wedge Plate, Bearing Plate w/ optional Trumpet and optional End Cap (where exposed).
Free Stressing Length: Corrosion inhibiting compound filled HDPE/PP sheath surrounded by external grout
Bond Length: Bare strands, grout encased.

Design and Construction Support

Williams is committed to assisting designers and foundation engineers with prebid product information, budget pricing and anchor details. Williams' technical staff will work with designers to ensure that the specified strand anchor system is economical and appropriate for the application.

Williams is also committed to assisting the contractor with project pricing, bearing plate calculations, quantity take-offs, anchor submittals and shop drawings. Williams' manufacturing personnel will work with the technical staff to ensure the anchors are delivered to the jobsite, ready to install and on time. Williams also offers on-site technical assistance to the contractor.

Anchor Table

Strand Anchor System

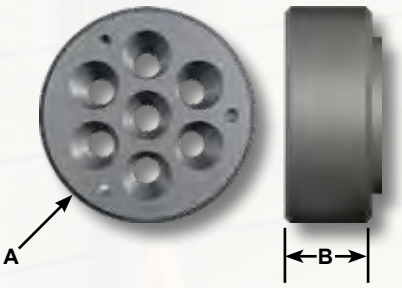
ASTM A416

Number of Strands	Cross-Sectional Area (Aps)	Ultimate Load (fpu*Aps)	Maximum Jacking Load (0.8*fpu*Aps)	Maximum Design Load (0.6*fpu*Aps)	HDPE Tubing	Anchor Heads	Weight per Foot
1	0.217 in² (140 mm²)	58.6 kips (261 kN)	46.9 kips (209 kN)	35.2 kips (157 kN)	3" nom. (3.5" OD)	C4.6	0.74 lbs (0.34 kg)
2	0.434 in² (280 mm²)	117 kips (522 kN)	93.8 kips (418 kN)	70.4 kips (314 kN)	3" nom. (3.5" OD)	C4.6	1.48 lbs (0.67 kg)
3	0.651 in² (420 mm²)	176 kips (783 kN)	141 kips (627 kN)	106 kips (471 kN)	3" nom. (3.5" OD)	C4.6	2.22 lbs (1.01 kg)
4	0.868 in² (560 mm²)	234 kips (1044 kN)	188 kips (836 kN)	141 kips (628 kN)	3" nom. (3.5" OD)	C7.6 - Class 1 C4.6 - Class 2	2.96 lbs (1.34 kg)
5	1.09 in² (700 mm²)	293 kips (1305 kN)	235 kips (1045 kN)	176 kips (785 kN)	3" nom. (3.5" OD)	C7.6	3.70 lbs (1.68 kg)
6	1.30 in² (840 mm²)	352 kips (1566 kN)	281 kips (1254 kN)	211 kips (942 kN)	3" nom. (3.5" OD)	C7.6	4.44 lbs (2.01 kg)
7	1.52 in² (980 mm²)	410 kips (1827 kN)	328 kips (1463 kN)	246 kips (1099 kN)	3" nom. (3.5" OD)	C7.6	5.18 lbs (2.35 kg)
8	1.74 in² (1120 mm²)	469 kips (2088 kN)	375 kips (1672 kN)	282 kips (1256 kN)	3" nom. (3.5" OD)	C9.6	5.92 lbs (2.69 kg)
9	1.95 in² (1260 mm²)	527 kips (2349 kN)	422 kips (1881 kN)	317 kips (1413 kN)	4" nom. (4.6" OD)	C9.6	6.66 lbs (3.02 kg)
10	2.17 in² (1400 mm²)	586 kips (2610 kN)	469 kips (2090 kN)	352 kips (1570 kN)	4" nom. (4.6" OD)	C12.6	7.40 lbs (3.36 kg)
11	2.39 in² (1540 mm²)	645 kips (2871 kN)	516 kips (2299 kN)	387 kips (1727 kN)	4" nom. (4.6" OD)	C12.6	8.14 lbs (3.69 kg)
12	2.60 in² (1680 mm²)	703 kips (3132 kN)	563 kips (2508 kN)	422 kips (1884 kN)	4" nom. (4.6" OD)	C12.6	8.88 lbs (4.03 kg)
13	2.82 in² (1820 mm²)	762 kips (3393 kN)	610 kips (2717 kN)	458 kips (2041 kN)	4" nom. (4.6" OD)	C19.6	9.62 lbs (4.36 kg)
14	3.04 in² (1960 mm²)	820 kips (3654 kN)	657 kips (2926 kN)	493 kips (2198 kN)	4" nom. (4.6" OD)	C19.6	10.36 lbs (4.70 kg)
15	3.26 in² (2100 mm²)	879 kips (3915 kN)	704 kips (3135 kN)	528 kips (2355 kN)	4" nom. (4.6" OD)	C19.6	11.10 lbs (5.03 kg)
16	3.47 in² (2240 mm²)	938 kips (4176 kN)	750 kips (3344 kN)	563 kips (2512 kN)	5" nom. (5.6" OD)	C19.6	11.84 lbs (5.37 kg)
17	3.69 in² (2380 mm²)	996 kips (4437 kN)	797 kips (3553 kN)	598 kips (2669 kN)	5" nom. (5.6" OD)	C19.6	12.58 lbs (5.71 kg)
18	3.91 in² (2520 mm²)	1055 kips (4698 kN)	844 kips (3762 kN)	634 kips (2826 kN)	5" nom. (5.6" OD)	C19.6	13.32 lbs (6.04 kg)
19	4.12 in² (2660 mm²)	1113 kips (4959 kN)	891 kips (3971 kN)	669 kips (2983 kN)	5" nom. (5.6" OD)	C19.6	14.06 lbs (6.38 kg)
20	4.34 in² (2800 mm²)	1172 kips (5220 kN)	938 kips (4180 kN)	704 kips (3140 kN)	5" nom. (5.6" OD)	C22.6	14.80 lbs (6.71 kg)
21	4.56 in² (2940 mm²)	1231 kips (5481 kN)	985 kips (4389 kN)	739 kips (3297 kN)	6" nom. (6.6" OD)	C22.6	15.54 lbs (7.05 kg)
22	4.77 in² (3080 mm²)	1289 kips (5742 kN)	1032 kips (4598 kN)	774 kips (3454 kN)	6" nom. (6.6" OD)	C22.6	16.28 lbs (7.38 kg)
23	4.99 in² (3220 mm²)	1348 kips (6003 kN)	1079 kips (4807 kN)	810 kips (3611 kN)	6" nom. (6.6" OD)	C27.6	17.02 lbs (7.72 kg)
24	5.21 in² (3360 mm²)	1406 kips (6264 kN)	1126 kips (5016 kN)	845 kips (3768 kN)	6" nom. (6.6" OD)	C27.6	17.76 lbs (8.06 kg)
25	5.43 in² (3500 mm²)	1465 kips (6525 kN)	1173 kips (5225 kN)	880 kips (3925 kN)	6" nom. (6.6" OD)	C27.6	18.50 lbs (8.39 kg)
26	5.64 in² (3640 mm²)	1524 kips (6786 kN)	1219 kips (5434 kN)	915 kips (4082 kN)	6" nom. (6.6" OD)	C27.6	19.24 lbs (8.73 kg)
27	5.86 in² (3780 mm²)	1582 kips (7047 kN)	1266 kips (5643 kN)	950 kips (4239 kN)	6" nom. (6.6" OD)	C27.6	19.98 lbs (9.06 kg)
28	6.08 in² (3920 mm²)	1640 kips (7308 kN)	1313 kips (5852 kN)	986 kips (4396 kN)	6" nom. (6.6" OD)	C31.6	20.72 lbs (9.40 kg)
29	6.29 in² (4060 mm²)	1699 kips (7569 kN)	1360 kips (6061 kN)	1021 kips (4553 kN)	6" nom. (6.6" OD)	C31.6	21.46 lbs (9.73 kg)
30	6.51 in² (4200 mm²)	1758 kips (7820 kN)	1407 kips (6270 kN)	1056 kips (4710 kN)	6" nom. (6.6" OD)	C31.6	22.20 lbs (10.07 kg)
31	6.73 in² (4340 mm²)	1816 kips (8091 kN)	1454 kips (6479 kN)	1091 kips (4867 kN)	6" nom. (6.6" OD)	C31.6	22.94 lbs (10.41 kg)
32	6.94 in² (4480 mm²)	1875 kips (8352 kN)	1500 kips (6688 kN)	1126 kips (5024 kN)	8" nom. * (9-1/2" OD)	C37.6	23.68 lbs (10.74 kg)
37	8.03 in² (5180 mm²)	2168 kips (9657 kN)	1735 kips (7733 kN)	1302 kips (5809 kN)	8" nom. * (9-1/2" OD)	C37.6	27.38 lbs (12.42 kg)
55	11.94 in² (7700 mm²)	3223 kips (14337 kN)	2578 kips (11468 kN)	1934 kips (8603 kN)	10" nom. * (11.9" OD)	C55.6	40.70 lbs (18.46 kg)
61	13.24 in² (8540 mm²)	3575 kips (15901 kN)	2860 kips (12722 kN)	2145 kips (9541 kN)	10" nom * (11.9" OD)	C61.6	45.14 lbs (20.48 kg)

1) Mill certification provided upon request to indicate the actual tensile strength of the 7-wire strand with each shipment of Williams strand anchors.
2) Larger diameter anchors available upon request.
3) Minimum grout cover shall be 1/2" (13 mm) over the OD of the encapsulation in a Class I Protected anchor and 1/2" (13 mm) over the tendon bond length in a Class II protected anchor.

* Corrugated tubing over 6" in diameter cannot be coiled with strands.

Accessories



Wedge Plates (Anchor Heads)

Williams Wedge Plates are full strength permanent components. Williams C4.6 and C7.6 Plates are prequalified by CALTRANS, with approval Nos. 040114a & 040114b respectively, for prestressed ground anchor construction.

Type	A Diameter	B Thickness	Part Number
C4.6	4-1/4" (108 mm)	2" (51 mm)	RSAH04W
C7.6	5" (127 mm)	2" (51 mm)	RSAH07W5
	5-1/2" * (140 mm)		RSAH07W5.5
C9.6	6-3/8" (162 mm)	2-1/2" (64 mm)	RSAH09W
C12.6	7-1/4" (184 mm)	2-1/2" (64 mm)	RSAH12S
C19.6	8-3/8" (213 mm)	3-3/8" (86 mm)	RSAH19S
C22.6	9" (229 mm)	3-3/8" (86 mm)	RSAH22
C27.6	9-3/4" (248 mm)	3-1/4" (82 mm)	RSAH27
C31.6	10-3/4" (273 mm)	4-1/2" (114 mm)	RSAH31
C37.6	11-1/2" (292 mm)	5" (127 mm)	RSAH37
C55.6	13-1/2" (343 mm)	5-3/4" (146 mm)	RSAH55
C61.6	14-1/2" (368 mm)	6-1/2" (165 mm)	RSAH61

* Recommended when bearing directly on 5-inch Schedule 160 pipe.

Bearing Plates

Williams Bearing Plates are available in sizes as required per anchor, and are designed in accordance with PTI specifications. Plate stock can be provided in Grade 36 or Grade 50. All plates are available galvanized upon request.

Type	Trumpet		Center Hole
	OD	ID (Nom.)	Head Clearance
C4.6	4-1/2" (114 mm)	4" (102 mm)	3-3/8" (86 mm)
C7.6	4-1/2" (114 mm)	4" (102 mm)	3-3/4" (95 mm)
C9.6	5-9/16" (141 mm)	5" (127 mm)	4-5/8" (117 mm)
C12.6	6-5/8" (168 mm)	6" (152 mm)	5-3/8" (137 mm)
C19.6	8-5/8" (219 mm)	7-7/8" (200 mm)	6-1/2" (165 mm)
C22.6	8-5/8" (219 mm)	7-7/8" (200 mm)	7-1/2" (191 mm)
C27.6	8-5/8" (219 mm)	7-7/8" (200 mm)	8" (203 mm)
C31.6	10-3/4" (273 mm)	10" (254 mm)	8-1/2" (216 mm)
C37.6	10-3/4" (273 mm)	10" (254 mm)	9-1/2" (241 mm)
C55.6	12-3/4" (324 mm)	12" (305 mm)	10-1/2" (267 mm)
C61.6	12-3/4" (324 mm)	12" (305 mm)	11-1/2" (292 mm)

Steel End Caps

Williams offers a bolt-on steel end cap to provide corrosion protection for exposed anchor ends. Caps are provided with a closed cell neoprene seal. Most often the caps are packed with corrosion inhibiting wax or grease.

Type	Pipe Outer Diameter	Flange Diameter	Height
C4.6	5-9/16" (141 mm)	7" (178 mm)	4-5/8" (117 mm)
C7.6	6-5/8" (168 mm)	8" (203 mm)	4-5/8" (117 mm)
C9.6	8-5/8" (219 mm)	10" (254 mm)	5-3/8" (137 mm)
C12.6	8-5/8" (219 mm)	10" (254 mm)	5-3/8" (137 mm)
C19.6	10-3/4" (273 mm)	12" (305 mm)	6" (152 mm)
C22.6	10-3/4" (273 mm)	12" (305 mm)	6" (152 mm)
C27.6	10-3/4" (273 mm)	14" (356 mm)	7-7/8" (200 mm)
C31.6	12-3/4" (324 mm)	14" (356 mm)	7-7/8" (200 mm)
C37.6	12-3/4" (324 mm)	14" (356 mm)	8-7/8" (225 mm)
C55.6	16" (406 mm)	18" (457 mm)	12" (305 mm)
C61.6	16" (406 mm)	18" (457 mm)	12" (305 mm)

Anchor Head Wedges - RSWG03

All wedges are equipped with a ring to keep the wedge attached to the tendon during elongation and/or tensioning operations.

The 3-Piece anchor wedges are PTI recommended for use on permanent anchors and/or anchors requiring incremental loading. They uniformly engage the strand with less relaxation at low loads. They are manufactured from quality steels and are carburized for durability.

Stressing Head Wedges - RSXSHW

Stressing head wedges are necessary for prestressing all classes of strand anchors. The stressing wedges are heat treated, chrome plated and designed for multiple uses.

Accessories

Centralizers

Centralizers are placed over the strand anchor assembly to maintain the minimum required 0.5" distance between the assembled anchor bundle and the drill hole wall. Depending on the anchor type and orientation, there are a wide variety of centralizers available for every application. State drill hole size for ordering.

Heavy Duty Plastic Grout Tube

Available with a 1" nominal OD and 3/4" nominal ID. Furnished in product lengths or in rolls.

Post-Grout Tube

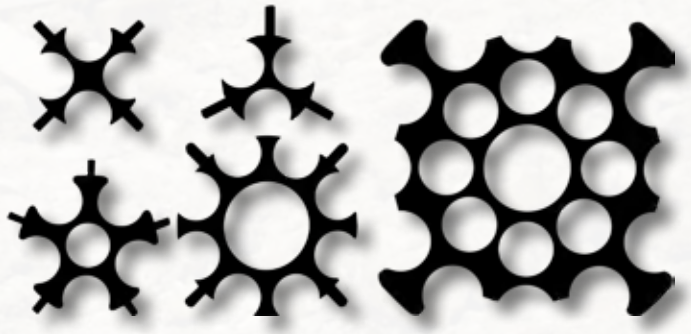
Williams will provide post-grout tubes for anchors bonded in weak rock or soil upon request. Williams supplies flexible Post-Grout Tube with bursting strengths of 1000 psi, as well as PVC Post-Grout Tube with bursting strengths of 900 psi. The Post-Grout Tube length and valve placement are adjustable and can be specified at the time of order. Drill hole diameter should be a 1" minimum clearance to accommodate Post-Grout Tube.

Corrosion Inhibiting Grease or Gel

Williams corrosion inhibiting compounds can be placed in the free stressing areas, in the end caps, and trumpet areas. Each are of an organic compound with either a grease or gel base. They provide the appropriate polar moisture displacement and have corrosion inhibiting additives with self-healing properties. They can be pumped or applied manually. Corrosion inhibiting compounds stay permanently viscous, chemically stable and non-reactive with the prestressing steel, duct materials or grout. Both compounds meet PTI standards for Corrosion Inhibiting Coating.

Spacers

Strand spacers are provided in the anchor bond zone to separate the strand and provide for the minimum required grout cover around each strand for corrosion protection and bond strength development. The strand spacers are normally located 1-2 feet above the bottom of the anchor and at the top of the bond zone. The intermediate strand spacers are typically placed at a distance of 5-10 feet, center to center along the bond zone between the top and bottom spacer.



Corrosion Protection Coatings

Optional coatings for steel end caps, bearing plates with trumpet and anchor heads are available for additional corrosion protection as required by the designer. Coating specifications are as follows:

Electro Zinc Plating:	**ASTM B633 (wedge plates)**
Hot Dip Galvanizing:	**ASTM A123 (bearing plates/trumpets and steel end caps)**
Epoxy Coating:	**ASTM A775 (bearing plates/trumpets and steel end caps)**

Corrugated Duct

Williams utilizes corrugated duct that complies with the required wall thickness (0.060" nominal) as specified by the Post-Tensioning Institute's *Recommendations for Prestressed Rock and Soil Anchors*.

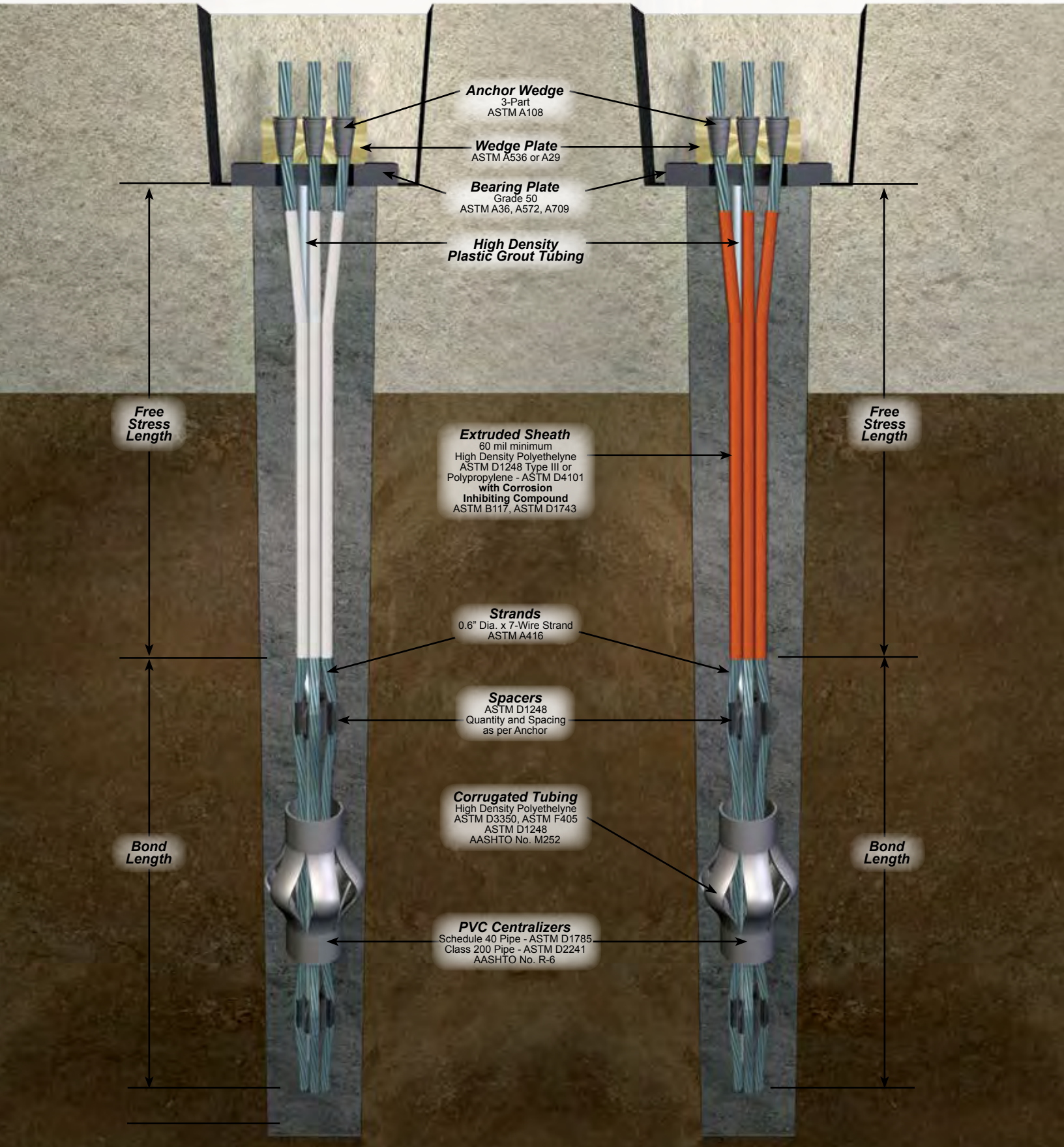
Heat Shrink Tubing

Provides a corrosion protected seal when connecting or repairing smooth and corrugated segments.

Specifications

Williams Type A System
Stuffed Sheath Free Stress

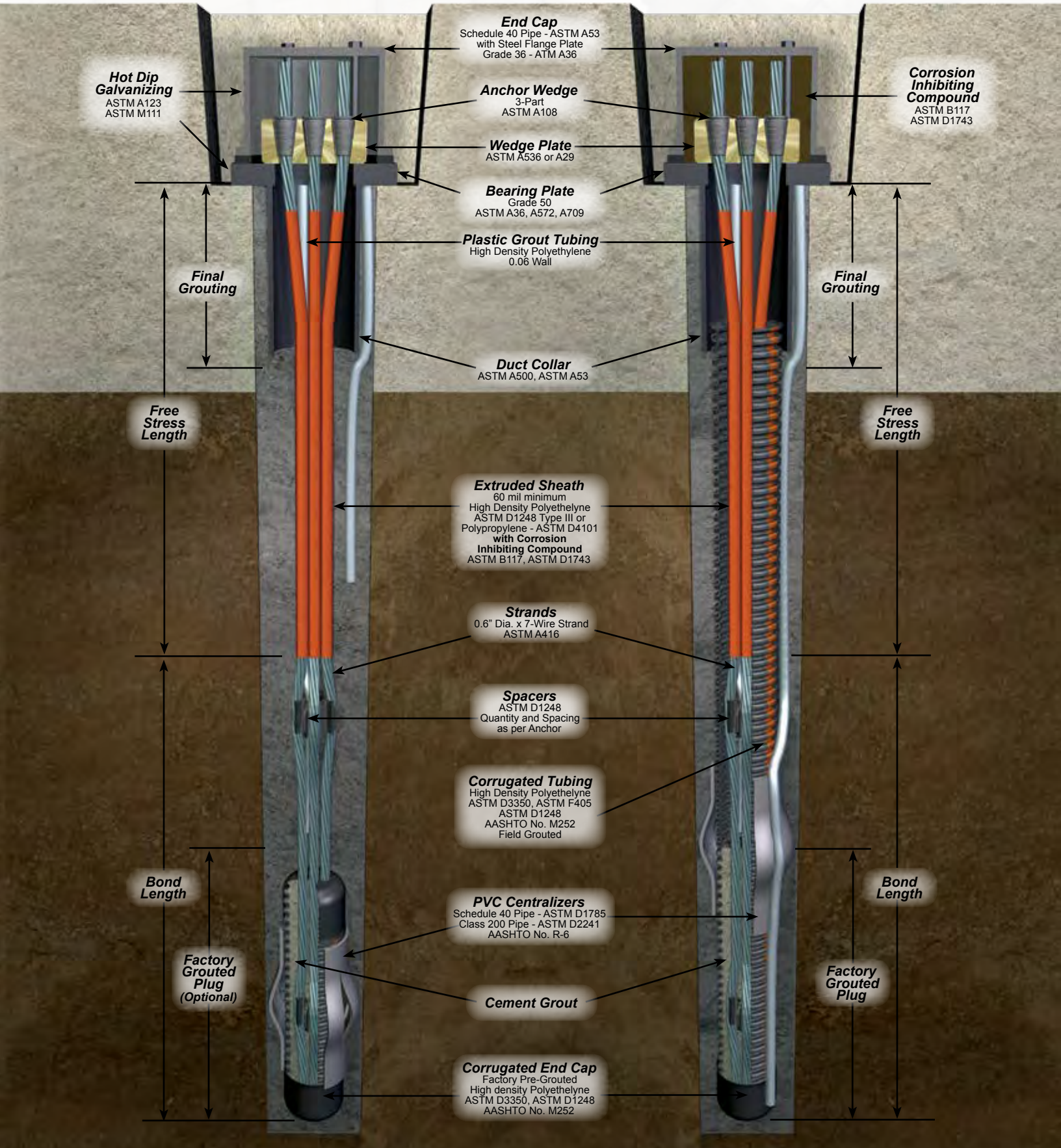
Williams Type B System
Extruded Free Stress Length



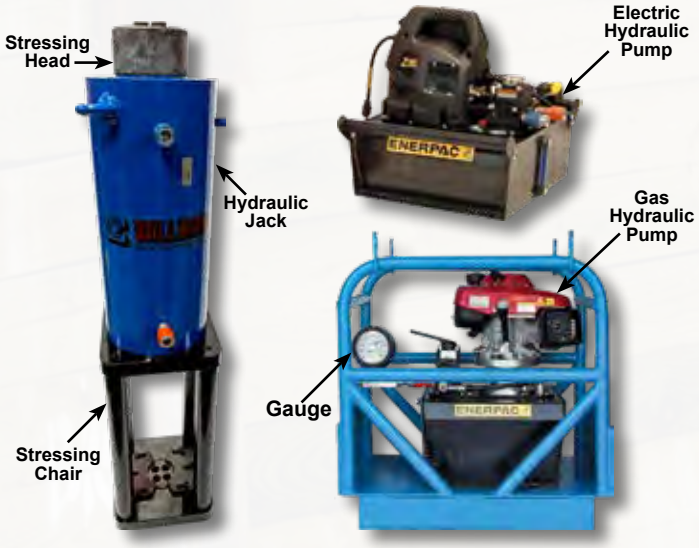
Specifications

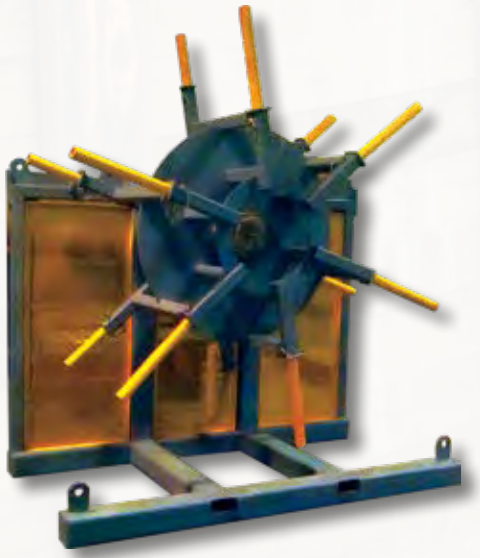
Williams Type C System
PTI Class II Anchor

Williams Type D System
PTI Class I Anchor



Strand Installation Equipment





Open Frame Hydraulic Jack Assembly

Used for testing and prestressing multi-strand anchors. Available with up to 13" center hole. Unit comes with hydraulic jack, pump, gauge, hoses, stressing head assembly and chairs as required.

Vertical Strand Anchor Uncoiler

The Williams Vertical Uncoiler can be utilized to install up to a 61 strand anchor. The uncoiler is a safe and cost effective strand anchor installation solution while minimizing damage to the corrosion protection sleeves. Contact a Williams representative for a monthly rental rate.

Jack Capacity	Wedge Plate	Pump Method	Jack Height	Open Frame Stressing Chair Size	Stressing Head Size (Dia x Height)	Ram Travel	Minimum Total Jack Assy Height	Ram Area	Approx Total Jack Assy Weight	Jack Minimum ID
100 tons (890 kN)	C4.6	Air or Electric Double Acting	13-1/2" (343 mm)	9" SQ x 12" H (229 mm x 305 mm)	6"x 4-1/4" (152 mm x 108 mm)	6" (152 mm)	31" (787 mm)	20.63 in² (133 cm²)	255 lbs (116 kg)	3.13" (80 mm)
200 tons (1779 kN)	C4.6 C7.6	Air or Electric Double Acting	16" (406 mm)	12" SQ x 15" H (305 mm x 381 mm)	6-1/4" x 6-1/2" (159 mm x 165 mm)	8" (203 mm)	39" (991 mm)	40.45 in² (261 cm²)	595 lbs (270 kg)	4.06" (103 mm)
200 tons (1779 kN)	C4.6 C7.6	Air or Electric Double Acting	23-1/2" (597 mm)	12" SQ x 22" H (305 mm x 559 mm)	6-1/4" x 6-1/2" (159 mm x 165 mm)	14" (356 mm)	52" (1321 mm)	40.45 in² (261 cm²)	870 lbs (395 kg)	4.06" (103 mm)
200 tons (1779 kN)	C4.6 C7.6	Air or Electric Double Acting	25-1/2" (648 mm)	12" SQ x 22" H (305 mm x 559 mm)	6-1/4" x 6-1/2" (159 mm x 165 mm)	15" (381 mm)	54" (1372 mm)	47.10 in² (304 cm²)	1046 lbs (474 kg)	4.06" (103 mm)
300 tons (2669 kN)	C9.6 C12.6	Air or Electric Double Acting	28-1/2" (724 mm)	13" DIA x 23" H (330 mm x 584 mm)	7-1/2" x 7-1/2" (191 mm x 191 mm)	15" (381 mm)	66" (1676 mm)	78.54 in² (507 cm²)	1460 lbs (662 kg)	5.50" (140 mm)
600 tons (5978 kN)	C19.6 C22.6	Electric or Gas Double Acting	30" (762 mm)	17-1/2" DIA x 25"H (445 mm x 635 mm)	10" x 8-1/2" (254 mm x 216 mm)	15" (381 mm)	62" (1575 mm)	122.5 in² (790 cm²)	3428 lbs (1550 kg)	8" (203 mm)
750 tons (7473 kN)	C27.6, C31.6 C37.6	Electric or Gas Double Acting	35" (889 mm)	22" DIA x 37" H (559 mm x 940 mm)	11-3/4" x 10" (298 mm x 254 mm)	18" (457 mm)	81" (2057 mm)	170.4 in² (1100 cm²)	5179 lbs (2349 kg)	9" (229 mm)
1500 tons (14946 kN)	C55.6 C61.6	Electric or Gas Double Acting	43" (1054 mm)	24" DIA x 57" H (588 mm x 1448 mm)	20" x 11" (508 mm x 279 mm)	18" (457 mm)	107" (2718 mm)	300.4 in² (1940 cm²)	9335 lbs (4230 kg)	13" (330 mm)

Stressing Head

Keeper Plate

Stressing Heads - RSXSHPK

The stressing head applies a temporary stressing force to the tendon and maintains the load until the lock-off load is transferred to the anchor head. The stressing head assembly should be used in all applications to insure uniform strand tension. Anti-seize compound is available to assist stressing head release.

Stressing Chairs - RSXCSC

This stressing chair is internally threaded to utilize an externally threaded keeper plate. The keeper plate is easily adjusted to the desired height by simply turning the pipe chair. It sits directly on the wedge plate so is ideal when wedge plates bear directly on a schedule 160 pipe. This chair is for purchase only and not available for rental.

Project Photos

Project Name: Boulder Highway
Contractor: GSI
Location: Boulder City, NV

Project: Hebgen Dam
Contractor: Jensen Drilling
Location: Hebgen, MT

Project: University of Cincinnati Indoor Practice Facility
Engineer: Scherzinger Drilling
Location: Cincinnati, OH

Project: Spavinaw Creek Causeway
Contractor: Foundation Specialties
Location: Lake Eucha, OK

Project: OCTA Landslide Repair
Contractor: Condon Johnson
Location: San Clemente, CA

Project: Northside Hospital Cherokee (Parking Garage)
Contractor: Berkel & Co
Location: Canton, GA

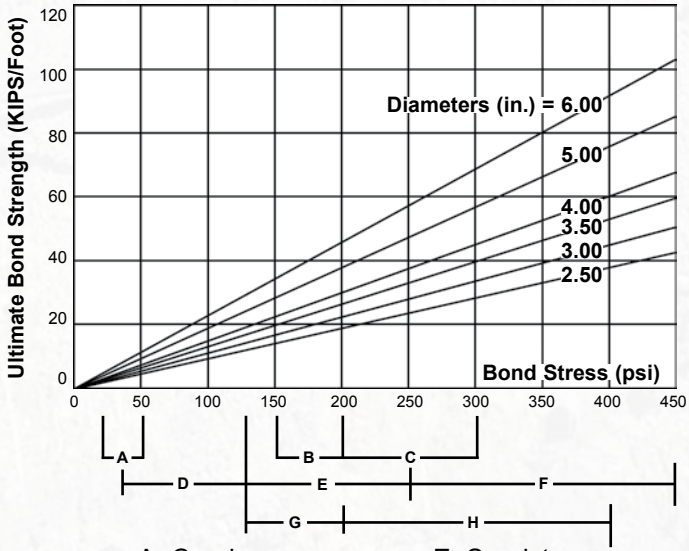
Multiple Corrosion Protection Anchors

Williams standard grout bonded rock & soil anchors consist of a plain or epoxy coated bar, grouted in an oversized drill hole. Centralizers should be used to assure good grout cover (approximately 25 mm) around the bar. Where anchors will penetrate aggressive soils that are low in pH value (<5.5) and high in sulfate, additional corrosion protection may be desirable. The degree of protection should be matched against the aggressivity of the environment and the expected life of the anchorage system. Williams Multiple Corrosion Protection (MCP) systems offer increasing barriers against corrosion attack for confidence in permanent anchorage in all ground environments. Williams protective outer end caps may also be used to seal the nut and washer from the environment when the outer end of the anchorage will not be encased in concrete.

Typically, Williams MCP anchors are supplied in 150 KSI All-Thread Grade (as shown below) and used in various applications such as externally supported earth structures and tension tie-down systems.

Ultimate Bond Strength

Per Linear Foot of Cement Grout by Diameter of Drill Hole



Rock Type		
	A. Coral	E. Sandstone
	B. Soft Limestone	F. Granite & Basalt
	C. Dolomitic Limestone	G. Hard Shale & Slate
	D. Soft Shale	H. Concrete

Notes: If overall length is over 50' (or 45' for 3" diameter), anchor coupling should be located in bond zone with field-applied barrier, such as heat shrink tube installed across splice joint. At minimum drill hole size, centralizers will only fit around anchor in the bond zone.
Drill hole diameters and bond lengths are based on geologic conditions. Consult your geotechnical engineer for recommendations.

Multiple Corrosion Protection Anchors

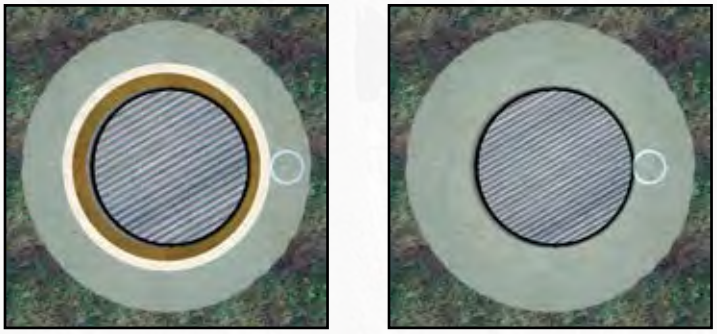
Shown with 150 KSI All-Thread Bar. Drill hole diameters and bond lengths are based on geological conditions. Consult your geotechnical engineer for recommendations. Per PTI, the minimum grout cover over the tendon bond length shall be 1/2" (13 mm).

Williams MCP I - PTI Class II Anchor

Two barriers around plain bar in free-stress zone plus drill hole grout.

- Plain or epoxy coated bar
- Smooth PVC sleeve over bar in free-stressing zone
- Grease/wax gel or grout filled smooth PVC sleeve over bar in the free-stress zone
- Unit is centered in drill hole grout with centralizers

Free-Stressing Zone ***Bond Zone***



Bar Diameter	Minimum Drill Hole Diameter	Common Drill Hole Diameter Range
1" (26 mm)	3-1/2" (89 mm)	3-1/2" to 5" (89 to 127 mm)
1-1/4" (32 mm)	3-1/2" (89 mm)	3-1/2" to 5" (89 to 127 mm)
1-3/8" (36 mm)	4" (102 mm)	4" to 6" (102 to 152 mm)
1-3/4" (45 mm)	4-1/2" (114 mm)	4-1/2" to 7" (114 to 178 mm)
2-1/4" (57 mm)	5" (127 mm)	5" to 8" (127 to 203 mm)
2-1/2" (65 mm)	5" (127 mm)	5" to 8" (127 to 203 mm)
3" (75 mm)	6" (152 mm)	6" to 8" (152 to 203 mm)

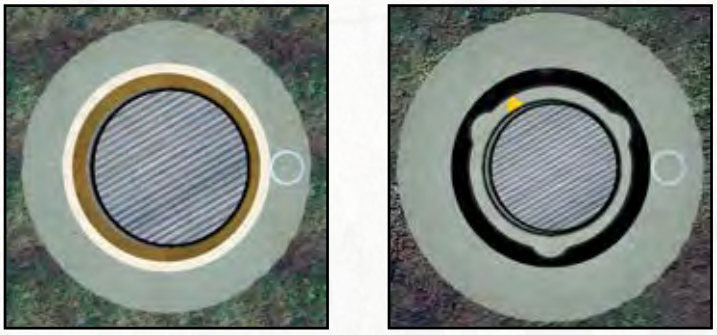
Note: Minimum hole diameter based on 1/2 cover over unbonded sleeve and may not consider grout tubes.

Williams MCP II - PTI Class I Anchor

Two barriers around plain bar full length plus drill hole grout.

- Bar engulfed in pre-grouted poly corrugated tube in the bond anchorage zone
- Smooth PVC sleeve over bar in free-stressing zone
- Grease/wax gel or grout filled smooth PVC sleeve over bar in the free stress zone
- Unit is centered in drill hole by centralizers and surrounded by grout

Free-Stressing Zone ***Bond Zone***



Bar Diameter	Minimum Drill Hole Diameter	Common Drill Hole Diameter Range
1" (26 mm)	3-1/2" (89 mm)	3-1/2" to 5" (89 to 127 mm)
1-1/4" (32 mm)	3-1/2" (89 mm)	3-1/2" to 5" (89 to 127 mm)
1-3/8" (36 mm)	4" (102 mm)	4" to 6" (102 to 152 mm)
1-3/4" (45 mm)	5" (127 mm)	5" to 7" (127 to 178 mm)
2-1/4" (57 mm)	5" (127 mm)	5" to 8" (127 to 203 mm)
2-1/2" (65 mm)	5" (127 mm)	5" to 8" (127 to 203 mm)
3" (75 mm)	6" (152 mm)	6" to 8" (152 to 203 mm)

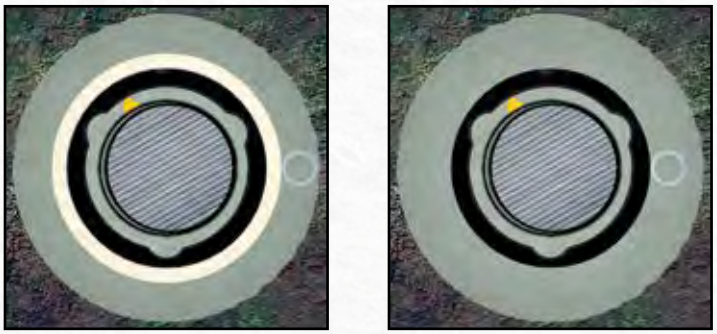
Note: Minimum hole diameter based on 1/2 cover over unbonded sleeve and may not consider grout tubes.

Williams MCP III - PTI Class I Anchor

Three barriers around plain bar in free-stress zone, two barriers in bond zone, plus drill hole grout.

- Bar engulfed in pre-grouted poly corrugated tube in the bond anchorage zone and the free-stressing zone.
- Smooth PVC sleeve over the corrugated tube in the free-stressing zone
- Unit is centered in drill hole by centralizer and surrounded by grout
- Plain or galvanized plate with a welded trumpet
- Protective end cap over nut and washer

Free-Stressing Zone ***Bond Zone***



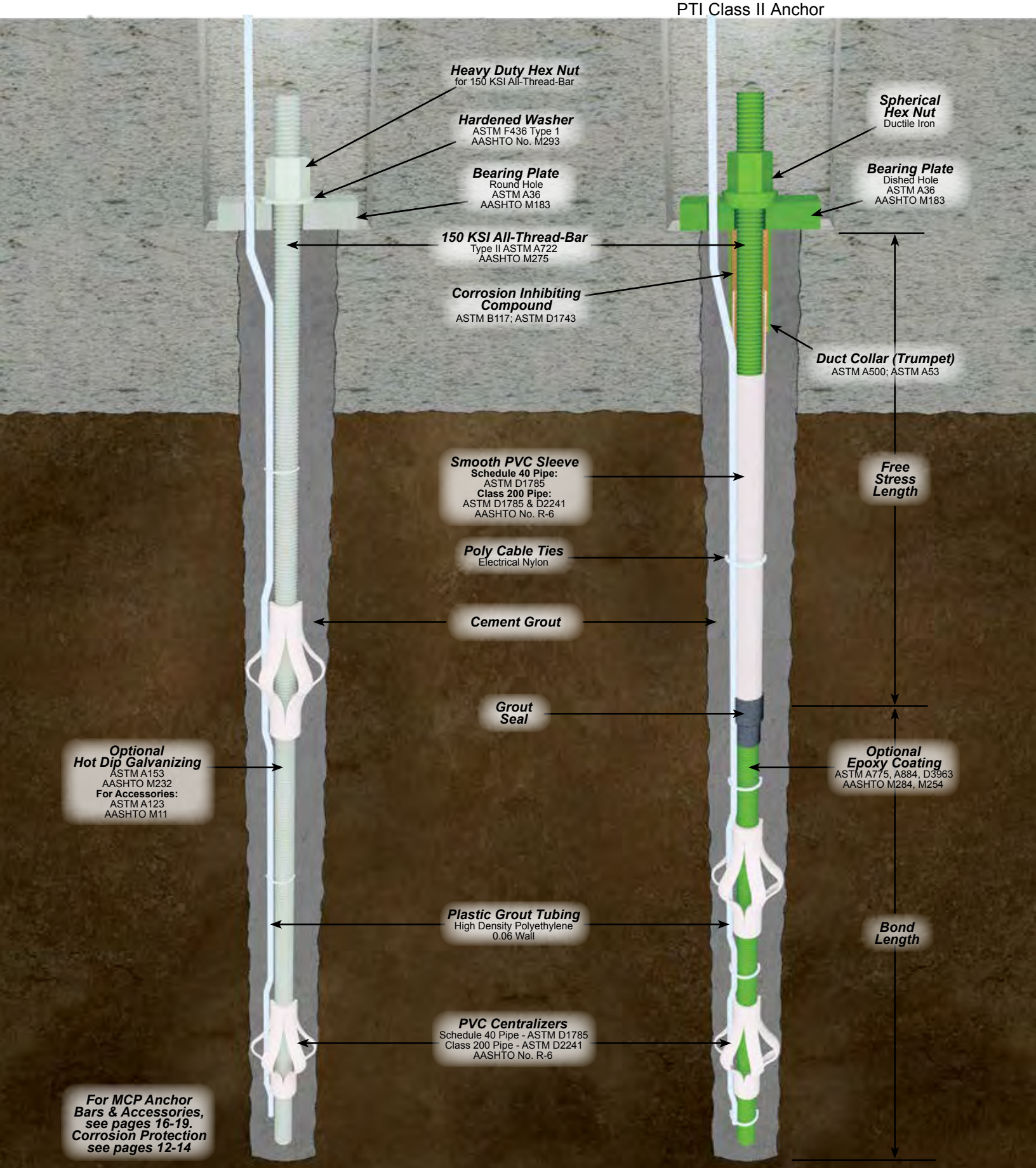
Bar Diameter	Minimum Drill Hole Diameter	Common Drill Hole Diameter Range
1" (26 mm)	4-1/2" (114 mm)	4-1/2" to 6" (114 to 152 mm)
1-1/4" (32 mm)	4-1/2" (114 mm)	4-1/2" to 6" (114 to 152 mm)
1-3/8" (36 mm)	4-1/2" (114 mm)	4-1/2" to 6" (114 to 152 mm)
1-3/4" (45 mm)	6" (152 mm)	6" to 8" (152 to 203 mm)
2-1/4" (57 mm)	6" (152 mm)	6" to 10" (152 to 254 mm)
2-1/2" (65 mm)	7" (178 mm)	7" to 10" (178 to 254 mm)
3" (75 mm)	7" (178 mm)	7" to 10" (178 to 254 mm)

Note: Minimum hole diameter based on 1/2 cover over unbonded sleeve and may not consider grout tubes.

Multiple Corrosion Protection Anchors

Williams Dowel

Williams MCP I
PTI Class II Anchor

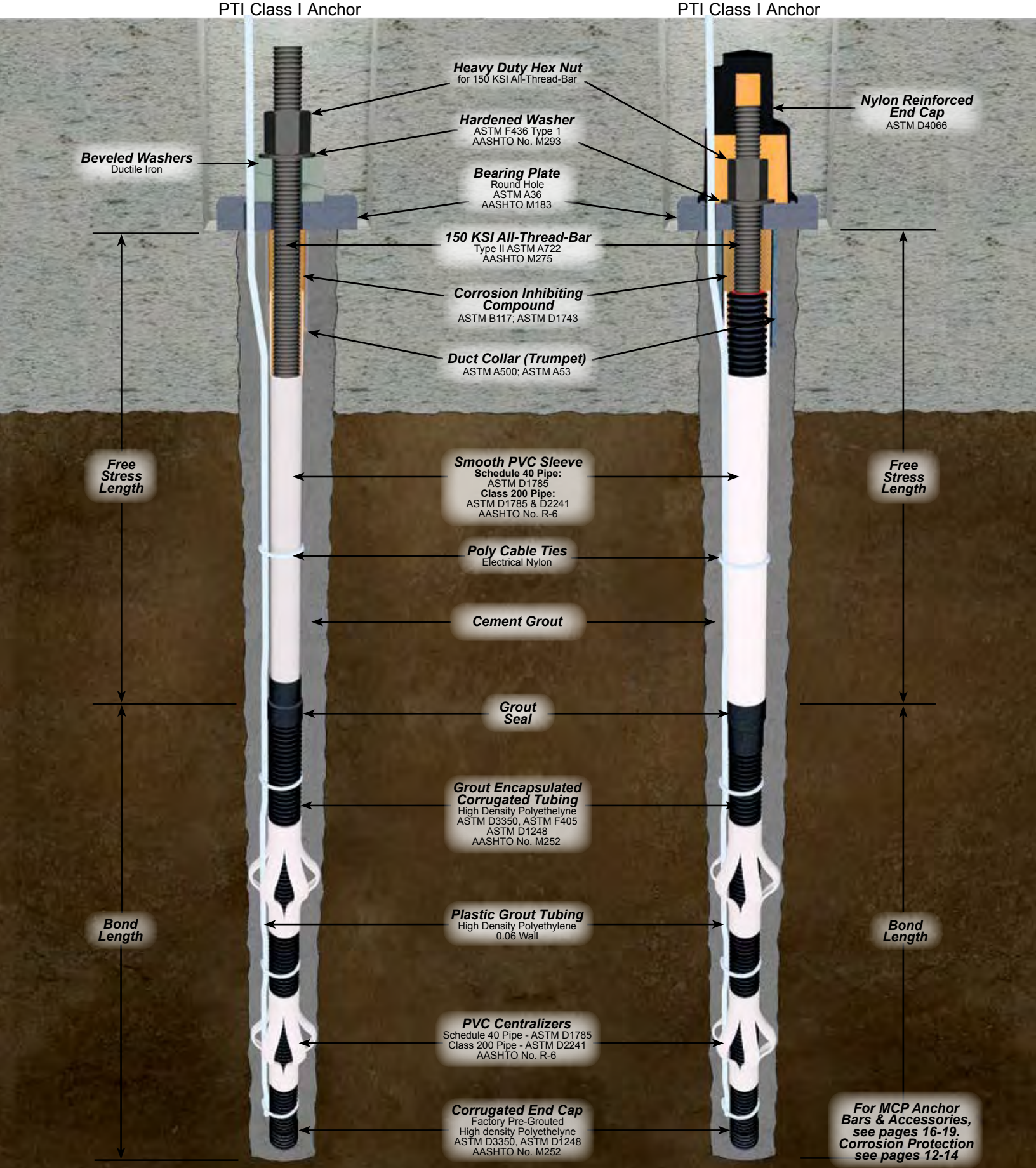


For MCP Anchor Bars & Accessories, see pages 16-19.
Corrosion Protection see pages 12-14

Multiple Corrosion Protection Anchors

Williams MCP II
PTI Class I Anchor

Williams MCP III
PTI Class I Anchor



For MCP Anchor Bars & Accessories, see pages 16-19. Corrosion Protection see pages 12-14

MCP Anchor Project Photos

Project: Hoover Dam Bypass Bridge
Contractor: Obayashi/PSM
Rock Anchors Subcontractor: Roy E. Ladd & Assoc.
Location: Boulder City, NV

Project: Morgan Roane Hwy
Contractor: GeoStabilization International
Location: Tennessee

Project: Globe Life Field
Contractor: Keller
Location: Arlington, TX

Project: Interstate 635
Contractor: Craig Olden
Location: Dallas, TX

Project: Peaks to Plains Trail
Contractor: Midwest Rockfall
Location: Golden, CO

Project: Arvada Parking Garage
Contractor: Atkinson Construction
Location: Arvada, CO

Soil Nail Information

Williams Grade 75 & Grade 80 and 150 KSI All-Thread-Bar soil nail components create an in-situ reinforcement system for the stabilization of excavations and slopes during top-down construction. Oversized holes of 4" to 10" in diameter are drilled and the centralized soil nail component is placed. The drill hole is then tremie grouted with cement grout. After the drill hole grout has cured, the soil nails may be torque tensioned against the protective shotcrete face to a slight load if desired.

Suggested working loads on common soil nails should not exceed 60% of the bar's ultimate strength. In granular soils, Williams Geo-Drill Injection Anchors are often used successfully as a substitution for solid bar soil nails. Pull out capacity is a function of drill hole diameter, depth, over burden stress and the angle of internal friction of the in-situ soil. Field tests are recommended to establish necessary bond lengths. However, typical anchorages in granular soils have yielded pull out strengths of 2-10 kips per foot of embedment on lengths over 10 feet. See pages 18-19 for Grade 75 & Grade 80 All-Thread Rebar information, pages 16-17 for 150 KSI All-Thread-Bar information, and pages 24-26 for Geo-Drill Injection Anchor information.

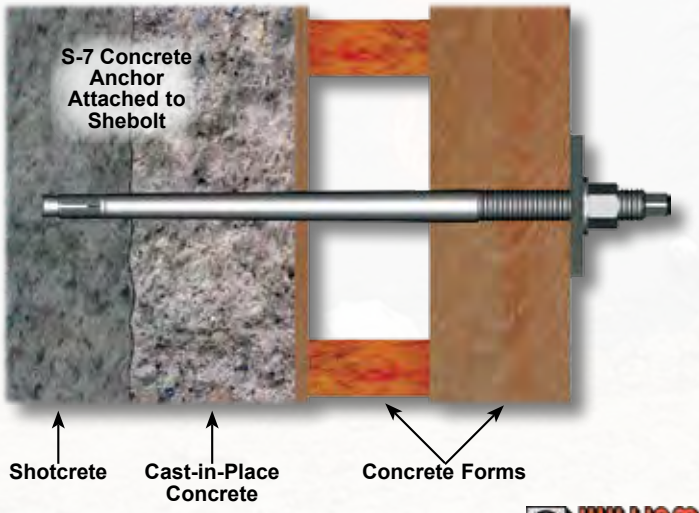
- Rugged thread with precision fit for durability and ease of use.
- 360° of concentric thread for unmatched grout to bar bond.
- Mechanical stop-type couplers able to develop 100% of the bar's tensile capacity for the most reliable bar to bar connections available.
- Grade 75 & Grade 80, Grade 150 KSI and Geo-Drill with full circular effective areas.
- Several options of corrosion protection including epoxy coating, galvanizing, sacrificial steel, cement grout and multiple corrosion protection for both temporary and permanent use.
- Manufacturing versatility unmatched by any soil nail supplier in North America.
- Connection abilities with structural and non-structural wall face attachments.

Stress Distribution of a Soil Nail

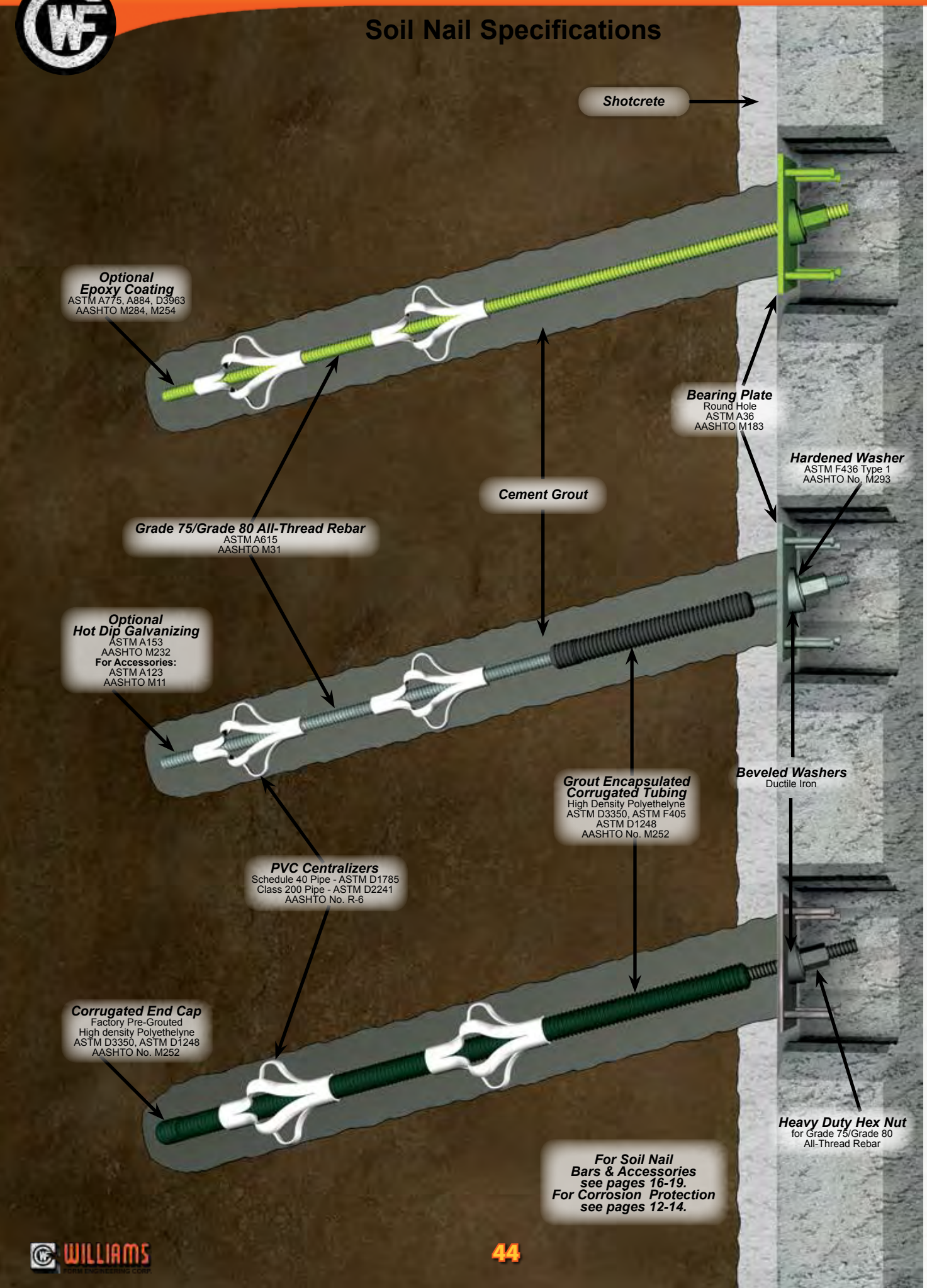
Unlike a prestressed rock or soil anchor, the interaction between soil nails, the facing, and the soil behind the wall is complex and causes redistributions of tensile forces at different points along the nail. The mobilized shear stress along the grout-soil interface is in general not uniform and changes in direction along the nail length at a point near the slip surface. The maximum force in the nail also occurs at this point. (Reference Report No FHWA-NHI-14-007, also known as Geocircular #7)

One-Sided Wall Forming

Williams offers an extensive line of concrete forming hardware that can be used in conjunction with soil nails for permanent wall forming. Williams offers she-bolts and coupling systems capable of developing 100% of the bar strength.



Soil Nail Specifications



For Soil Nail Bars & Accessories see pages 16-19. For Corrosion Protection see pages 12-14.

Soil Nail Project Photos

Project: Globe Life Park
Contractor: Keller
Location: Arlington, TX

Project: Sepulveda Blvd
Contractor: Access Limited
Location: Los Angeles, CA

Project: Landslide Repair
Contractor: GeoStabilization Incorporated
Location: Geyser, MO

Project: PR-10 Highway
Contractor: Strata LLC
Location: Utuado, Puerto Rico

Project: OHSU Hospital Expansion
Contractor: Pacific Foundation
Location: Vancouver, WA

Project: University of Colorado Boulder Athletics Complex
Contractor: Nicholson Construction
Location: Boulder, CO

Fiberglass Soil Nails

Williams Form fiberglass soil nails are ideally suited to be used for temporary shoring applications. Sireg Geotech, of Italy, has created a dependable flat bar fiberglass system that has been used on large projects in the United States, and now have teamed with Williams Form Engineering to provide local supply. The partnership between Williams and Sireg allows customers the benefit to have quick access to engineering support services offered by Williams.

The intended use of this product line is for temporary applications (<2 years duration). As such, the considerations documented in ACI 440.1R-06 are not pertinent to this application. Per ACI 440.1R-06, for permanent applications (sustained loads) there would be an advised environmental safety factor of 0.7 applied for degradation of the resin within the fiberglass strap as well as a sustained stress safety factor of 0.2. Since the intended use of this product is for temporary application, no degradation of the resin takes place in less than 2 years and no sustained stress losses need be accounted for as it is a short duration. An acceptable working/service load should not exceed 50% of the ultimate tensile strength of the tendon (equivalent to a reduction factor of 0.5).

Sireg 40mm x 9mm Geotech Durglass Soil Nails

Durglass Soil Nail	Nominal Area	Weight ± 8%	Ultimate Load Soil Nail	Ultimate Load Blocking System	Average Elastic Modulus	Type of Spacer	Part Number
1-Durglass	0.55 in² (355 mm²)	0.46 lbs/ft (0.68 kg/m)	65 kips (289 kN)	33 kips (147 kN)	6000 ksi (41 Gpa)	Single	RFA1
2-Durglass	1.11 in² (710 mm²)	0.91 lbs/ft (1.36 kg/m)	130 kips (578 kN)	66 kips (294 kN)	6000 ksi (41 Gpa)	Double	RFA2
3-Durglass	1.67 in² (1065 mm²)	1.37 lbs/ft (2.04 kg/m)	195 kips (867 kN)	100 kips (445 kN)	6000 ksi (41 Gpa)	Triple	RFA3

1-Durglass Soil Nail

2-Durglass Soil Nail

3-Durglass Soil Nail

Fiberglass Soil Nails

Long Lengths - No Splices

- The continuous fiberglass flat bars come in rolls and can be cut to the length necessary for each individual nail. Also, by function of them being transported in rolls, there is an option to assemble in the field and have very long nails with no issues related to spontaneous length adjustments. The only fasteners used are those of the blocking system of the tendon anchorage.

Lightweight

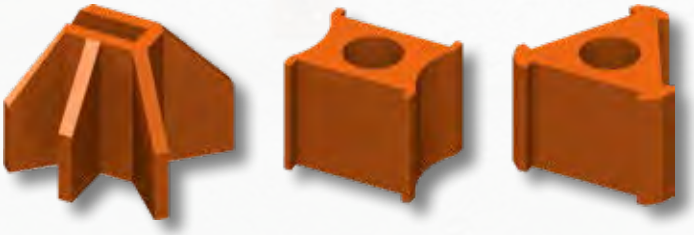
- The lightweight nature of the fiberglass bars lends to easy handling in the field. The soil nail elements can be very long and still require minimal lifting equipment.
- With a single fiberglass strap weighing a mere 0.454 lbs/ft, large quantities of this material can ship via flatbed, thus eliminating multiple shipments to project sites. The bulk of the weight in shipping comes from the steel bearing plates and wedge cups. The spacers and fiberglass wedges are non-steel and lightweight.

Removable

- With urban development requirements of no permanent support of excavation steel tendons left in place for the upper 25 feet of excavation in some urban cities, the fiberglass product saves a great deal of time and money by not requiring anchor or nail removal. These fiberglass elements can simply be excavated through and buried with no harmful environmental side effects or costly damage to machinery.

Plastic Spacers

RFPS01 RFPS02 RFPS03

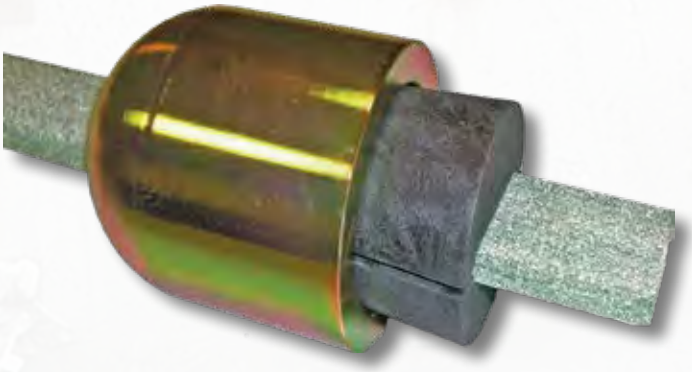


Project: Texas State Capital Bldg
Contractor: Oscar Orduno, Inc.
Location: Austin, TX

Blocking System

The Blocking system to be used with fiberglass soil nails is composed of a Steel Head Wedge Cup and Plastic Conical Wedges.

Diameter	Length	Weight	Part Number
3-1/4" (82 mm)	3-3/8" (85 mm)	4.52 lbs (2.05 kg)	RFBS



Steel Plates

Durglass Soil Nail	Number of Holes	Length & Width	Thickness	Part Number
1-Durglass	1	6" (150 mm)	3/4" (19 mm)	RFSP01
2-Durglass	2	8" (200 mm)	3/4" (19 mm)	RFSP02
3-Durglass	3	8" (200 mm)	3/4" (19 mm)	RFSP03

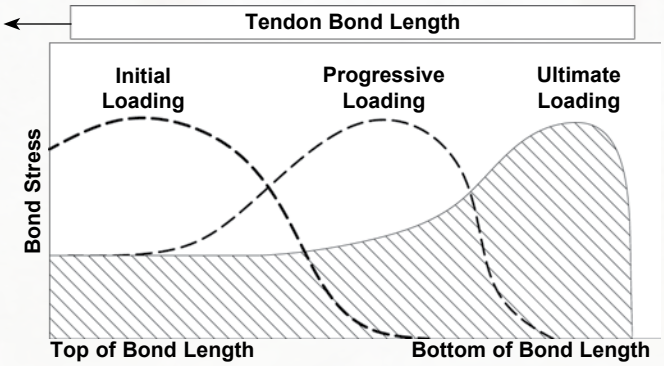
Project: Seattle Northgate Link Extension
Contractor: DBM
Location: Seattle, WA

WILLIAMS FORM ENGINEERING CORP.

Tieback & Tiedown Anchors

Williams Grade 150 KSI All-Thread Bars, Grade 75 & Grade 80 All-Thread Bars, Geo-Drill Injection Anchors and 270 KSI low relaxation strand have been successfully used as Prestressed Ground Anchors for a wide variety of Civil Engineering applications. Bonded deep into the ground using cementitious grout, these anchors transfer necessary forces to resists walls from overturning, water tanks from uplift, towers from uplift, dams from rotating and other naturally or phenomenally occurring forces applied to structures. Anchors are designed and fabricated to the latest standards as set forth in the Post-Tensioning Institute's Recommendations for Prestressd Rock and Soil Anchors. Anchor capacity is a function of the steel capacity as well as the geotechnical holding capacity. Steel capacity should be limited to 80% maximum test load and 60% when using 150 KSI Bars or strands (consult a Williams Engineer for recommendations if using a different steel tendon). Geotechnical capacity is a function of ground bond stress characteristics which can be optimized by field procedures.

Anchor Load Transfer Concepts



Taken from PTI's *Recommendations for Prestressed Rock and Soil Anchors*

Elements of a Tieback/Tiedown Anchor

Tiedown and other prestressed ground anchors work on the same philosophy as the tieback anchors with a load transfer to a structure. Key elements to all these types of anchors include:

- Anchor Bond Zone
- Uninhibited load transfer through the Free Zone
- Anchors prestressed and locked off at a predetermined load.

Tieback Walls

Tieback Walls rely on prestressed anchors transferring load to a structural front fascia to resist naturally occurring deflection forces resulting from below grade excavated bulkhead construction. The anchors achieve their geotechnical capacity by being bonded deep into the ground and behind the theoretical failure plane where the ground movement would originate should the anchors not be present. The portion of the tieback anchor carrying the load in the soil is known as the bond length. The anchor transfers the load applied to the bond length uninhibited through the failure zone by using a bond-breaker. This portion of the anchor containing the bond-breaker is known as the free-stressing length. The anchor finally terminates at the front fascia of the wall to an anchor head consisting of a plate and hex nut. The anchor head is prestressed against the outer shoring system of the wall, which in most cases would be steel soldier piles with intermediate wood lagging.

Corrosion Protection

Corrosion protection for tiebacks is specified per PTI as either Class I or Class II. MCP pregrout in a polyethylene corrugated sleeve is commonly used for permanent protection schemes.

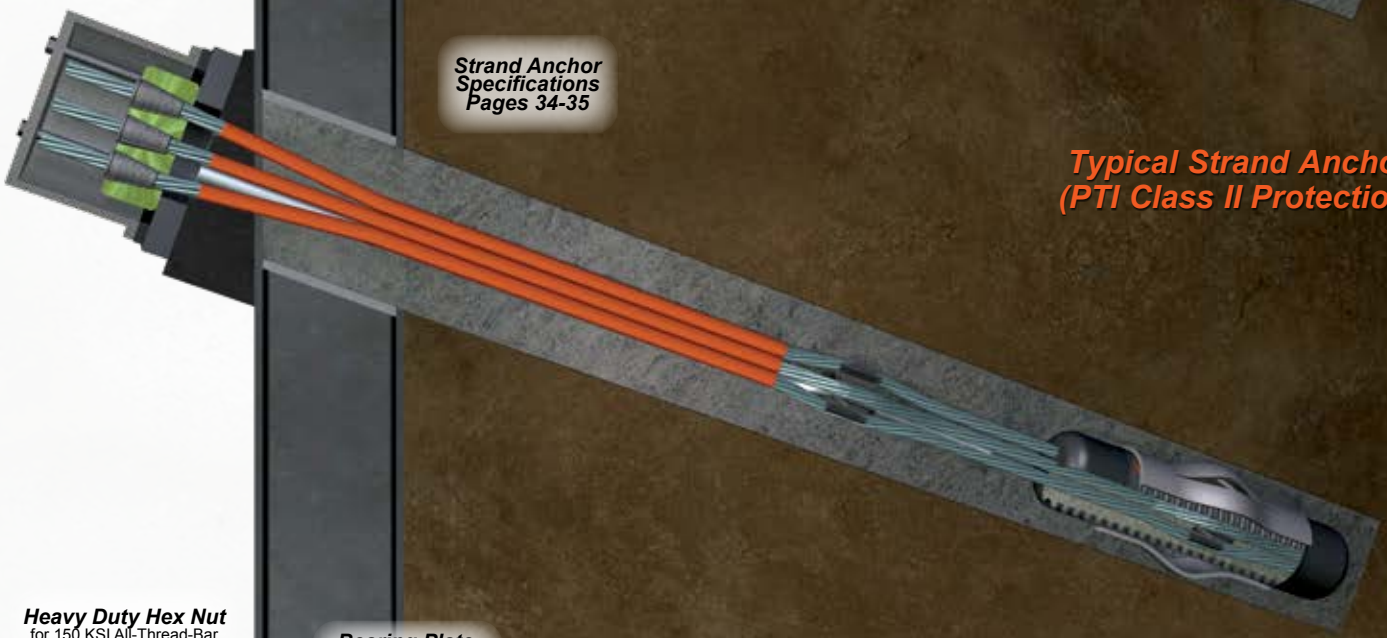
Project: Broadway and Pacific
Contractor: Condon-Johnson & Associates
Location: San Diego, CA

Project: Sand Bluff Wind Turbines
Designer: Patrick & Henderson
Location: Big Spring, TX

Specifications

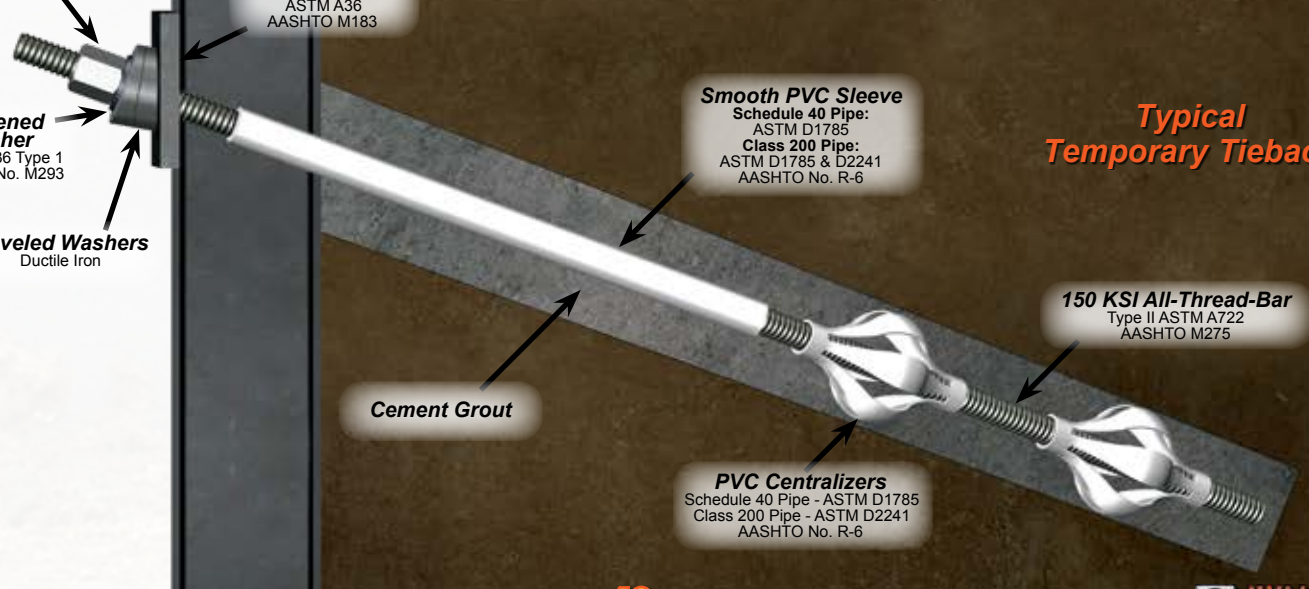
MCP Anchor Specifications Pages 40-41

Typical Multiple Corrosion Protection Anchor (PTI Class 1 Protection)



Strand Anchor Specifications Pages 34-35

Typical Strand Anchor (PTI Class II Protection)



Heavy Duty Hex Nut
for 150 KSI All-Thread-Bar

Bearing Plate
Round Hole
ASTM A36
AASHTO M183

Hardened Washer
ASTM F436 Type 1
AASHTO No. M293

Beveled Washers
Ductile Iron

Smooth PVC Sleeve
Schedule 40 Pipe:
ASTM D1785
Class 200 Pipe:
ASTM D1785 & D2241
AASHTO No. R-6

Typical Temporary Tieback

150 KSI All-Thread-Bar
Type II ASTM A722
AASHTO M275

Cement Grout

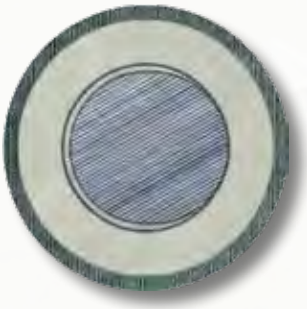
PVC Centralizers
Schedule 40 Pipe - ASTM D1785
Class 200 Pipe - ASTM D2241
AASHTO No. R-6

Micropile Information

Micropiles are high capacity, small diameter (5" to 12") drilled and grouted in-place piles designed with steel reinforcement to primarily resist structural loading. Micropiles have rapidly gained popularity for foundations in urbanized areas or in locations with low headroom and restricted access. They are an ideal choice for underpinning or emergency repairs because they can be installed in virtually any ground condition with minimal vibration and disturbance to existing structures. Williams larger diameters of All-Thread Rebar are popular choices for micropile reinforcement.

Williams offers right-hand threaded Grade 75 & Grade 80 All-Thread Rebar in #14 - #32 along with a selection of reducer couplers that can adapt to splice together any larger size bar to any smaller size. Williams also offers Grade 90 All-Thread-Rebar and 150 KSI All-Thread-Bar as alternatives for micropile design applications upon request.

#28 Bar
Cross Section Area
9.61 in²
(6,200 mm²)



Larger Bar Micropile Cost Saving Advantages

In larger micropile designs, casing diameter is minimized because the effective net area available for reinforcement is optimized with a single larger bar versus smaller bundled bars (see example). There is also an increased rate of production installing a single larger bar versus smaller bundled bars. See pages 18-19 for Grade 75 & Grade 80 All-Thread Rebar information.

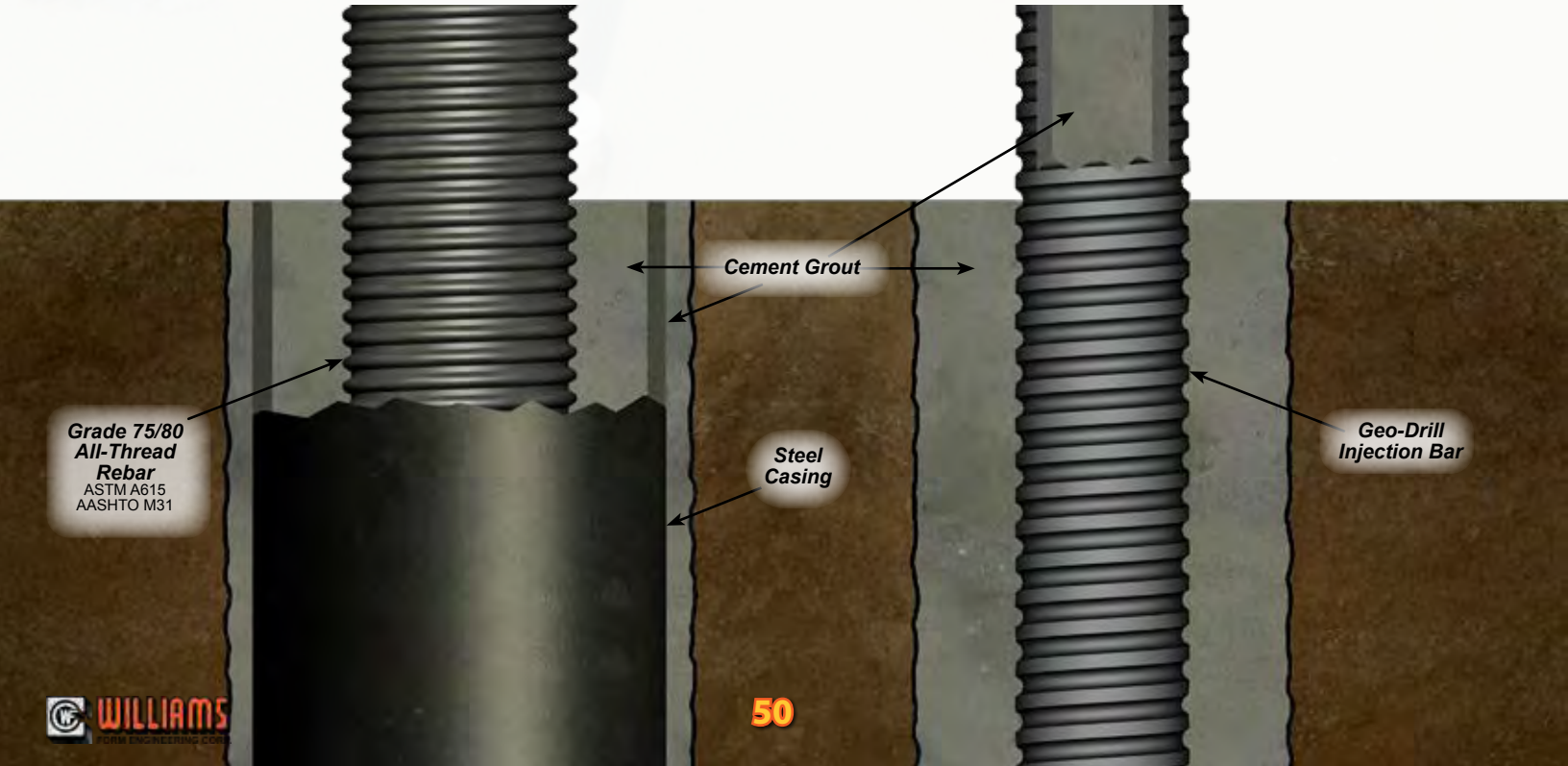
Bundled #20 Bars
Cross Section Area
9.82 in²
(6,336 mm²)

Hollow Bar Micropiles

Accepted by the FHWA in the *Micropile Design and Construction Guidelines Manual*, Hollow Bars are being used increasingly for micropile applications. Through the increased bond stress resultant from the simultaneous drilling and grouting operation, Hollow Bars are the reinforcement bar choice in collapsing soil conditions.

Using sizes from 32 mm to 130 mm, these Hollow Bars offer up to 1785 kips of strength, up to 16.2 in² of cross sectional reinforcement area, and their section modulus provides considerable bending resistance. A variety of drill bits promise efficient installation and Williams offers a full line of adaptation equipment and rental grout plants necessary for Hollow Bar anchor installation. See pages 24-29 for Hollow Bar information.

Single Bar Micropile System



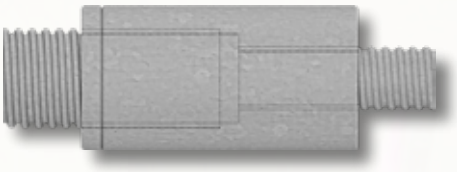
Micropile Accessories & Testing

Compression Sleeves

Compression Sleeves are smaller in diameter than standard couplings and are offered for use in splicing steel reinforcement for compression-only micropile designs. Compression Sleeves offer the advantage of designing around smaller diameter casings. Compression Sleeves will not develop the full tensile strength of the bar.

Reducer Coupling

Reducer Couplings are available to transition from a larger diameter bar to a smaller diameter bar. Reducer Couplings will develop the full ultimate strength of the smaller diameter bar.



Multi-Bar Micropiles

Multi-bar elements are often used for attaining ultra-high load carrying capacity in micropiles. High-rise office buildings and high-rise condominiums are examples where such high load carrying micropiles (or sometimes referred to as mini-caissons) are used. Each multi-bar micropile project is uniquely designed by Williams to specific contractor specifications and shipped to the jobsite fabricated in durable cages for quick installation. Williams stands alone in being a customized manufacturer and therefore offers the advantage to the industry of niche accessories to optimize efficiency and costs.

Micropile Testing

Micropiles are often tested in compression and tension for verification and proof tests. Micropiles are more frequently designed to resist large lateral loads, therefore, it is necessary to perform pre-production lateral load tests on single piles or groups of piles as well. Williams manufactures all products necessary for the reaction piles and offers a full line of testing equipment. Compression testing is accomplished by reacting against the bottom of a test beam that is anchored to the ground with reaction piles. The reaction piles are installed from the test pile at a minimum distance, so the reaction piles do not influence the loading of the test pile.

Compression and Lateral Load Test

On a typical compression test, the reaction beam is cribbed a distance off of the ground to accommodate the test jack and load cell between the test pile and the bottom of the test beam. The compressive load is then applied to the pile through the test jack reacting against the bottom of the beam. The prestress force on the reaction piles keep the beam from rolling.

Typical Compression Test

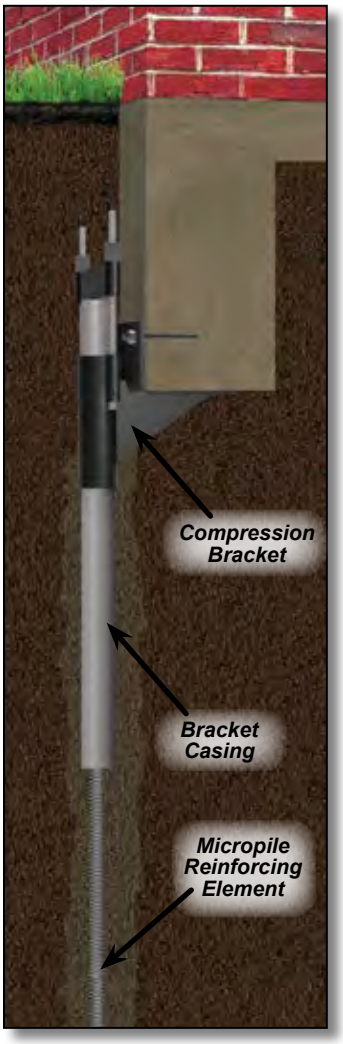
Typical Tension Test

Micropile Remedial Repair Underpinning Brackets

Williams Form Engineering Corp. offers underpinning brackets for tension and/or compression foundation remediation applications. Prior to micropile drilling, the bracket is attached to the footing using concrete anchor bolts. The bracket provides a drill template to ensure pile eccentricity is within the allowable limit. Brackets are offered in three sizes ranging from 20 kip to 63 kip allowable capacities where the bracket is attached to a grouted micropile casing in medium stiff soils (N>4). The unbraced length of micropile is minimum 5'; so per section 1810.2.1 of IBC, a casing length of min 6' is required to resist buckling and bending stresses. Brackets can be used in soft soils (N<4), however, the capacity may be reduced as the unbraced length of the micropile would be greatly increased in weaker soils. Please consult with a professional engineer to determine allowable working design load.

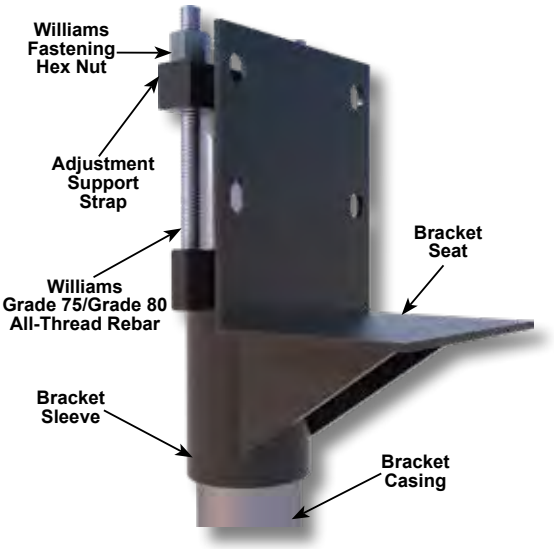
Compression Underpinning Bracket (C)

Supports and raises existing foundations via connection to grouted micropile casing.
Attaches to footing using two 1/2" diameter concrete anchor bolts.

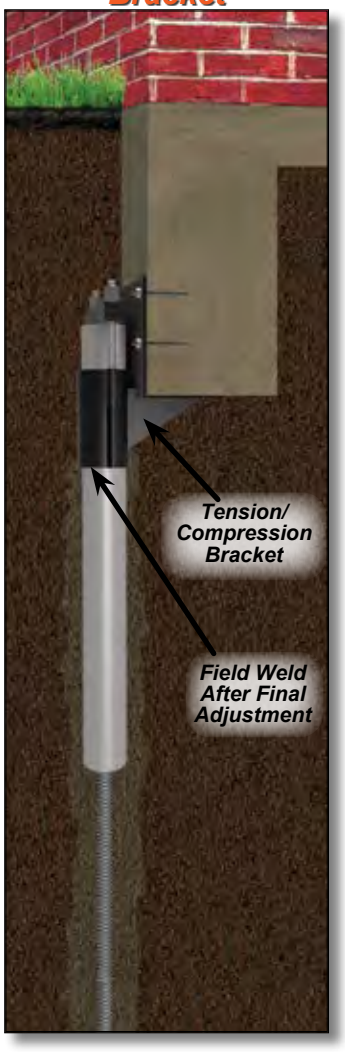


Bracket Number	Allowable Bracket Capacity *	Bracket Sleeve		Bracket Seat	Bracket Casing **			
		OD	Wall Thickness	Bearing Area	OD	Wall Thickness	Standard Length	Yield Stress
WMS-MPB-20-C	20 kips (88.9 kN)	3-1/2" (89 mm)	1/4" (6.4 mm)	90 in² (580 cm²)	2-7/8" (73 mm)	0.2" (5.5 mm)	6' (1.8 m)	65 KSI (448 Mpa)
WMS-MPB-40-C	40 kips (178 kN)	5-9/16" (141 mm)	3/8" (9.5 mm)	90 in² (580 cm²)	4-1/2" (114 mm)	0.44" (11.1 mm)	6' (1.8 m)	65 KSI (448 Mpa)
WMS-MPB-63-C	63 kips (280 kN)	6-5/8" (168 mm)	0.43" (11 mm)	90 in² (580 cm²)	5-9/16" (141 mm)	0.26" (6.6 mm)	6' (1.8 m)	36 KSI (248 Mpa)

* Allowable bracket capacity is based on the usage of an equal or greater size, grade, and length of bracket casing shown in the chart above and assumes the back of the bracket seat is no more than 1.5" from the edge of the footing.
** WFEC does not provide the bracket casing



Tension/Compression Bracket



Tension/Compression Underpinning Bracket (TC)

Supports and raises existing foundations via connection to grouted micropile casing. In tension, bracket requires a postive connection to the foundation through four 1" diameter concrete anchors bolts with embedment depths designed by the EOR for adequate shear capacity to resist uplift loads. To complete the tension load path, the bracket must be positively connected to the micopile casing by field welding the bracket sleeve to the mircropile casing or by attaching shear bolts from the bracket sleeve through the micropile casing.

Bracket Number	Allowable Bracket Capacity *	Bracket Sleeve		Bracket Seat	Bracket Casing **			
		OD	Wall Thickness	Bearing Area	OD	Wall Thickness	Standard Length	Yield Stress
WMS-MPB-20-TC	20 kips (88.9 kN)	3-1/2" (89 mm)	1/4" (6.4 mm)	90 in² (580 cm²)	2-7/8" (73 mm)	0.22" (5.5 mm)	6' (1.8 m)	65 KSI (448 Mpa)
WMS-MPB-40-TC	40 kips (178 kN)	5-9/16" (141 mm)	3/8" (9.5 mm)	90 in² (580 cm²)	4-1/2" (114 mm)	0.44" (11 mm)	6' (1.8 m)	65 KSI (448 Mpa)
WMS-MPB-63-TC	63 kips (280 kN)	6-5/8" (168 mm)	0.43" (11 mm)	90 in² (580 cm²)	5-9/16" (141 mm)	0.26" (6.6 mm)	6' (1.8 m)	36 KSI (248 Mpa)

See notes above

Micropile Project Photos

Project: Acrisure Amphitheater
Contractor: Nicholson Construction
General Contractor: Pioneer Construction/Barton Malow
Location: Grand Rapids, MI

Project: NASCAR Hall of Fame
Contractor: Hayward Baker
Location: Charlotte, NC

Project: 535 Mission
Contractor: Malcolm Drilling
Location: San Francisco, CA

Project: Kimmel Pavillion
Contractor: Stressbar/Posillico
Foundation Consultant: FNA Associates
Location: New York, NY

Project: UCSD
Contractor: Condon-Johnson & Associates
Location: San Diego, CA

Project: Private Residence
Contractor: Park Range Construction
Location: Ridgeway, CO

Introduction

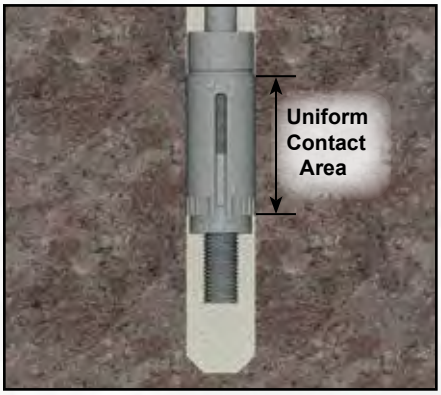
Williams Spin-Lock anchors were first used in the 1950's for rock/roof bolting in projects such as NORAD and Australia's Snowy Mountain power facility. Since then many engineers, contractors and owners have seen the advantages of the Spin-Locks on dams, locks, water/waste treatment facilities and many other large scale civil projects. Williams Spin-Lock anchors provide the advantage of immediate anchorage for prestressing and require shorter embedments than traditional grout bond anchor systems.

The Spin-Lock has been job-proven, time and time again to meet all bolting requirements in any strata which can be bolted.

To comply with the need for bolts which will satisfactorily anchor a broad range of variable rock formations, Williams has developed a complete family of rock bolts with a simple and efficient system of installation. Williams offers a complete line of rental equipment for installing, testing and grouting of Spin-Lock anchors.

Before proceeding with your next project, consult with a design agency familiar with Williams Rock Bolting. Williams would be pleased to recommend an ideal system for you.

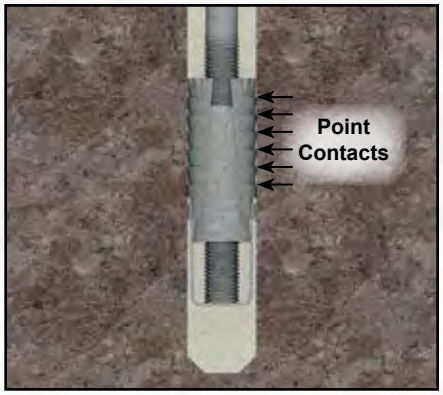
Project: NORAD - Cheyenne Mountain Air Station
Contractor: Utah Construction & Mining Company
Location: Cheyenne Mountain, CO



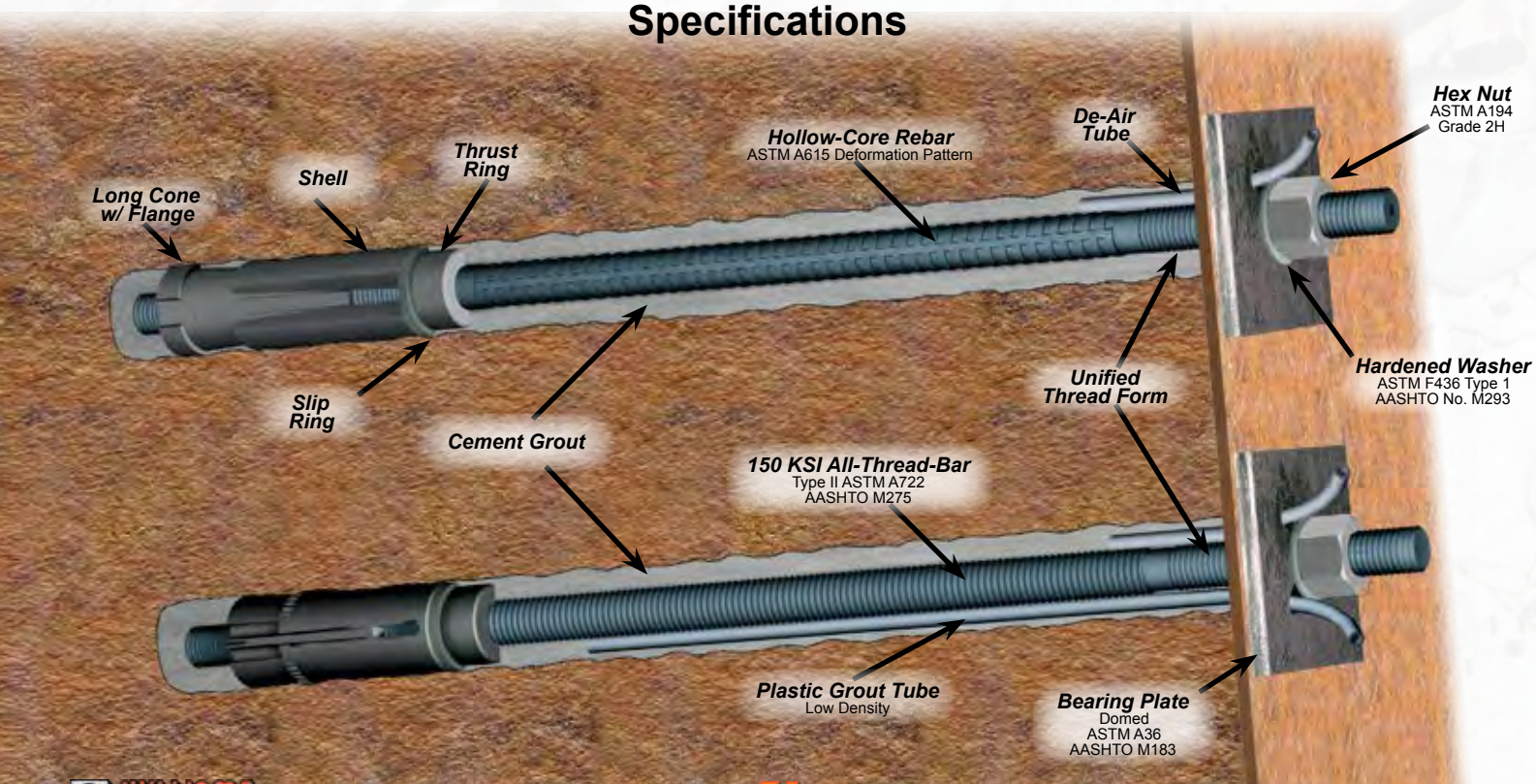
Anchor Head Comparison

Williams Spin-Lock Anchor (Left)
Expansion shell receives full bearing support from solid 300° cone design.

Serrated Anchor by others (Right)
Quartered cone design leaves expansion shell unsupported at adjacent gaps. Shell can collapse in under high stress.

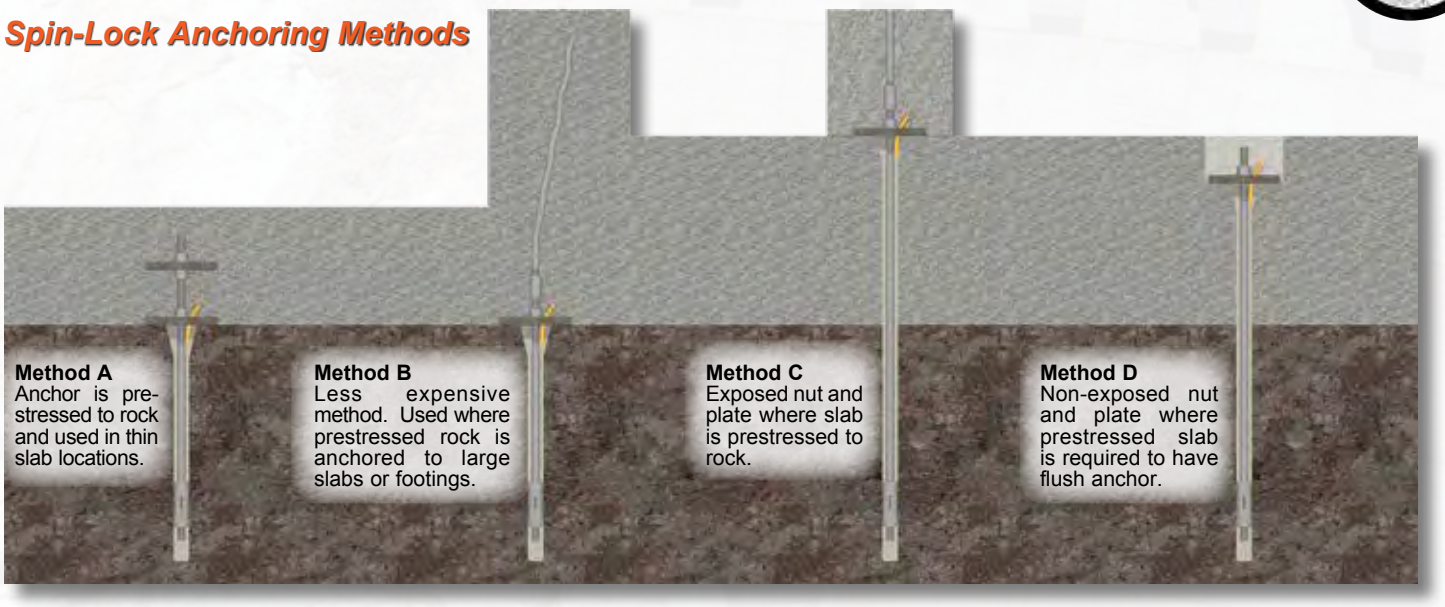


Specifications



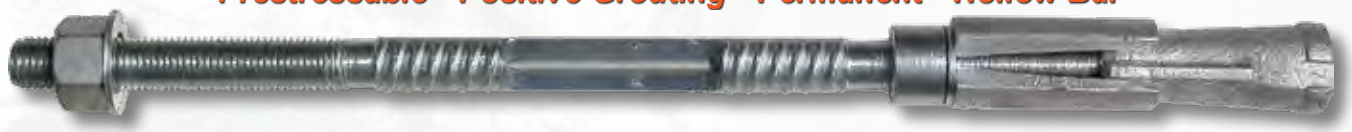
Anchor Data

Spin-Lock Anchoring Methods



R1H Hollow-Core Spin-Lock Rock Bolt

Prestressable • Positive Grouting • Permanent • Hollow Bar



Through years of development Williams has produced and patented the prestressable, groutable, Hollow-Core Spin-Lock Rock Bolting Systems. The hollow-core allows the bolt to always be grouted from the lowest gravitational point. In an up-bolting situation, the grout is pumped in through the plastic grout tube and begins to fill the drill hole from the plate. The grout rises until the entire hole is filled and the grout returns through the hollow bar. In down grouting situations, the grout is pumped through the hollow bar and starts at the bottom of the hole. Grout rises and returns through the de-air tube when the hole is filled. Improperly or incomplete grouted bolts are subjected to relaxation and corrosion. Pre-measured capsule systems cannot properly account for unknown fissures and voids and often leave the bolt vulnerable to deterioration. The Williams Hollow-Core Grouting System spreads grout through the rock fissures creating a completely protected monolithic section including rock, grout and bolt. Because the Spin-Lock head assembly provides 300° perimeter expansion anchorage and develops the full strength of the rod, the hollow-core rock bolt may be prestressed to the desired load and tested prior to grouting. The 1” diameter Hollow-Core is also available in an All-Thread design of identical capacities. The Hollow-Core rebar is not available from a domestic source.

R1H Structural Properties

Yield Stress	Ultimate Stress	Elongation in 2” (51 mm)	Reduction of Area
91 KSI (627 MPa)	124 KSI (854 MPa)	15% min	40% min

R1H High Grade Hollow-Core Rock Anchor

ASTM A615 Deformation Pattern

Dia & Threads per In.	Max Recommended Design Load at 2:1 Safety Factor	Yield Strength (fy)	Ultimate Strength (fu)	Drill Hole Diameter (1)	Type Head Ass’y	Torque (ft-lbs) To Expand Shell (2)	Torque (ft-lbs) On Nut for Tension (3)	Part Number
1” - 8 (25 mm)	33 kips (147 kN)	47 kips (209 kN)	66 kips (294 kN)	1-5/8” - 41 mm) 1-3/4” - (44 mm) 1-3/4” - (44 mm) 2” - (51 mm)	A 13 B 14 C 14 B 16	250 ft-lbs (450*)	400	R1H08A13 R1H08B14 R1H08C14 R1H08B16
1-3/8” - 8 (35 mm)	69 kips (307 kN)	100 kips (445 kN)	138 kips (614 kN)	2-1/4” - (57 mm) 2-1/2” - (64 mm) 3” - (76 mm)	B 18 B 20 B 24	750 ft-lbs (1200*)	Note (4)	R1H11B20 R1H11B24
2” - 6 (51 mm)	150 kips (667 kN)	219 kips (974 kN)	300 kips (1334 kN)	3-1/2” - (89 mm)	C 28	1000 ft-lbs (3700*)	Note (4)	R1H16C28

(*) Do not exceed these numbers
(1) Care should be taken to drill a straight and properly sized hole.
(2) A function of strata strength. More torque may be required on long anchors or in special rock conditions. Consult your Williams Representative.
(3) Torque value listed will achieve approximate load of 50% of the anchor ultimate strength, and is based on the torque tension curves on page 79.
(4) Stress to desired tensile load using a hollow ram hydraulic jack. Consult your Williams Representative.

- Inconsistencies in rock from site to site and even from hole to hole may affect anchor performances. Fissures, voids, seams, rock psi, drilling through clay or bentonite and direction of bedding planes are all possible variables. Should problems occur, consult Williams for troubleshooting.
- Spin-Locks come standard with 12” of threaded area. Other lengths available upon request.
- WILLIAMS reserves the right to ship full length or coupled units as necessary.
- For Spin-Lock Accessories see page 23.

R1J & R7S Spin-Lock Rock Bolt

R1J Structural Properties

Diameter Range	Yield Stress	Ultimate Stress	Elongation in 8" Gauge Length
1/2" to 1" (13 to 25 mm)	60 KSI (413 MPa)	80 KSI (552 MPa)	7% min
1-1/8" and up (29 mm)	60 KSI (413 MPa)	80 KSI (552 MPa)	9% min

The R1J uses an ASTM Grade 60 material for the anchor bolt which is generally less expensive than other Spin-Lock anchors which incorporate higher strength steels.

R1J Solid Rebar Spin-Lock Rock Anchor

ASTM A615

Dia & Threads per In.	Max Recommended Design Load at 2:1 Safety Factor	Yield Strength (fy)	Ultimate Strength (fu)	Drill Hole Diameter (1)	Type Head Ass'y	Torque (ft-lbs)		Part Number
						To Expand Shell (2)	On Nut for Tension (3)	
1/2" - 13 (13 mm)	5.7 kips (25.4 kN)	8.5 kips (37.9 kN)	11.3 kips (50.5 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	50 ft-lbs (50*)	60	R1J04A10 R1J04A13
5/8" - 11 (16 mm)	9.0 kips (40.0 kN)	13.6 kips (60.3 kN)	18.1 kips (80.4 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	100 ft-lbs (100*)	110	R1J05A10 R1J05A13
3/4" - 10 (19 mm)	13.4 kips (59.6 kN)	20.0 kips (89.1 kN)	26.7 kips (119 kN)	1-3/4" - (44 mm) 1-3/4" - (44 mm)	B 14 C 14	165 ft-lbs (165*)	175	R1J06B14 R1J06C14
7/8" - 9 (22 mm)	18.5 kips (82.3 kN)	27.7 kips (123 kN)	37.0 kips (164 kN)	1-3/4" - (44 mm) 2" - (51 mm)	C 14 B 16	265 ft-lbs (265*)	290	R1J07B16
1" - 8 (25 mm)	24.2 kips (108 kN)	36.4 kips (162 kN)	48.5 kips (216 kN)	2" - (51 mm)	B 16	400 ft-lbs (400*)	420	R1J08B16
1-1/8" - 7 (29 mm)	30.5 kips (136 kN)	45.8 kips (204 kN)	61.0 kips (271 kN)	2" - (51 mm) 2-1/4" - (57 mm)	B 16 C 18	450 ft-lbs (550*)	610	R1J09B16 R1J09C18
1-1/4" - 7 (32 mm)	38.8 kips (173 kN)	58.1 kips (259 kN)	77.5 kips (345 kN)	2-1/4" - (57 mm)	C 18	750 ft-lbs (750*)	810	R1J10C18
1-3/8" - 8 (35 mm)	49.3 kips (219 kN)	73.8 kips (328 kN)	98.6 kips (439 kN)	2-1/2" - (64 mm)	B 20	750 ft-lbs (1000*)	Note (4)	R1J11B20
1-3/4" - 5 (45 mm) †	74.5 kips (331 kN)	110 kips (489 kN)	149 kips (663 kN)	3" - (76 mm)	B 24	1000 ft-lbs (1700*)	Note (4)	R1J14B24
2" - 6 (51 mm)	106 kips (472 kN)	159 kips (707 kN)	212 kips (943 kN)	3-1/2" - (89 mm)	C 28	1000 ft-lbs (4000*)	Note (4)	R1J16C28

† 1-3/4" diameter is made from 400W rebar from Canada.

See additional Notes on page 57.

The R7S Spin-Lock incorporates a high strength post-tension steel giving the designer the highest strength to anchor diameter ratio available for use with the Spin-Lock head assembly.

R7S Structural Properties

Yield Stress	Ultimate Stress	Elongation in 20 Bar Dia.	Reduction of Area
120 KSI (827 MPa)	150 KSI (1034 MPa)	4% min	20% min

R7S 150 KSI Spin-Lock Rock Anchor

ASTM A722

Dia & Threads per In.	Max Recommended Design Load at 2:1 Safety Factor	Yield Strength (fy)	Ultimate Strength (fu)	Drill Hole Diameter (1)	Type Head Ass'y	Torque (ft-lbs)		Part Number
						To Expand Shell (2)	On Nut for Tension (3)	
1" - 8 (25 mm)	45.5 kips (202 kN)	72.7 kips (324 kN)	90.9 kips (404 kN)	2" - (51 mm)	B 16	500 ft-lbs (650*)	680	R7S08B16
1-1/4" - 7 (32 mm)	72.7 kips (323 kN)	116 kips (517 kN)	145 kips (647 kN)	2-1/2" - (64 mm)	B 20	750 ft-lbs (1200*)	Note (4)	R7S10B20
1-1/2" - 6 (38 mm)	105 kips (469 kN)	169 kips (750 kN)	211 kips (937 kN)	3" - (76 mm)	B 24	1000 ft-lbs (1700*)	Note (4)	R7S12B24
1-7/8" - 8 (48 mm)	181 kips (804 kN)	289 kips (1286 kN)	362 kips (1608 kN)	3-1/2" - (89 mm)	C 28	1000 ft-lbs (3400*)	Note (4)	R7S15C28

See Notes on page 57.

R1S High Tensile Spin-Lock Rock Bolt

R1S Structural Properties

Diameter Range	Yield Stress	Ultimate Stress	Elongation in 2" Gauge Length	Reduction of Area
1/2" to 1" (13 to 25 mm)	92 KSI (634 MPa)	120 KSI (827 MPa)	11% min	20% min
1-1/8" and up (29 mm)	81 KSI (558 MPa)	105 KSI (723 MPa)	11% min	20% min

Meets strength of ASTM A325

Williams R1S High Tensile Spin-Lock Rock Anchor Bolt utilizes an ASTM A108 Grade C1045 steel which provides high strength capacity and has the advantage of utilizing a more common steel for greater availability.

R1S High Tensile Spin-Lock Rock Anchor

ASTM A108 Grade C1045

Dia & Threads per In.	Max Recommended Design Load at 2:1 Safety Factor	Yield Strength (fy)	Ultimate Strength (fu)	Drill Hole Diameter (1)	Type Head Ass'y	Torque (ft-lbs)		Part Number
						To Expand Shell (2)	On Nut for Tension (3)	
1/2" - 13 (13 mm)	8.51 kips (37.9 kN)	13.1 kips (58.1 kN)	17.0 kips (75.7 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	50 ft-lbs (70*)	85	R1S04A10 R1S04A13
5/8" - 11 (16 mm)	13.6 kips (60.3 kN)	20.8 kips (92.5 kN)	27.1 kips (121 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	125 ft-lbs (250*)	125	R1S05A10 R1S05A13
3/4" - 10 (19 mm)	20.0 kips (89.1 kN)	30.7 kips (137 kN)	40.1 kips (178 kN)	1-3/4" - (44 mm) 1-3/4" - (44 mm)	B 14 C 14	210 ft-lbs (250*)	210	R1S06B14 R1S06C14
7/8" - 9 (22 mm)	27.7 kips (123 kN)	42.5 kips (189 kN)	55.4 kips (247 kN)	1-3/4" - (44 mm) 2" - (51 mm)	C 14 B 16	390 ft-lbs (410*)	390	R1S07B16
1" - 8 (25 mm)	36.4 kips (162 kN)	55.8 kips (248 kN)	72.7 kips (323 kN)	2" - (51 mm)	B 16	500 ft-lbs (600*)	550	R1S08B16
1-1/8" - 7 (29 mm)	40.1 kips (178 kN)	61.8 kips (275 kN)	80.1 kips (356 kN)	2" - (51 mm) 2-1/4" - (57 mm)	B 16 C 18	550 ft-lbs (600*)	770	R1S09B16 R1S09C18
1-1/4" - 7 (32 mm)	50.9 kips (226 kN)	78.5 kips (349 kN)	102 kips (453 kN)	2-1/4" - (57 mm) 2-1/2" - (64 mm)	C 18 B 20	750 ft-lbs (1200*)	1000	R1S10C18 R1S10B20
1-3/8" - 8 (35 mm)	65 kips (287 kN)	100 kips (443 kN)	129 kips (575 kN)	2-1/2" - (64 mm)	B 20	750 ft-lbs (1600*)	Note (4)	R1S11B20
1-1/2" - 6 (38 mm)	73.8 kips (328 kN)	114 kips (506 kN)	148 kips (656 kN)	3" - (76 mm)	B 24	1000 ft-lbs (1700*)	Note (4)	R1S12B24
2" - 6 (51 mm)	139 kips (619 kN)	215 kips (955 kN)	278 kips (1238 kN)	3-1/2" - (89 mm)	C 28	1000 ft-lbs (4000*)	Note (4)	R1S16C28

(*) Do not exceed these numbers
(1) Care should be taken to drill a straight and properly sized hole.
(2) A function of strata strength. More torque may be required on long anchors or in special rock conditions. Consult your Williams Representative.
(3) Torque value listed will achieve approximate load of 50% of the anchor ultimate strength, and is based on the torque tension curves on page 79.
(4) Stress to desired tensile load using a hollow ram hydraulic jack. Consult your Williams Representative.

- Inconsistencies in rock from site to site and even from hole to hole may affect anchor performances. Fissures, voids, seams, rock psi, drilling through clay or bentonite and direction of bedding planes are all possible variables. Should problems occur, consult Williams for troubleshooting.
- Spin-Locks come standard with 12" of threaded area. Other lengths available upon request.
- WILLIAMS reserves the right to ship full length or coupled units as necessary.
- For Spin-Lock Accessories see page 23.

B7S & R1V Spin-Lock Rock Bolt

Williams B7S Coil All-Thread Spin-Lock Rock Anchor Bolt utilizes an ASTM A108 Grade C1045 steel which provides high strength capacity and has the advantage of utilizing a more common steel for greater availability.

B7S Structural Properties

Diameter Range	Yield Stress	Ultimate Stress	Elongation in 2" Gauge Length	Reduction of Area
1/2" to 1" (13 to 25 mm)	92 KSI (634 MPa)	120 KSI (827 MPa)	11% min	20% min
1-1/8" and up (29 mm)	81 KSI (558 MPa)	105 KSI (723 MPa)	11% min	20% min

Meets strength of ASTM A325

B7S Coil All-Thread Spin-Lock Rock Anchor

ASTM A108 Grade C1045

Dia & Threads per In.	Max Recommended Design Load at 2:1 Safety Factor	Yield Strength (fy)	Ultimate Strength (fu)	Drill Hole Diameter (1)	Type Head Ass'y	Torque (ft-lbs)		Part Number
						To Expand Shell (2)	On Nut for Tension (3)	
1/2" - 13 (13 mm)	8.45 kips (37.6 kN)	13.0 kips (57.7 kN)	16.9 kips (75.2 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	50 ft-lbs (70*)	85	B7S04A10 B7S04A13
5/8" - 11 (16 mm)	13.3 kips (59.0 kN)	20.3 kips (90.4 kN)	26.5 kips (118 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	125 ft-lbs (250*)	125	B7S05A10 B7S05A13
3/4" - 10 (19 mm)	20.0 kips (88.9 kN)	30.6 kips (136 kN)	40.0 kips (178 kN)	1-3/4" - (44 mm) 1-3/4" - (44 mm)	B 14 C 14	210 ft-lbs (250*)	210	B7S06B14 B7S06C14
7/8" - 9 (22 mm)	27.5 kips (122 kN)	42.1 kips (187 kN)	55.0 kips (245 kN)	1-3/4" - (44 mm) 2" - (51 mm)	C 14 B 16	390 ft-lbs (410*)	390	B7S07B16
1" - 8 (25 mm)	35.4 kips (157 kN)	54.3 kips (241 kN)	70.8 kips (315 kN)	2" - (51 mm)	B 16	500 ft-lbs (600*)	550	B7S08B16
1-1/8" - 7 (29 mm)	38.8 kips (173 kN)	59.9 kips (266 kN)	77.6 kips (345 kN)	2" - (51 mm) 2-1/4" - (57 mm)	B 16 C 18	550 ft-lbs (600*)	770	B7S09B16 B7S09C18
1-1/4" - 7 (32 mm)	50.8 kips (226 kN)	78.5 kips (349 kN)	102 kips (452 kN)	2-1/4" - (57 mm) 2-1/2" - (64 mm)	C 18 B 20	750 ft-lbs (1200*)	1000	B7S10C18 B7S10B20
1-1/2" - 6 (38 mm)	73.8 kips (328 kN)	114 kips (506 kN)	148 kips (656 kN)	3" - (76 mm)	B 24	1000 ft-lbs (1700*)	Note (4)	B7S12B24

See Notes on page 57.

R1V Structural Properties

Yield Stress	Ultimate Stress	Elongation in 4 Bar Dia.	Reduction of Area	Charpy at -40° F (-40° C)
105 KSI (723 MPa)	125 KSI (861 MPa)	16% min	50% min	20 ft-lbs (27 Joules)

The R1V is often specified for applications in extreme cold temperatures or if the anchor may be exposed to impact loading.

R1V High Impact Spin-Lock Rock Anchor

ASTM A193 Grade B7

Dia & Threads per In.	Max Recommended Design Load at 2:1 Safety Factor	Yield Strength (fy)	Ultimate Strength (fu)	Drill Hole Diameter (1)	Type Head Ass'y	Torque (ft-lbs)		Part Number
						To Expand Shell (2)	On Nut for Tension (3)	
1/2" - 13 (13 mm)	8.9 kips (39.5 kN)	14.9 kips (66.3 kN)	17.8 kips (79.0 kN)	1-1/4" - (32 mm) 1-5/8" - (41 mm)	A 10 A 13	50 ft-lbs (50*)	85	R1V04A10 R1V04A13
3/4" - 10 (19 mm)	20.9 kips (92.9 kN)	35.1 kips (156 kN)	41.8 kips (186 kN)	1-3/4" - (44 mm) 1-3/4" - (44 mm)	B 14 C 14	210 ft-lbs (250*)	250	R1V06B14 R1V06C14
1" - 8 (25 mm)	37.9 kips (169 kN)	63.6 kips (284 kN)	75.8 kips (337 kN)	2" - (51 mm)	B 16	500 ft-lbs (600*)	550	R1V08B16
1-1/4" - 7 (32 mm)	60.6 kips (269 kN)	102 kips (453 kN)	121 kips (538 kN)	2-1/4" - (57 mm) 2-1/2" - (64 mm)	C 18 B 20	750 ft-lbs (1600*)	1000	R1V10C18 R1V10B20
1-3/8" - 8 (35 mm)	76.9 kips (342 kN)	129 kips (575 kN)	154 kips (684 kN)	2-1/2" - (64 mm)	B 20	750 ft-lbs (1600*)	Note (4)	R1V11B20
1-1/2" - 6 (38 mm)	87.8 kips (391 kN)	148 kips (656 kN)	176 kips (781 kN)	3" - (76 mm)	B 24	1000 ft-lbs (1700*)	Note (4)	R1V12B24
1-3/4" - 5 (45 mm)	119 kips (528 kN)	200 kips (887 kN)	238 kips (1056 kN)	3" - (76 mm) 3-1/2" - (89 mm)	B 24 C 28	1000 ft-lbs (1700*)	Note (4)	R1V14B24 R1V14C28
2" - 6 (51 mm)	166 kips (737 kN)	278 kips (1238 kN)	331 kips (1473 kN)	3-1/2" - (89 mm)	C 28	1000 ft-lbs (4000*)	Note (4)	R1V16C28

See Notes on page 57.

Head Assemblies

The Williams Spin-Lock anchor assembly gives full 300° bearing area. The smooth shell design allows for maximum shell to rock contact and eliminates "point of contact" created by serrated designs. The cone design supports the shell 300°, thereby eliminating any possible collapse of the shell under high load conditions. The thrust ring stop in front of the shell prevents any possible rebound of the expanded shell down the cone when subjected to nearby blasting. The Williams Spin-Lock anchor has been field proven on the world's largest projects to far exceed in tension capacity any other mechanical anchor on the market.

Type A
Short Shell & Cone

Type B
Long Shell & Cone

Type C
Long Shell & Cone w/ Flange

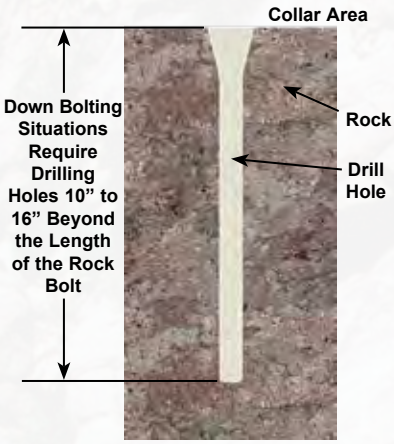
Head Assembly	Drill Hole Diameter	Diameter & Threads per Inch	Cone		Shell		Thrust Ring		Slip Rings	Overall Assembly Length
			Length	Part No.	Length	Part No.	Diameter	Thickness		
A10	1-1/4" (32 mm)	1/2" - 13 NC (13 mm)	1-7/8" (48 mm)	SC-114-4	1-7/8" (48 mm)	SS-114	1-1/8" (29 mm)	9/16" (14 mm)	1/16" (1.6 mm)	4-7/16" (112 mm)
		5/8" - 11 NC (16 mm)	1-7/8" (48 mm)	SC-114-5	1-7/8" (48 mm)	SS-114	1-1/8" (29 mm)	9/16" (14 mm)	1/16" (1.6 mm)	4-7/16" (112 mm)
A13 †	1-5/8" (41 mm)	1/2" - 13 NC (13 mm)	1-7/8" (48 mm)	SC-158-4	1-7/8" (48 mm)	SS-158	1-1/2" (38 mm)	9/16" (14 mm)	1/16" (1.6 mm)	3-3/4" (95 mm)
		5/8" - 11 NC (16 mm)	1-7/8" (48 mm)	SC-158-5	1-7/8" (48 mm)	SS-158	1-1/2" (38 mm)	9/16" (14 mm)	1/16" (1.6 mm)	3-3/4" (95 mm)
		* 1" - 8 NC (25 mm)	1-7/8" (48 mm)	SC-158-8	1-7/8" (48 mm)	SS-158	1-1/2" (38 mm)	9/16" (14 mm)	1/16" (1.6 mm)	4-1/8" (108 mm)
B14 †	1-3/4" (44 mm)	3/4" - 10 NC (19 mm)	3-3/4" (95 mm)	LC-158-6	3-3/4" (95 mm)	LS-175	1-5/8" (41 mm)	15/16" (24 mm)	1/16" (1.6 mm)	8" (210 mm)
		* 1" - 8 NC (25 mm)	3-3/4" (95 mm)	LC-158-8	3-3/4" (95 mm)	LS-175	1-5/8" (41 mm)	15/16" (24 mm)	1/16" (1.6 mm)	8-1/2" (216 mm)
B16 †	2" (51 mm)	7/8" - 9 NC (22 mm)	2-1/2" (64 mm)	LC-200-7	4" (102 mm)	LS-200	1-7/8" (48 mm)	15/16" (24 mm)	1/16" (1.6 mm)	7-3/8" (187 mm)
		1" - 8 NC (25 mm)	2-1/2" (64 mm)	LC-200-8	4" (102 mm)	LS-200	1-7/8" (48 mm)	15/16" (24 mm)	1/16" (1.6 mm)	7-3/8" (187 mm)
		1-1/8" - 7 NC (29 mm)	2-1/2" (64 mm)	LC-200-9	4" (102 mm)	LS-200	1-7/8" (48 mm)	1-1/8" (29 mm)	1/16" (1.6 mm)	7-1/2" (191 mm)
B18 †	2-1/4" (57 mm)	* 1-3/8" - 8 UN (35 mm)	2-5/8" (67 mm)	LC-225	4" (102 mm)	LS-225	1-7/8" (48 mm)	1-3/8" (35 mm)	1/16" (1.6 mm)	7-1/2" (191 mm)
B20 †	2-1/2" (65 mm)	1-1/4" - 7 NC (32 mm)	4" (102 mm)	LC-250	4" (102 mm)	LS-250	2-1/8" (54 mm)	1-1/4" (32 mm)	9/64" (3.6 mm)	9-1/2" (241 mm)
		1-3/8" - 8 NC (35 mm)	4" (102 mm)	LC-250	4" (102 mm)	LS-250	2-1/8" (54 mm)	1-3/8" (35 mm)	9/64" (3.6 mm)	9-5/8" (244 mm)
B24	3" (76 mm)	* 1-3/8" - 8 UN (35 mm)	5-1/2" (140 mm)	LC-300	5-1/2" (140 mm)	LS-300	2-3/4" (70 mm)	1-3/8" (35 mm)	1/8" (3.2 mm)	12-1/2" (318 mm)
		1-1/2" - 6 NC (38 mm)	5-1/2" (140 mm)	LC-300	5-1/2" (140 mm)	LS-300	2-3/4" (70 mm)	1-1/2" (38 mm)	1/8" (3.2 mm)	12-7/8" (325 mm)
		1-3/4" - 5 NC (45 mm)	5-1/2" (140 mm)	LC-300	5-1/2" (140 mm)	LS-300	2-3/4" (70 mm)	1-3/4" (45 mm)	1/8" (3.2 mm)	13" (330 mm)
C14	1-3/4" (44 mm)	3/4" - 10 NC (19 mm)	4-1/4" (108 mm)	LCF-175-6	3-3/4" (95 mm)	LS-175	1-5/8" (41 mm)	3/4" (19 mm)	1/16" (1.6 mm)	9-3/8" (238 mm)
		7/8" - 9 NC (22 mm)	4-1/4" (108 mm)	LCF-175-7	3-3/4" (95 mm)	LS-175	1-5/8" (41 mm)	1" (25 mm)	1/16" (1.6 mm)	9-1/2" (241 mm)
		* 1" - 8 NC (25 mm)	4-1/4" (108 mm)	LCF-175-8	3-3/4" (95 mm)	LS-175	1-5/8" (41 mm)	1-1/4" (32 mm)	1/16" (1.6 mm)	9-5/8" (244 mm)
C18 †	2-1/4" (57 mm)	1-1/8" - 7 NC (30 mm)	4-7/8" (124 mm)	LCF-225-9	4" (102 mm)	LS-225	2" (51 mm)	1-1/4" (32 mm)	1/16" (1.6 mm)	10-1/4" (260 mm)
		1-1/4" - 7 NC (32 mm)	4-7/8" (124 mm)	LCF-225-10	4" (102 mm)	LS-225	2" (51 mm)	1-3/8" (35 mm)	1/16" (1.6 mm)	10-1/4" (260 mm)
C28	3-1/2" (89 mm)	1-7/8" - 8 UN (48 mm)	7" (178 mm)	LCF-350-16	6" (152 mm)	LS-350	2-7/8" (73 mm)	1-7/8" (48 mm)	1/8" (3.2 mm)	15-1/8" (384 mm)
		2" - 6 UN (51 mm)	7" (178 mm)	LCF-350-16	6" (152 mm)	LS-350	2-7/8" (73 mm)	2" (51 mm)	1/8" (3.2 mm)	15-1/4" (387 mm)

* Hollow-Core Spin-Lock only
† Non-domestic

Coupled Head Assemblies

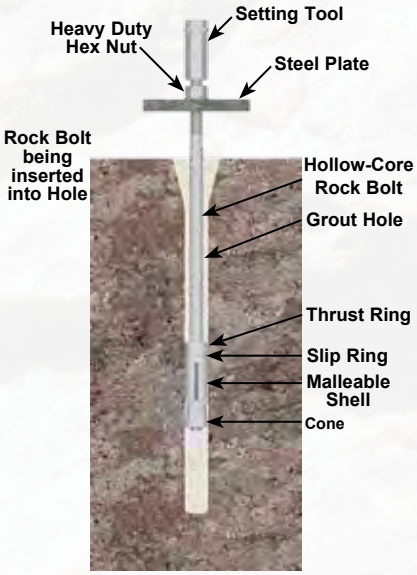
Williams can manufacture Spin-Lock Anchor systems with the use of a transition coupling, which allows the anchor to be designed with a continuously workable thread-form. This is advantageous when the anchor length may need to be adjusted in the field due to variable site conditions. The transition coupling engages a continuously threaded U.N. bar into the head assembly and the All-Thread Bar (typically Grade 75 & Grade 80 All-Thread Rebar or 150 KSI All-Thread-Bar) is attached to the other end of the coupling.

Installation



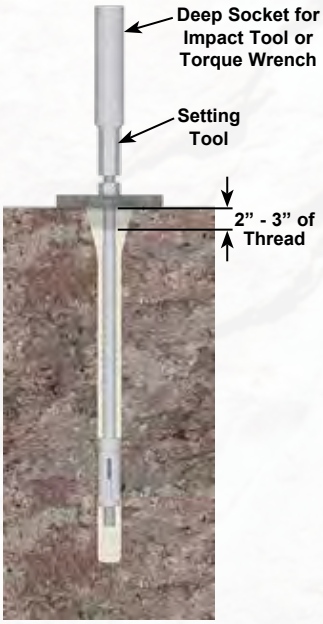
Step 1: Drilling

Care should be taken to insure an accurate diameter and a straight hole. The depth should be over drilled to allow any debris to fall to the bottom of the hole when the anchor is inserted. Clean the drill hole by blowing air to the full depth to remove debris. Efforts should be made to prepare the collar area with a flat surface and as perpendicular to the bolt axis as possible.



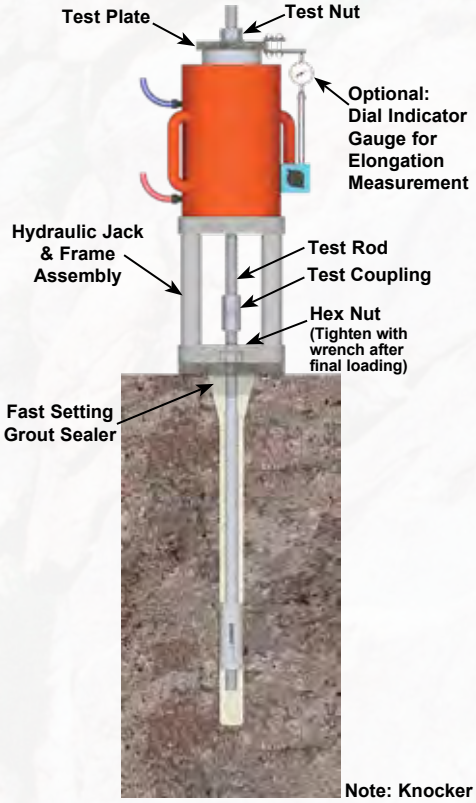
Step 2: Bolt Placement

Place the nut, washer, bevel washers (if required), and plate on the rock bolt and push the bolt into the hole to the correct embedment depth. If the bolt becomes stuck in the hole, attach a setting tool to the end of the bolt and drive it into the hole with a sledgehammer.



Step 3: Setting the Anchor

Install setting tool fully onto the exposed threaded end. Provide space between the setting tool and the hex nut. Initially torque the bolt to the required torque with an impact gun, pneumatic, or hydraulic torque wrench. This action migrates the cone into the shell, thus expanding the mechanical anchor into the rock. Final torque can be checked and adjusted with a manual or hydraulic torque wrench. Remove the setting tool by restraining the lower part while rotating it's upper section until the setting tool is loose. Prepare collar area with fast setting grout sealer to ensure full bearing under the plate.



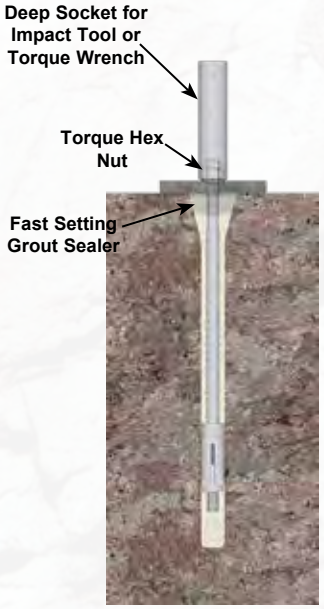
Note: Knocker Wrench not shown for clarity

Step 4a: Testing the Anchor Bolt

Method A: Tensioning with a Test Jack

Place the jack and frame over the bolt and attach the test rod and couplings to the bolt. Attach the test nut and test plate over the test rod on top of the jack. Test the rock bolt by tensioning the jack to the required test load (usually half of the ultimate strength) but never to exceed the advertised yield strength of the anchor. Adjust the loading of the jack to the required final tension and lock in the final prestress load. This is done by tightening the rock bolt hex nut with a knocker wrench (through the frame opening) until a slight reduction is noticed on the jack gauge. The full prestress load will be transferred to the anchor bolt once the tension in the test jack has been released and test components removed.

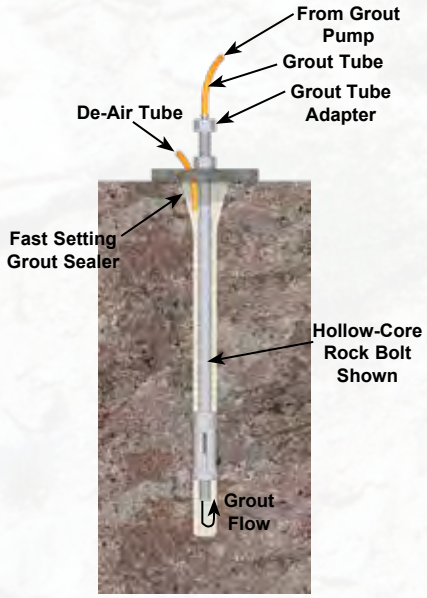
Installation



Step 4b: Testing the Anchor Bolt

Method B: Testing by Torque Tensioning

the "Torque On Nut" column on the Spin-Lock Bolt charts listed on pages 55-58. For other loads, see the torque tension graphs shown on pages 78 & 79. **Please Note:** The torque/tension relationship is not as accurate as direct tensioning with a hydraulic jack and should not be used where critical tension loads need to be verified. A high pressure lubricant should be used between all bearing components.

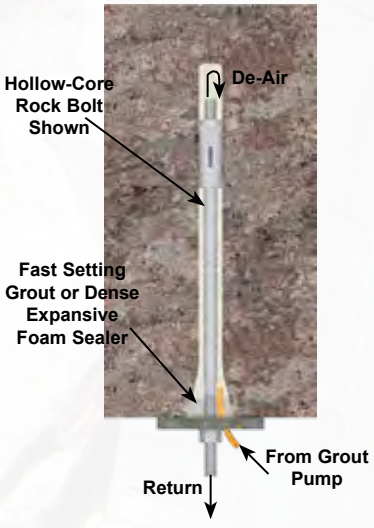


Step 5a: DownGrouting the Anchor

Always grout from the lowest gravitation point on the anchor bolt until a steady stream of pure grout is seen coming out around the bearing plate or grout tube, and/or from the de-air tube. For solid bolts, this means that a separate grout tube must be placed in the drill hole (through an opening in the bearing plate) as deep as possible before grouting. Long length solid bolts should have the grout tube attached to the bolt before inserting and setting the anchor. Down-grouting of Hollow Core Rock Bolts can be simply grouted through the hollow core by attaching a grout tube adapter to the outer end of the tensioned bolt and grouting. When the grouting is complete, all air and standing water has been removed from the drill hole by displacement and all cracks and voids in the anchor area are filled with cement grout.

Step 5b: Up-Grouting the Anchor

Up-grouting of Hollow-Core Rock Bolts can be done by grouting through a short length grout tube extending just past the drill hole sealer in the collar area thus using the hollow core at the end of the rock bolt to de-air the hole. Up-grouting of solid rock bolts involves attaching a long length grout tube to the anchor (prior to insertion, setting, and tensioning) and grouting through a separate short length tube that extends past the sealer area thus allowing the rock bolt to de-air from the longer grout tube.



Williams offers a field installation advising service to aid contractors in the initial installation process of installing all types of anchor bolts. Contact your Williams sales representative for details.

Project Photos

Project: Slope Stabilization
Contractor: Yenter Companies
Location: Cheeseman Reservoir, CO

Project: Mill Hend Transmission Line
Contractor: Xcel Energy
Location: Silverthorne, CO

Project: Red River Gorgeous Resorts
Contractor: The Canopy Crew
Location: Stanton, KY

Project: Nantahala Dam
Contractor: Boyles Brothers
Location: Ashville, NC

Project Name – University of Minnesota Archive Storage
Contractor – CS McCrossan
Location – Minneapolis, MN

Project: 45, 90, 180 Rock Sculpture
Michael Heizer, Environmental Artist
Location: Elko, NV

Sledge Drive Anchors

Quick, simple anchor designed to develop the full strength of the bar. Recommended for short anchors in rock or concrete. Available with 1-5/8" diameter aluminum expansion shell. In temporary situations, bar may be removed and used again. Williams can supply custom length steel drive pipes at your request.

Stee Type	Bar Diameter	Maximum Factored Design Load	Ultimate Strength (fu)	Drill Hole	Minimum Embedment (3000 PSI - f'c)	Minimum Embedment (6500 PSI - f'c)	Part Number B8S Cone / Shell (B7S Cone / Shell)
B1S Smooth Rod B7S All-Thread Coil Rod B8S All-Thread N.C. Rod	3/8" (9.5 mm)	7.8 kips (32.7 kN)	9.8 kips (43.6 kN)	1-5/8" (41 mm)	5" (127 mm)	4" (102 mm)	R4M03RB0 / R4A13 (R4MC3RB0 / R4A13)
	1/2" (13 mm)	13.5 kips (60.0 kN)	18 kips (80.1 kN)	1-5/8" (41 mm)	8" (204 mm)	6" (153 mm)	R4M04RB0 / R4A13 (R4MC4RB0 / R4A13)
	5/8" (16 mm)	16.8 kips (74.7 kN)	22.5 kips (100 kN)	1-5/8" (41 mm)	9" (229 mm)	7" (178 mm)	R4M05RB0 / R4A13 (R4MC5RB0 / R4A13)
	3/4" (19 mm)	27.0 kips (120 kN)	36 kips (160 kN)	1-5/8" (41 mm)	12" (305 mm)	9" (229 mm)	R4M06RAC / R4A13 (R4MC6RAC / R4A13)
	7/8" (22 mm)	43.5 kips (193 kN)	58 kips (258 kN)	1-5/8" (41 mm)	16" (407 mm)	12" (305 mm)	R4M07RAC / R4A13 (R4MC7RAC / R4A13)
R50 Grade 60 All-Thread Rebar	#4 - 1/2" (13 mm)	12 kips (53.3 kN)	16 kips (71.2 kN)	1-5/8" (41 mm)	8" (204 mm)	6" (153 mm)	R4MG4RAC / R4A13
	#5 - 5/8" (16 mm)	19.2 kips (85.4 kN)	26 kips (114 kN)	1-5/8" (41 mm)	10" (254 mm)	8" (204 mm)	R4MG5RAC / R4A13
R61 Grade 75 & Grade 80 All-Thread Rebar	#6 - 3/4" (19 mm)	33.0 kips (146 kN)	44 kips (196 kN)	1-5/8" (41 mm)	13" (331 mm)	10" (254 mm)	R4MG6RAC / R4A13

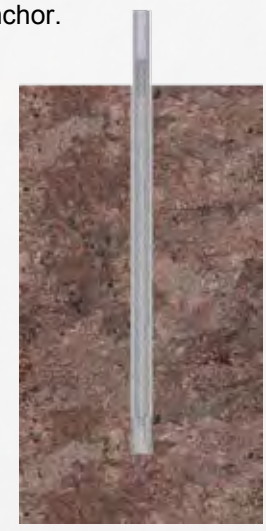
(1) Minimum embedment depths reflect values for ductile steel failure in accordance with ACI 318 for 3000 and 6500 PSI concrete, respectively.
(2) Sledge drive anchor minimum spacing shall be the minimum embedment depth (h.ef) multiplied by 3 in accordance with ACI 318 for 3000 and 6500 PSI concrete, respectively.
(3) Sledge drive anchor minimum edge distance shall be the minimum embedment depth (h.ef) multiplied by 1.5 in accordance with ACI 318 for 3000 and 6500 PSI concrete, respectively.

Sledge Drive Anchor Installation

Step 1
Drill hole to prescribed diameter and exact embedment depth for rock bolt.

Step 2
Insert Sledge Drive Anchor to bottom of hole. Bolt may be tapped in place.

Step 3
Place heavy wall pipe driver over bar and drive shell down over cone to expand anchor.



Step 4
Attach item to be anchored or plate and nut. Anchor may be prestressed or pre-tested.

Bail Anchors

Bail Anchors are fast setting mechanical anchors that are simple to use for light to moderate loads in temporary or permanent applications. They set in a one step torque tension operation and work well with Williams Grade 75 All-Thread Rebar, constant torque nuts and domed plates/spherical washer assemblies. They are well suited for use in single or twin grout tube installations due to the minimal rotation the bar undergoes during the setting process.

R5M-F9F

R5M-D20

B-16

B-16 "One Step" Spin-Lock Anchor Head Assembly

Similar to the Spin-Lock anchors but with the advantage of being quickly set and tensioned in one torque operation using a Constant Torque Nut. These anchors are often used where pattern bolting of slope stabilization or tunneling projects require a medium duty fast production anchor.

The nut has a special compressed end that acts initially as a setting tool and then under a higher torque overcomes the compressed threads in the nut to allow the nut to torque against the bearing plate to further set and tension the anchor in one step.

Blank Part Number	Range of Bar Diameter		Hole Diameter	Ultimate Capacity	Shell Length	Wedge Length
	UNC / Coil	Grade 75				
R5M-F9F	3/4" - 1" (20-25 mm)	#6, #7 (20-22 mm)	1-3/4" (45 mm)	33-40 kips (147-178 kN)	3-1/4" (83 mm)	2-1/4" (57 mm)
R5M-D20	5/8" - 1-1/8" (16-28 mm)	#6, #7, #8 (20-25 mm)	2" (51 mm)	15-50 kips (67-222 kN)	4" (102 mm)	3-7/8" (98 mm)
B-16	3/4" - 1" (20-25 mm)	#6, #7, #8 (20-25 mm)	2" (51 mm)	33-79 kips (147-351 kN)	4" (102 mm)	2-1/4" (57 mm)

Bail Anchor Installation

Bail anchors are initially set in the hole using relatively low torques that should not exceed 20 ft-lbs. Higher setting torques applied to the bail anchor alone will not help in the setting process. Final set of the Bail Anchor is accomplished through direct tension with a hydraulic jack or preferably by torquing the nut against the plate. This action pulls the cone further into the shell locking it into place. The outward migration of the bar is usually no more than 1" to 2" maximum. This movement must be anticipated and allowed for in the design and application of this anchor type in ungrouted conditions. Bail anchor installations are tested and grouted by normal methods.

For Bail Anchor Bars and Accessories, see pages 15-23.

Project Name – St. Lawrence Seaway Lock 5
Contractor – Rankin Construction Inc
Location – St. Catharines, ON

Bail & Resin Anchor Accessories

Spherical Washers

These adjustable angle washers are self aligning and provide full hex nut bearing. They can be used with Domed Plates or with thicker standard plates with chamfered holes. Use a hardened flat washer between the nut and spherical washer.

Range of Bar		Dimensions (Dia. x H x I.D.)	Part Number
UNC/ / Coil	Grade 75		
5/8" - 7/8" (16 - 22 mm)	#6 (20 mm)	2" x 1/2" x 13/16" (51 x 13 x 21 mm)	R81-06-F
7/8" - 1-1/8" (22 - 29 mm)	#7 - #8 (22 - 25 mm)	2-3/4" x 1-3/16" x 1-1/8" (70 x 30 x 29 mm)	R81-08-HDC
1-1/4" - 1-1/2" (32 - 38 mm)	#9 - #11 (28 - 35 mm)	3-5/8" x 1-3/8" x 1-5/8" (92 x 35 x 41 mm)	R81-11-HDCA

Domed Plates

Domed plates allow for the optimum use of Williams Spherical Washers to provide high angles of variation between the bar and the plate. Plate sizes listed below are standard. Other sizes are available.

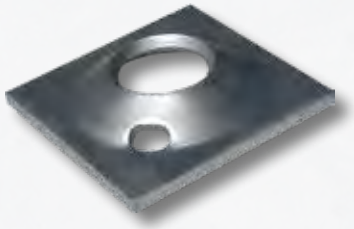
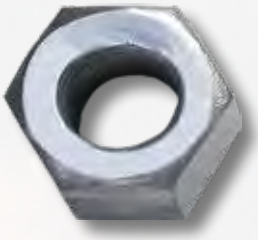


Plate Dimensions	Center Hole	Degree of Rotation	Minimum Collapse Load
3/8" x 6" x 6" (10 x 152 x 152 mm)	1-1/2" (38 mm)	0 - 20°	50 kips (222 kN)
3/8" x 6" x 6" (10 x 152 x 152 mm)	1-7/8" (48 mm)	0 - 20°	50 kips (222 kN)
1/2" x 8" x 8" (13 x 203 x 203 mm)	2-7/8" (73 mm)	0 - 20°	100 kips (445 kN)



Constant Torque Nuts

These hex nuts for Grade 75 All Thread Bar have a special compressed end to allow a predictable torque resistance while torquing the nut which jams onto the outer end of a threaded anchor bar. This resistance allows the bar to be rotated by the constant torque nut to mix polyester resin or to initially set a mechanical bail anchor. After the resin sets or the bail anchor is initially set, the nut can then be torqued to forces in excess of the preset resistance which will allow the nut to break away. The nut is then run down the bar and against the plate where it is torqued up to tension the anchor to the required load for a one step installation. Some of the torque resistance will remain on the nut after the initial "break away" torque.

Constant Torque Nuts are available with UNC or All-Thread Rebar type threads. Allow 1/16" to 1/8" increase in the hex size of the drive socket tool for allowance of the compressed end of these nuts. Available for bar sizes up to #11. See your Williams representative for the size and torque requirements for this product.

Spherical Seat Constant Torque Combination Square Nut/Washer

Williams has combined the spherical seat washer with a nut to deliver a one piece fastener that will both spin the bar and then self-align as it contacts the bearing plate. This nut features a constant torque compressed ring to allow a predictable torque resistance similar to the constant torque nuts above. Some of the torque resistance will remain on the nut after the initial "break away" torque of approximately 10-20 ft./lbs. The spherical seat nut is available for the following bar sizes: #6 - #8 Grade 75 All-Thread Rebar, 3/4"-1-1/8" UNC, and 3/4"-1" Coil.
The #6 nut is a 1-1/8" square drive.

Note: During installation using constant torque nuts of any type, ensure that the drill hammer is off or the steel shank in the drive steel has been shortened to eliminate any hammering in the drive steel.

Anchor Data

Resin anchoring provides quick rock reinforcement for active and passive installations for dams, locks, underground structures, rock cuts, and tie downs. Both Williams Grade 75 & Grade 80 and 150 KSI All-Thread Bars are used for resin anchoring.

Williams inventories quality resin cartridges. Resin cartridges consist of two components: (1) A polyester resin grout and (2) its catalyst. These precisely measured quantities are separated by a thin plastic film and are enclosed by this same film. After holes are drilled, the sausage-shaped cartridges are inserted. When rotating a deformed bar through the cartridge and into the hole, the components are mixed and the curing action begins. When cured, the comprehensive strength of the resin is often stronger than the surrounding rock. Resin systems offer a quick economical approach resulting in an encapsulated rock anchor.

Tensioned Bolts vs. Non-Tensioned Bolts

Tensioned bolt systems use fast-setting resin for anchorage in the back (bond zone) portion of the drill hole. The forward portion of the hole can be left open for temporary bolting situations, filled with slow-setting resin or pumped with cement grout depending on the situation.

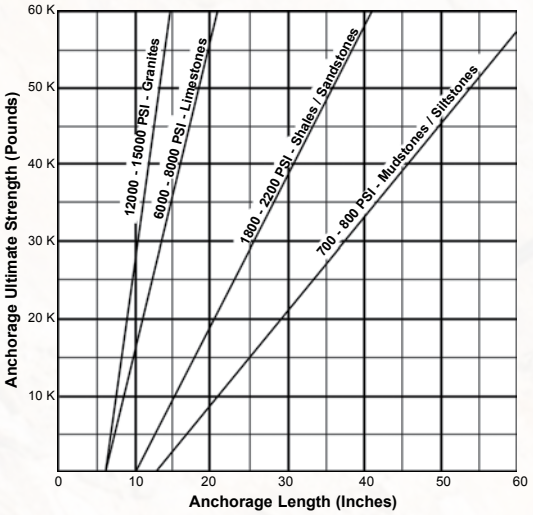
Non-tensioned systems would use resin of the same set time the full length of the drill hole.

Drill Hole Fill Charts

The charts to the left show the length of drill hole that will be encapsulated by a twelve inch long polyester resin cartridge. It should be used as a guide to the most common combinations of hole diameter, bolt diameter, and resin diameter. Other combinations are possible provided the annular space does not exceed 1/4 to 3/8".

Due to the difficulty of overcoming the drag of the bar through the resin cartridges during insertion, encapsulated resin drill holes are most practical with shorter anchorages. Other Resin Cartridge diameters may be available upon special order.

Anchorage Chart



This chart is intended as a guide for on site trials which will establish the working specifications in the actual ground conditions.

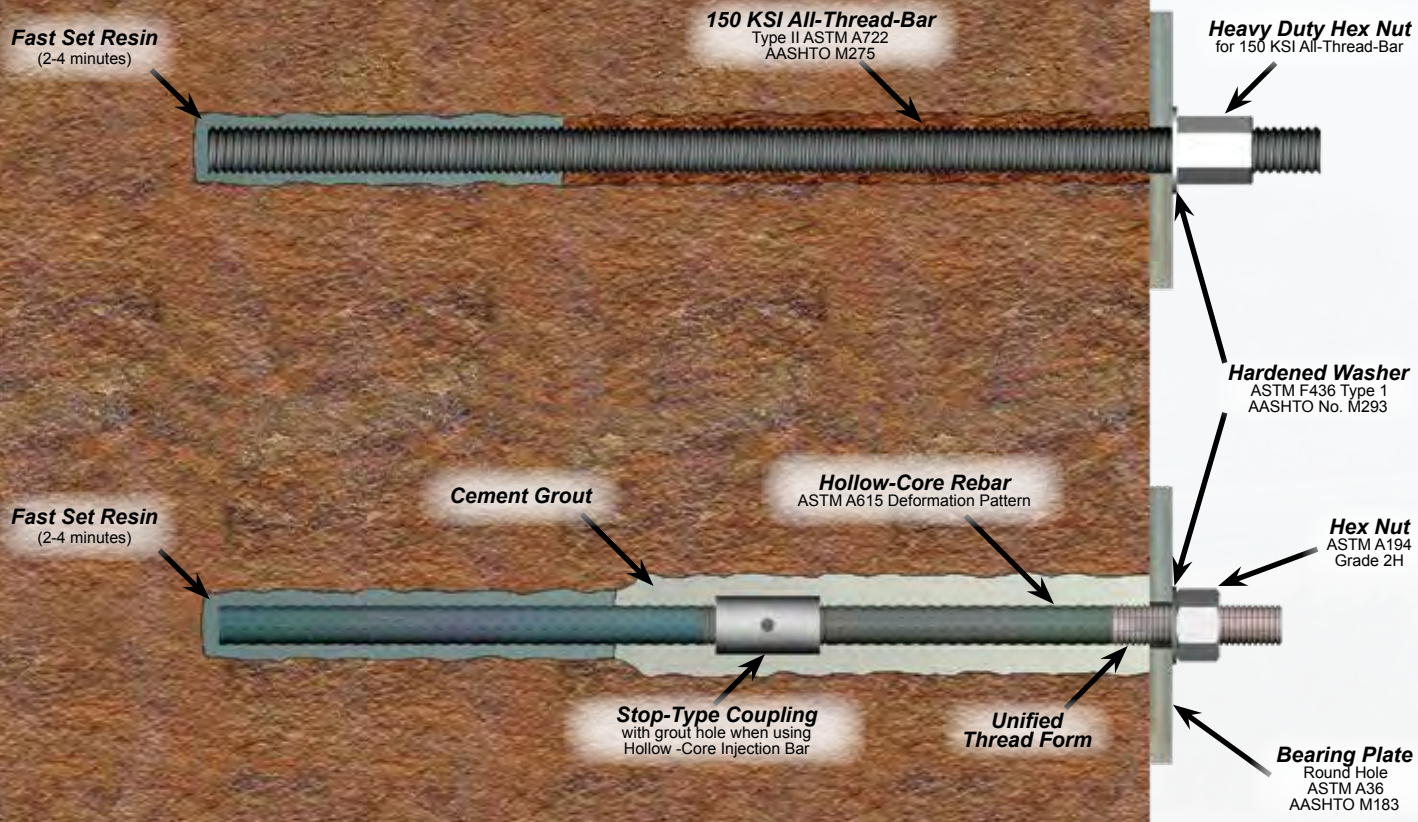
1-1/4" (32 mm) Resin Cartridge

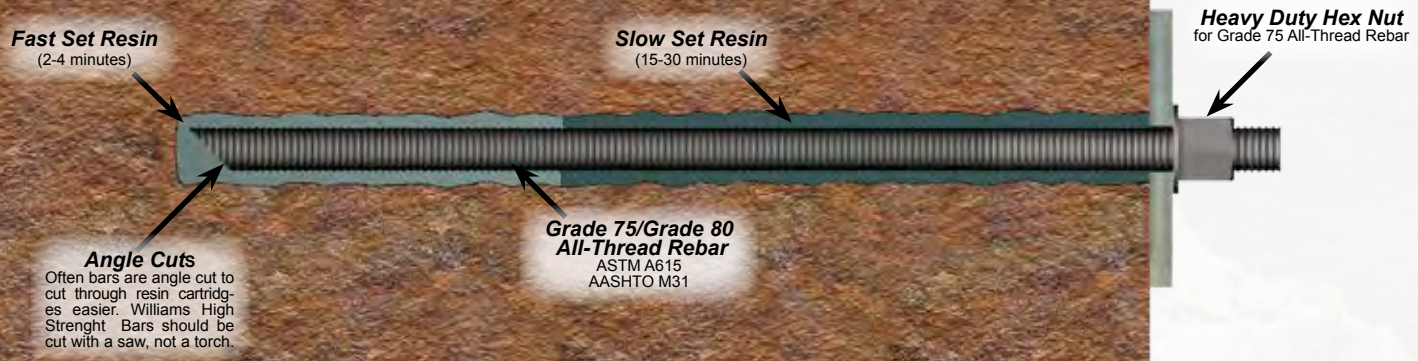
Steel Type	Bar Diameter	Drill Hole		
		1-3/8" (35 mm)	1-1/2" (38 mm)	1-5/8" (41 mm)
Grade 75 All-Thread Rebar Grade 60 Rebar	#7 - 7/8" (22 mm)	14.4" (366 mm)	-	-
	#8 - 1" (25 mm)	18.2" (462 mm)	13" (330 mm)	-
	#9 - 1-1/8" (28 mm)	-	16" (406 mm)	11.8" (300 mm)
	#10 - 1-1/4" (32 mm)	-	-	15" (381 mm)
150 KSI All-Thread-Bar	1" (26 mm)	15" (381 mm)	12" (305 mm)	-

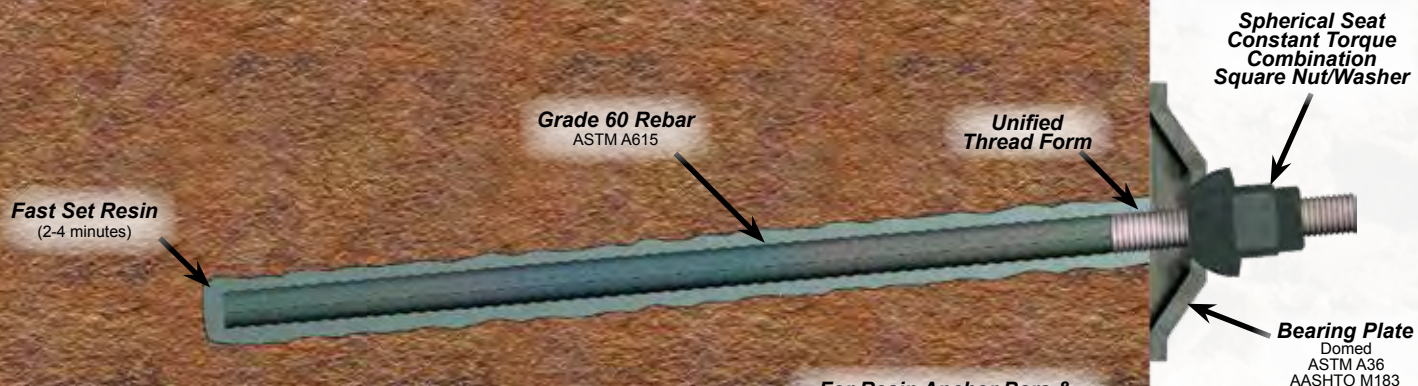
1-9/16" (40 mm) Resin Cartridge

Steel Type	Bar Diameter	Drill Hole			
		1-3/4" (45 mm)	1-7/8" (48 mm)	2" (51 mm)	2-1/4" (57 mm)
Grade 75 All-Thread Rebar Grade 60 Rebar	#9 - 1-1/8" (28 mm)	14.1" (358 mm)	11.2" (284 mm)	-	-
	#10 - 1-1/4" (32 mm)	16.9" (429 mm)	13" (330 mm)	10.4" (264 mm)	-
	#11 - 1-3/8" (35 mm)	23" (584 mm)	16" (406 mm)	12" (305 mm)	-
	#14 - 1-3/4" (45 mm)	-	-	-	12.7" (323 mm)
150 KSI All-Thread-Bar	1-1/4" (32 mm)	20" (508 mm)	14" (356 mm)	10.5" (267 mm)	-
	1-3/8" (36 mm)	-	17" (432 mm)	14" (356 mm)	-
	1-3/4" (46 mm)	-	-	-	16" (406 mm)

Specifications

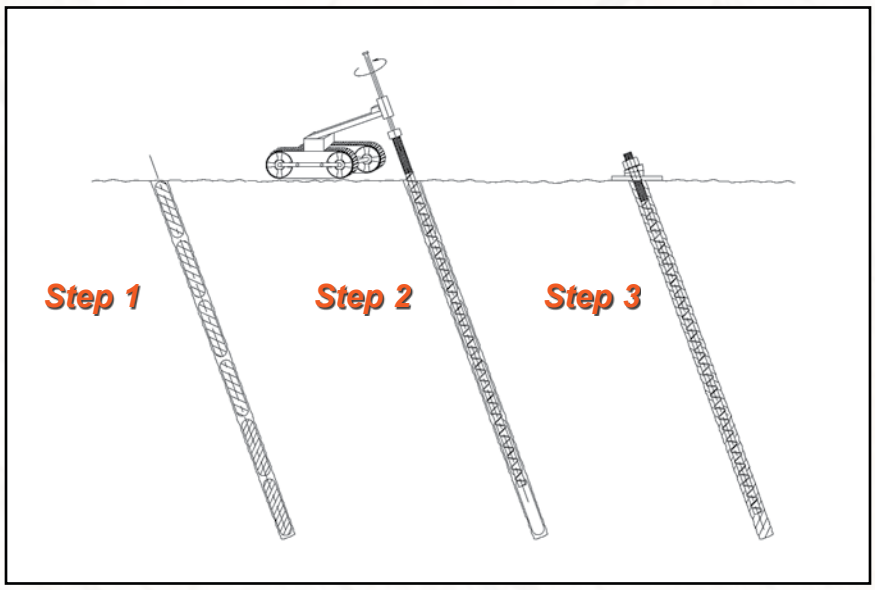






For Resin Anchor Bars & Accessories, see pages 15-23

Resin Anchor Installation



Step 1

For Pre-Tensioned bolts, insert the necessary resin cartridges into the drill hole, by placing the fast-setting cartridges in first and the slow-setting cartridges last. Do not allow cartridges to free fall to bottom of hole.

Step 2

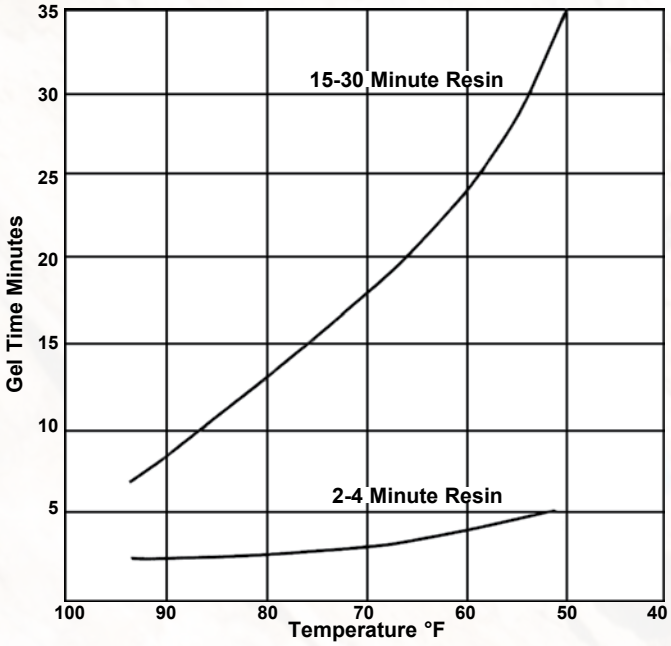
Push bolt into hole (rotating at this time is optional). When bolt is completely inserted into the hole, rotate 40-60 revolutions (approximately 10-15 seconds). Caution should be taken to avoid under-spinning or over-spinning.

Step 3

Install bearing plate, washer and hex nut. Complete pre-tensioning before slow-setting cartridges gel by using a hydraulic jack or torque wrench depending on design requirements. Installation is complete when slow-setting resin has hardened. Special accessories used for bolt angle adjustment are shown on page 65.

Gel Time

Two gel times are offered for varied conditions. The standard 2-4 minute gel time meets most requirements. However, for special conditions, where installations are difficult or full length anchored tensioned bolts are used, a 15-30 minute gel time is available. Gel times are standardized at 55-60° F. The effect of temperature on gel time is shown on the left. Temperatures below 35° F will significantly slow down set times. Call your Williams Representative for special fast set resins.



Compressive Strength

90% of Compressive Strength should be reached in 6 times gel time at 75° F.

Caution & Safety

This product is intended for industrial use only. Avoid contact with eyes and prolonged contact with skin. Wear safety glasses when handling or installing. If contact occurs, wash eyes or skin with water for 15 minutes. In case of eye contact, obtain medical attention. Cartridges contain benzoyl peroxide, polyester resin, styrene and inert fillers. The relationship between hole dimensions, bolt size and the size and number of cartridges is critical to good performance. Your Williams representative will be glad to assist in determining the proper combinations for specific applications.

Storage

Resin cartridges should be stored in a cool, well-ventilated and dry area away from direct sunlight. High temperature conditions can reduce shelf life. Cartridges stored in extreme temperatures should be “normalized” at 50-70° F for at least two days prior to use to provide the expected gel time.

Pallets should not be stacked. Stock rotation is recommended so the oldest stock is used first.

Project Photos

Project: Clarksville Lift Station Basin
Contractor: Rembco Geotechnical Contractors
Location: Clarksville, TN

Project: Central City Bypass
Contractor: Ames Construction
Location: Central City, CO

Project: East Side Resivoir
Contractor: Atkinson, Washington, Zachary
Location: Winchester, CA

Project: Thornton Reservoir
Contractor: Walsh Construction
Location: Thornton, IL

Project: I-70 Hanging Lake Tunnel Cross Passage
Contractor: Mays Constuction Specialties Inc.
Location: Glenwood Canyon, CO

Project: Gross Reservoir Dam
Contractor: Kiewit Corp.
Location: Boulder County, CO

Earth Anchor Systems

Williams offers two versions of Soil Earth Anchors in order to meet customer needs. These anchors are intended for use in soil conditions for moderately loaded anchoring requirements. WFEC Soil Anchors use a tipping plate which is dependent upon the strength of the soil in order to react tensile loads. Anchors are driven into soil to a specified depth using special drive steel which is adaptable to percussion driving equipment, (i.e. jackhammer, concrete breaker or similar). The drive steel is removed and the anchor is tipped into place and proof tested with Williams' Anchor Locking Kit by pulling on the anchor rod. This is called "load locking" and provides an immediate proof test of each anchor's holding capacity. Interested customers should contact their local Williams technical representative in order to evaluate the appropriate anchor for each specific project.

Applications

- Retaining Walls
- Slope Stabilization
- Bridges
- Sheet Piling
- Gabion Support
- Buoyancy Control
- Guyed Structures
- Scaffolding
- Foundations
- Portable Buildings
- General Security
- Marine Applications
- Temporary Shoring
- Utility Poles
- Seawalls
- Pipelines
- Erosion Control
- Underwater Applications

Advantages

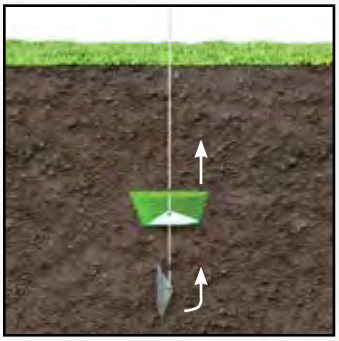
- Fast, easy installation
- Immediate proof test results
- No grout
- Inexpensive installation equipment
- Environmentally friendly
- No drilling required

PLATIPUS EARTH ANCHORING SYSTEMS

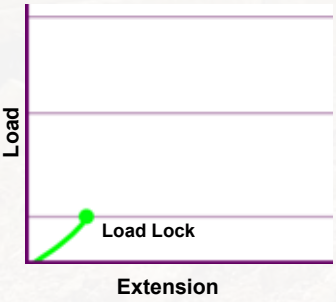
The Platipus® Earth Anchoring Systems offer anchors with available tensile loading up to 44,000 lbs. These anchors are made from spheroidal graphite cast iron and are galvanized for superior corrosion protection. They are manufactured by a NAFTA free trade country and may meet domestic requirements on publicaly funded projects. Platipus "Stealth" Anchors are used for lower load applications and numerous termination options are available. Platipus "BAT" anchors achieve higher loads, utilize a unique "t-knuckle" pivoting attachment point, and utilize Williams' Grade 75 All-Thread Rebar, couplings, hex nuts and other accessories necessary for load transfer. Williams' robust course thread pattern used on the All-Thread Rebar is extremely durable during anchor driving and eliminates the concern for thread chasing often required when using NC thread pattern anchor rods. All products are available galvanized upon request.

Typical Anchor Behavior

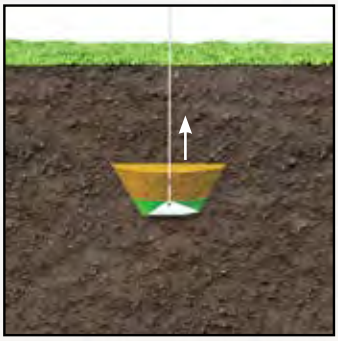
Load Lock



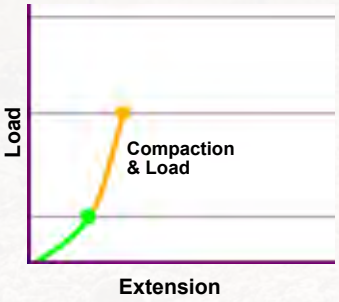
The first stage is where a load is applied to rotate the anchor into its load locked position. Elements of both load and extension are present.



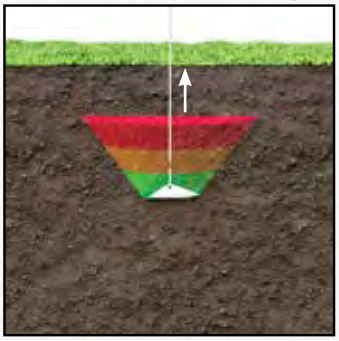
Compaction & Load



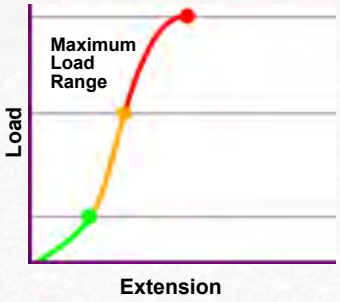
The second stage is where the anchor system is generating a frustum of soil immediately in front of the anchor. At this point load normally increases with minimum extension. The soil type will affect the overall amount of extension observed.



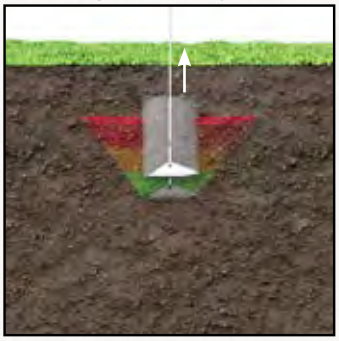
Maximum Load Range



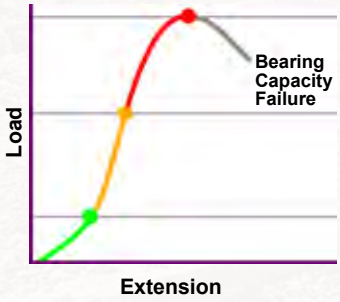
The third stage is where the anchor produces its geotechnical ultimate load. As the anchor load approaches the bearing capacity of the soil, the rate of increase in load will reduce until bearing capacity failure of the soil takes place.



Bearing Capacity Failure



Caution: If the mechanical shear strength and/or bearing capacity of the soil is exceeded, the residual load will decrease with continued extension as the anchor shears through the ground.



Platipus BAT Anchors

The 'Bat' anchor is designed to achieve higher loads than the Stealth Anchor product line, and enhance anchoring in soft cohesive soils. Their ability to accept the pivoting T-knuckle allows flexibility with regard to anchor rod sizer. It can be used with #6 or #7 Grade 75 All-Thread Rebar. Installation requires powerful hand-held hydraulic breakers or, in some cases, an excavator with a percussive breaker attachment.

Bat Anchor Structural Properties

Anchor Type	Dimensions L x W x H	Projected Surface Area	Typical Load Range*	Minimum Driven Depth
B4	12.2" x 4.3" x 3.6" (310 x 110 x 93 mm)	~44.33 in² (286 cm²)	4.4 - 13.2 kips (20 - 60 kN)	5' - 8' (1.5-0.5 m)
B6	13.2" x 8.1" x 3.6" (336 x 206 x 91 mm)	~71.3 in² (460 cm²)	6.6 - 22 kips (30 - 100 kN)	6' - 10' (2 - 3 m)
B8	16.6" x 10.2" x 4.1" (423 x 259 x 105 mm)	~142.6 in² (925 cm²)	11 - 33 kips (50 - 150 kN)	10' - 13' (3 - 4 m)
B10	21.3" x 13.2" x 4.3" (541 x 335 x 110 mm)	~213.9 in² (1380 cm²)	16.5 - 44 kips (75-200 kN)	13' - 16' (4 - 5 m)

*The typical load range of an anchor is dependent on the engineering properties of the soil.

R61 Grade 75 All-Thread Rebar

Diameter	Minimum Ultimate Strength	Minimum Yield Strength	Nominal Weight	Approx. Thread Major Dia.	Part Number
#6 (19 mm)	44 kips (196 kN)	33 kips (147 kN)	1.5 lbs/ft (2.4 kg/m)	7/8" (22 mm)	R61-06
#7 (22 mm)	60 kips (267 kN)	45 kips (200 kN)	2.0 lbs/ft (3.0 kg/m)	1" (25 mm)	R61-07

Fully threaded rods can be field cut and coupled in lengths up to 50 feet uncoated. Galvanized rods should be cut to size prior to galvanizing to insure good nut fit.
See pages 18 & 19 for accessories.

Platipus Stealth Anchors

The stealth anchor is designed to cover a wide range of light-weight anchoring solutions. Its chisel point and streamline shape makes installation easy, in most cases, using simple hand or power tools These anchors are also an idea choice when working in areas with restricted access.

Stealth Anchor Structural Properties

Anchor Type	Dimensions L x W x H	Projected Surface Area	Typical Load Range*	Minimum Driven Depth
S6**	6.7" x 2.3" x 2.0" (171 x 58 x 50 mm)	12.71 in² (820 cm²)	1.1 - 5.5 kips (5 - 25 kN)	3.9' (1.2 m)
S8	10.4" x 3.5" x 3.0" (263 x 90 x 76 mm)	30.31 in² (195.6 cm²)	2.2 - 8.8 kips (10 - 40 kN)	4.9' (1.5 m)

*The typical load range of an anchor is dependent on the engineering properties of the soil.
** 1/2" High Tensile UNC Rod is recommended for this size.

Stealth Anchor Steel Bar Options

Steel Type	Diameter	Minimum Net Area	Minimum Ultimate Strength	Minimum Yield Strength	Part Number
High Tensile UNC Rod	1/2" - 13 (13 mm)	0.14 in² (91.6 mm²)	17.0 kips (75.7 kN)	13.1 kips (58.0 kN)	B8S-04
Grade 60 All-Thread	#4 - 1/2" (13 mm)	0.2 in² (129 mm²)	18 kips (80.1 kN)	12.0 kips (53.4 kN)	R51-04

Fully threaded rods can be field cut and coupled in lengths up to 40 feet uncoated. Galvanized rods should be cut to size prior to galvanizing to insure good nut fit.
See Williams Concrete Forming Hardware catalog for accessories.

Project: Atlanta Air Dome
Location: Atlanta, GA

Project: Boys and Girls Club
Location: Hendersonville, NC

Manta Ray Anchors

Manta Ray Earth Anchors are available in a variety of sizes and are perfectly matched to Williams #6 Grade 75 galvanized All-Thread Rebar to achieve working loads up to 20,000 lbs. The galvanized, cast ductile-iron Manta Ray Anchors utilize a secured, pivoting shackle tapped with Williams' All-Thread Rebar thread pattern in order to transfer tensile loads. The robust, course thread pattern is extremely durable during anchor driving and eliminates the concern for thread chasing often required when using NC thread pattern anchor rods.

The Manta Ray system provides a holding capacity chart that should be used for estimation purposes in order to select the appropriate Manta Ray model for your specific loading and soil conditions. Williams Form Engineering recommends a field test of anchor strength prior to anchor ordering whenever possible.

There are six **Manta Ray Anchors** with light to heavy duty holding capacities and working loads up to 20 kips. All anchors can be driven with the drive steel set and can be tested to the desired holding capacity with the load locker. Bars and accessories for Manta Ray anchors can be found on pages 15-23.

Manta Ray Anchor Structural Properties

Manta Ray Anchor	Max Safe Working Load (2:1 FS)	Soil Reaction Area	Anchor Rod		Weight per Each
			Diameter	Part Number	
MR-68	2.5 kips (11 kN)	5.3 in² (34 cm²)	3/8" (10 mm)	B8S-03	1 lbs (0.5 kg)
MR-88	5 kips (22 kN)	10.2 in² (66 cm²)	1/2" (12 mm)	B8S-04	2.1 lbs (1 kg)
MR-3	10 kips (45 kN)	33.6 in² (217 cm²)	#6 - 3/4" (20 mm)	R61-06	7 lbs (3.2 kg)
MR-2	20 kips (89 kN)	42.8 in² (276 cm²)	#6 - 3/4" (20 mm)	R61-06	12 lbs (5.4 kg)
MR-1	20 kips (89 kN)	71.9 in² (464 cm²)	#6 - 3/4" (20 mm)	R61-06	14 lbs (6.4 kg)
MR-SR	20 kips (89 kN)	143.4 in² (926 cm²)	#6 - 3/4" (20 mm)	R61-06	22 lbs (10 kg)

Williams Anchor Rods are fully threaded and can be field cut and coupled. R61 lengths up to 50 feet uncoated. B8S up to 20 feet.
Galvanized rods should be cut to size prior to galvanizing to insure good nut fit.

Manta Ray Estimated Holding Capacities in Listed Soils

Common Soil Type Description	Typical Blow Count "N" per ASTM D1586	MR-68	MR-88	MR-3	MR-2	MR-1	MR-SR
Very dense/cemented sands; coarse gravel and cobbles	60 - 100+	2.5 kips (1, 3)	5 kips (1, 3)	10 kips (1, 3)	20 kips (1, 3)	(5)	(5)
Dense fine sand; very hard silts and clays	45 - 60	1.5-2 kips (2, 3, 4)	4-5 kips (2, 3, 4)	8.5-10 kips (2, 3, 4)	10.5-14 kips (2, 4)	18-20 kips (1, 3, 4)	20 kips (1, 3)
Dense clays, sands and gravel; hard slits and clays	35 - 50	1.1-1.5 kips (4)	2-3 kips (4)	6-9 kips (2, 4)	7.5-11 kips (2, 4)	12-18 kips (2, 4)	16-20 kips (2, 3, 4)
Medium dense sandy gravel; very stiff to hard silts and clays	24 - 40	0.75-1 kips (4)	1.5-2 kips (4)	4.5-7 kips (4)	6-9 kips (4)	9-10 kips (2, 4)	12-17 kips (2, 4)
Medium dense coarse sand and sandy gravel; stiff to very stiff silts and clays	14 - 25	0.55-.75 kips (4)	1-1.5 kips (4)	3.5-4.5 kips (4)	4.5-6 kips (4)	7.5-10 kips (4)	9-12 kips (4)
Loose to medium dense fine to coarse sand; firm to stiff clays and silts	7 - 14	0.45-0.6 kips (4)	0.75-1.25 kips (4)	2.5-4 kips (4)	3.5-5 kips (4)	5-7.5 kips (4)	7-9 kips (4)
Loose fine sand; alluvium; soft-firm clays; varied clays; fills	4 - 8	0.3-0.5 kips (4)	0.45-0.75 kips (4, 6)	1.5-2.5 kips (4, 6)	2.5-4 kips (4, 6)	4-6 kips (4, 6)	4.5-7 kips (4, 6)
Peat, organic silts; inundates silts fly ash	0 - 5	(5)	0.1-0.45 kips (4, 6)	0.4-1.5 kips (4, 6)	1-2.5 kips (4, 6)	1.5-4 kips (4, 6)	2-6 kips (4, 6)

1 - Drilled hole required to install.
2 - Installation may be difficult. Pilot hole may be required.
3 - Holding capacity limited by max safe working load of anchors.
4 - Holding capacity limited by soil strength.
5 - Not recommended in these soils.
6 - Wide variation in soil properties reduces prediction accuracy.

Use this chart for estimation only, true capacity must be tested with anchor locker. The values in chart are based on minimum 3' embedment depth for models MR-68 & MR-88 and 7' for Models MR-3 thru MR-SR. (Minimum overburden depth is 4'.) Field testing is recommended for other possible depths.

Earth Anchor Installation

Drive Anchor

Remove Drive Steel

Pull Anchor

Drive Steel

Drive steel and accessories are available for all earth anchors in basic lengths of 3 feet and 6 feet. Multiple sections are coupled together to achieve the required depth of installation.

Installation Methods

Vehicle Mounted Breakers or Compactors

Boom mounted demolition breakers are very effective for driving earth anchors. This method requires a special tool in the breaker to adapt to the drive steel. Skid steer loaders, backhoes or excavators work well. Breaker rated at between 250 to 500 foot-pound pavement breakers are best. Breaker tools are made for a variety of diameters. Consult your WFEC representative for more information.

Rock Drills

Top hammer or down-the-hole hammer rock drills are very effective for installation of soil anchors. For hard soil or weak rock installations, the drill can be used to drill a pilot hole. Williams can provide striker bar adapters for these types of drills. Rock drilling steel can also be modified to drive WFEC soil anchors.

Manual Installation

In some applications, earth anchors are driven into the soil with a 90 lb. pavement breaker and coupled drive steel. Pneumatic or hydraulic breakers are acceptable.

Load Locking Kits

For Manta Ray Anchors, the LL-1 is a 10-ton fast acting jack with an 8 inch stroke. The direct reading gauge and rod gripping jaws make load locking easy and quick. The base and jack are self-aligning to the actual installed angle of the anchor. It requires a hydraulic flow of 2 to 8 gallons per minute and a maximum pressure of 2,000 psi. A power supply is not included with this load-locking kit, it must be provided separately. Models GPU18-8 or GPU-2 are suitable. Consult your WFEC representative for more information.

Project: Van Andel Hospital
Contractor: King Co.
Location: Grand Rapids, MI

Grout & Grouting Accessories

US Spec RA Grout

Product Description

US Spec RA Grout consists of specialty blended cements and admixtures to provide maximum flow, shrinkage compensation and extended working times in an aggregate free formulation where clearances are minimal. RA Grout is non-metallic and non-corrosive. RA Grout has been specifically formulated to meet and exceed the testing requirements of **ASTM C-1107** and US Army Corps of Engineers CRD C-621. When tested in accordance with ASTM C-827 RA Grout yields a controlled positive expansion.

Time	PSI	MPa
1 Day	4,500	31.02
7 Days	9,000	62.05
28 Days	12,000	82.73

Advantages

- Pumpable fluid grout for very tight clearances
- Non-bleeding
- Attains high compressive strengths at specified w/c ratios
- Extended working time for maximum pumping range
- Non-shrink from time of placement
- Thixotropic: High flow restored by agitation
- Encapsulates tendons, bolts or bars to protect from corrosion
- Consistent: Strict Quality Control testing and standards

Packaging and Yield

US Spec RA Grout is packaged in heavy duty, polyethylene line backs containing 50 lb (22.7 kg), yielding 0.53 cubic feet when 7.75 quarts of mixing water is used. Each pallet contains 48 bags of RA Grout.

Note: Results based on a controlled laboratory environment (see product data for details). Jobsite results may vary.

Mixing

Mix US Spec RA Grout to a uniform consistency in accordance with the manufacturer's instructions. Potable water containing no chlorides or other foreign substance shall be used. The water shall be accurately measured and placed in the mixer first. Start with 1.94 gallons of water per 50lb bag of US Spec RA Grout and mix continuously for 3-5 minutes before placing. If possible, the grout should be mixed continuously until placing is completed, but if this is not practical, a brief remixing prior to pumping or placement is adequate to overcome the effect of "thixotropic set". Do not use any other admixtures or additives.

Post-Grout Tube

Williams will provide post-grout tubes for anchors bonded in weak rock or soil upon request. The Williams supplied flexible or rigid post-grout tube has a bursting strength of 1000 psi. The post-grout tube length and valve placement are adjustable and can be specified at the time of order. There is no field assembly of the post grout tube, other than attaching it to the anchor as it is being installed down the drill hole. Drill hole diameter should be a 1" minimum clearance to accommodate Post-Grout Tube.

T3P Heavy Duty Plastic Grout Tube

Furnished in product lengths for the rockbolts or in rolls.

O.D.	I.D.	Part No.
3/8" (10 mm)	1/4" (6 mm)	T3P03002
1/2" (13 mm)	3/8" (10 mm)	T3P04003
5/8" (16 mm)	1/2" (13 mm)	T3P05004
3/4" (19 mm)	5/8" (16 mm)	T3P06005
1" Nom. (25 mm)	3/4" Nom. (19 mm)	T3P06

T4Z Grout Tube Adapter

For down pressure grouting only when grout is forced through normal grout hole in the hollow rebar.

Grout Socks

What was once considered to be an impossible anchorage is made easy with a practical solution from Williams. For difficult bonding applications such as anchors in weak coral, sandstone, highly fractured rock, underwater holes and in artesian water conditions, we place Grout Socks on our grout bonded anchors to prevent grout loss due to permeation or washing away by flowing water. The socks are individually manufactured to be a minimum of 1" larger than the drill hole diameter, allowing the sock to expand into the deformations in the drill hole wall, and in many cases providing the only means to achieve a mechanical bond. In some geotechnical conditions, designers should be aware that Grout Sock may adversely affect the bond strength between the grout and ground. Williams recommends that a testing program be implemented to determine actual bond stress values for elements installed with grout socks.

Super Plasticizer

Plasticizer is available and is used as a water reducer for ease of pumping grout through tubes at lower water to cement ratios.

Grout Pumps

T6Z-04 Hand Pump

Use of plasticizer is recommend with hand pumps.

Pump

Pump Type: 2” piston
Output: 2-3 gpm (7-11 lpm)
Pressure: 200 psi (14 bar)

Physical Specifications

Dimensions: 27”W x 47”H x 44”L
Weight: 52 lbs (24 kg)

ChemGrout CG-050M

T6Z-08 Air Pump

Pump

Output/Pressure: 8 gpm, 261 psi

Mixer

Mix Tank: 22 Gallon
Holding Hopper: 12 Gallon

Drive Power

Air: 175 CFM, 100 psi

Physical Specifications

Dimensions: 59”L x 30”W x 51”H
Weight: 575 lbs

ChemGrout CG-550A

Colloidal Mixing

The heavy duty, high volume Colloidal Grout Plant is favored for precision grouting. The unit features a high speed shear mixer that thoroughly wets each particle and discharges the mixed material into an agitating holding tank. A direct coupled progressing cavity pump delivers the slurries. The unit easily mixes and pumps slurries of Portland cement, fly ash, bentonite, and lime flour. All controls are conveniently located on the operator platform for easy one-man control.

Colloidal Grout Plant

ChemGrout CG-600A

Pump

Pump Type: Progressing cavity
Output: Variable up to 20 gpm
Pressure: 261 psi

Colloidal Mixer

Mix Tank: 13 CF with bottom clean out
Mixing Pump: High Shear Colloidal
Holding Tank: 13 CF paddle agitating

Drive Power

Air: 300 CFM, 100 psi

Physical Specifications

Dimensions: 96”L x 60”W x 74”H
Weight: 1,550 lbs

High Pressure Colloidal Grout Plant

ChemGrout CG-460A

Pump

Pump Type: Double acting 2x8 plunger pump
Output: 15 gpm (57 lpm)
Pressure: 2,000 psi (138 bar)

Colloidal Mixer

Mix Tank: Dual 70 gallon (265 liter)
Mixing Pump: High Shear Colloidal

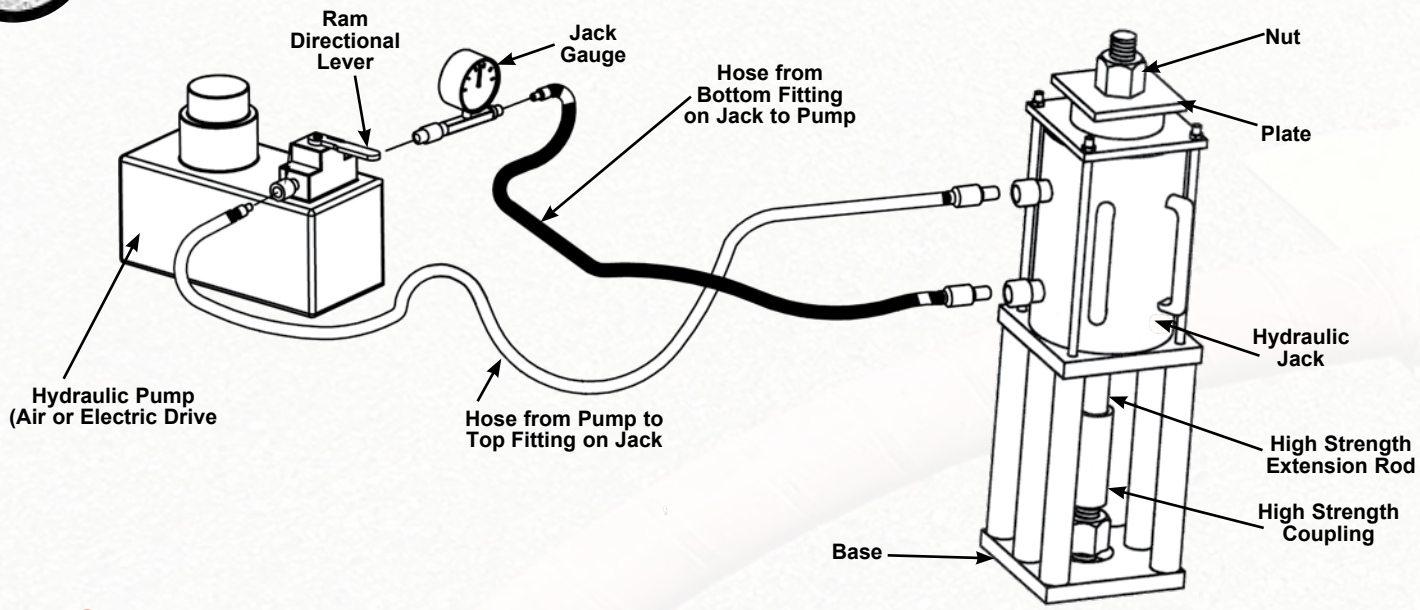
Drive Power

Air: 375 CFM @ 100 psi (10.6 M3/Min @ 7 bar)

Physical Specifications

Dimensions: 96”L x 40”W x 56”H
Weight: 1,400 lbs (635 kg)

Hydraulic Jacks for Threaded Bar Anchors



T7Z Open Frame Hydraulic Jacks

Used for testing and prestressing All-Thread-Bars. Available with up to 5-1/8" center hole. Unit comes with ram, pump, gauge, hoses, jack stand, high strength coupling, high strength test rod, plate, hex nut and knocker wrench.

Jack Capacity	Pump Method	Ram Height	Base Size	Ram Travel	Minimum Total Ram & Frame Height	Maximum Test Rod Diameter	Ram Area	Approx. Total Ram & Frame Weight
30 tons (267 kN)	Hand Double Acting	6-1/16" (154 mm)	8" x 8" (203 x 203 mm)	3" (76 mm)	19" (483 mm)	1-1/4" (32 mm)	5.89 in² (38 cm²)	80 lbs (36 kg)
60 tons (534 kN)	Hand, Air, or Electric Double Acting	9-1/2" (241 mm)	9" x 9" (228 x 228 mm)	5" (127 mm)	29" (737 mm)	2-1/8" (54 mm)	12.31 in² (79 cm²)	153 lbs (69 kg)
60 tons (534 kN)	Hand, Air, or Electric Double Acting	12-3/4" (324 mm)	9" x 9" (228 x 228 mm)	6-1/2" (165 mm)	32-1/4" (737 mm)	2-1/8" (54 mm)	12.73 in² (82 cm²)	173 lbs (78 kg)
100 tons (890 kN)	Air or Electric Double Acting	13-1/2" (343 mm)	9" x 9" (228 x 228 mm)	6" (152 mm)	29-1/8" (740 mm)	3-1/8" (79 mm)	20.63 in² (133 cm²)	198 lbs (87 kg)
100 tons (890 kN)	Air or Electric Double Acting	12-3/8" (314 mm)	9" x 9" (228 x 228 mm)	6" (152 mm)	28" (711 mm)	2" (51 mm)	20.03 in² (129 cm²)	192 lbs (87 kg)
200 tons (1779 kN)	Air or Electric Double Acting	12-1/4" (311 mm)	12" x 12" (305 x 305 mm)	8" (203 mm)	34" (864 mm)	4-1/16" (103 mm)	40.45 in² (261 cm²)	518 lbs (235 kg)
200 tons (1779 kN)	Air or Electric Double Acting	27-1/2" (699 mm)	12" x 12" (305 x 305 mm)	15" (381 mm)	49-1/4" (1250 mm)	4" (102 mm)	47.20 in² (303 cm²)	604 lbs (274 kg)
300 tons (2670 kN)	Electric Double Acting	27-1/2" (699 mm)	15" Dia. (381 mm)	15" (381 mm)	50-1/2" (1283 mm)	5-3/8" (137 mm)	78.5 in² (506 cm²)	1,400 lbs (635 kg)
400 tons (3558 kN)	Electric Double Acting	18-3/4" (476 mm)	15" Dia. (381 mm)	6" (152 mm)	45-3/4" (1162 mm)	4-1/4" (108 mm)	91.5 in² (590 cm²)	1,300 lbs (590 kg)

T80 Post-Tension Hydraulic Jacks

With the T80 series the enclosed bearing housing contains a geared socket drive to tighten the bolt hex nut during tensioning. Test jack housing will accommodate up to a 16" deep pocket.

Jack Capacity	Pump Method	Ram Height	Gear Box	Cylinder Diameter	Ram Travel	Minimum Total Ram & Frame Height	Maximum Test Rod Diameter	Max. 150 KSI Bar Size	Ram Area	Approx. Total Ram & Frame Weight
100 tons (890 kN)	Air or Electric Double Acting	13-1/2" (343 mm)	8.5" x 20.5" (216 x 520 mm)	4.63" (118 mm)	6" (152 mm)	39" (991 mm)	3-1/8" (79 mm)	1-3/8" (35 mm)	20.63 in² (133 cm²)	270 lbs (123 kg)

Torque Equipment

T8Z Hydraulic Torque Wrench

The hydraulic torque wrench is used for tensioning anchors in tight fitting locations where it would be difficult to use an hydraulic jack. The wrench is also recommended for use when setting the large diameter Spin-Lock anchors. The torque wrenches are light weight and can achieve a maximum of 7,400 ft-lbs. All Hydraulic Torque Wrenches have 1-1/2" square drive outputs.

Maximum Torque	Length	Height	Weight
5,590 ft-lbs (773 kg/M)	11.1" (279 mm)	4.5" (114 mm)	16.8 lbs (7.6 kg)
7,400 ft-lbs (1,023 kg/M)	10.7" (273 mm)	7" (178 mm)	19 lbs (11.3 kg)

T9F Impact Tool

Lightweight air impact guns for applying torque to anchor bolts when setting or tensioning the anchor assembly.

Capacity (ft-lbs)	Square Drive Size	Size
1,700 - 2,000	1"	T9F-08
3,000 - 4,000	1-1/2"	T9F-12

S6Z Spin-Lock Setting Tool

This tool is required for torque setting the Spin-Lock anchors or for spinning rebars into resin cartridges without jamming or scoring the bolt threads. Special two piece design allows lower hex to be held in place while upper hex is loosened for easy removal.

Hardened steel allows for several reuses. Two piece design assures easy removal. Other thread forms are available for all Williams anchors.

Bolt Rod Diameter	Part Number
1/2"	S6Z-OH-004
5/8"	S6Z-OH-005
3/4"	S6Z-OH-006
7/8"	S6Z-OH-007
1"	S6Z-OH-008
1-1/8"	S6Z-OH-009
1-1/4"	S6Z-OH-010
1-3/8"	S6Z-OH-011
1-1/2"	S6Z-OH-012
1-3/4"	S6Z-OH-014
1-7/8"	S6Z-OH-015
2"	S6Z-OH-016

T8Z Torque Wrench

For applying torque to the anchor bolt when setting the anchor.

Capacity (ft-lbs)	Square Drive Size
100-600	3/4"
200-1,000	1"

Available with Ratchet Adapter

T8Z-04 Torque Multiplier (4:1)

For use with T8Z Torque Wrench. Other sizes available.

Size	Square Drive Input	Square Drive Output	Maximum Torque
GA 186	1"	1-1/2"	4,000 (ft-lbs)

T1Z & T2Z Long Fitting Tool Adapters

For driving hex nuts and setting tools, typically with our Spin-Lock anchor systems. Works with torque wrench or impact gun.

Available with a 3/4", 1" and 1-1/2" square drive. Please specify square drive for compatibility with your equipment.

T2Z Regular Socket

T1Z Deep Socket

K3F-26 Long Fitting Wrench Adapter

For applying torque to recessed rockbolt nuts that are under tension when using hydraulic jacks. Available in all rockbolt sizes.

T3Z Hex Knocker Wrench

Hex knocker wrenches are used for safe hex nut adjustment inside of open frame jacks.

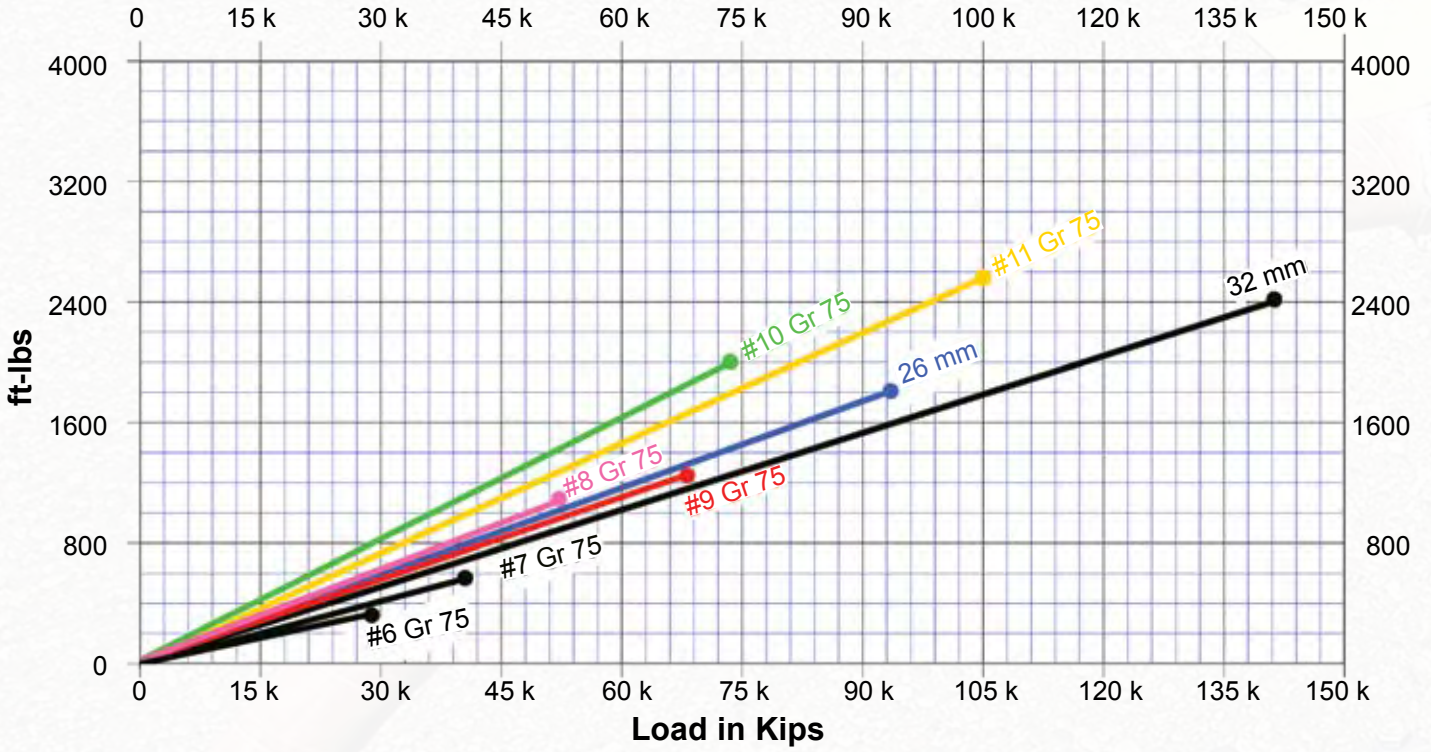
Spin Adapter

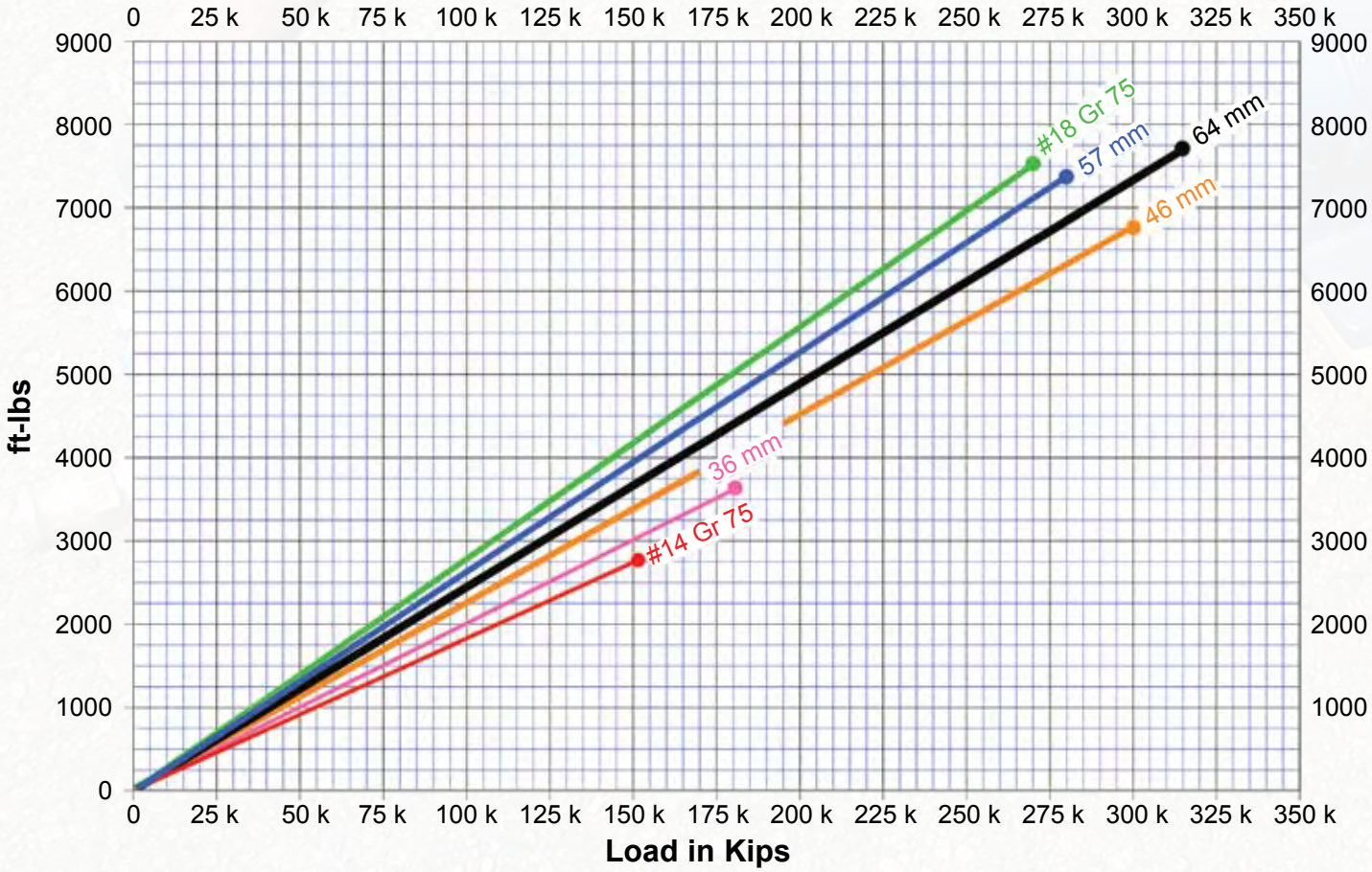
This tool provides a transition between the drill steel and the setting tool when the drilling equipment is used to spin the anchor bar through the resin cartridges. Adaptations to various drill steel types are available and must be specified when placing order.

All-Thread Bar Torque Tension Charts

R71 150 KSI All-Thread-Bar &
R61 Grade 75 & Grade 80 All-Thread Rebar Torque Tension Chart

All data based on greased (MolyKoat GN) threads and surfaces. Torque-tension relationships should be used as a guide and are only applicable to uncoated (plain finish) bars. Actual tension can vary significantly, and should be verified in the field. If accurate tension is required, Williams recommends tensioning using a hydraulic ram.

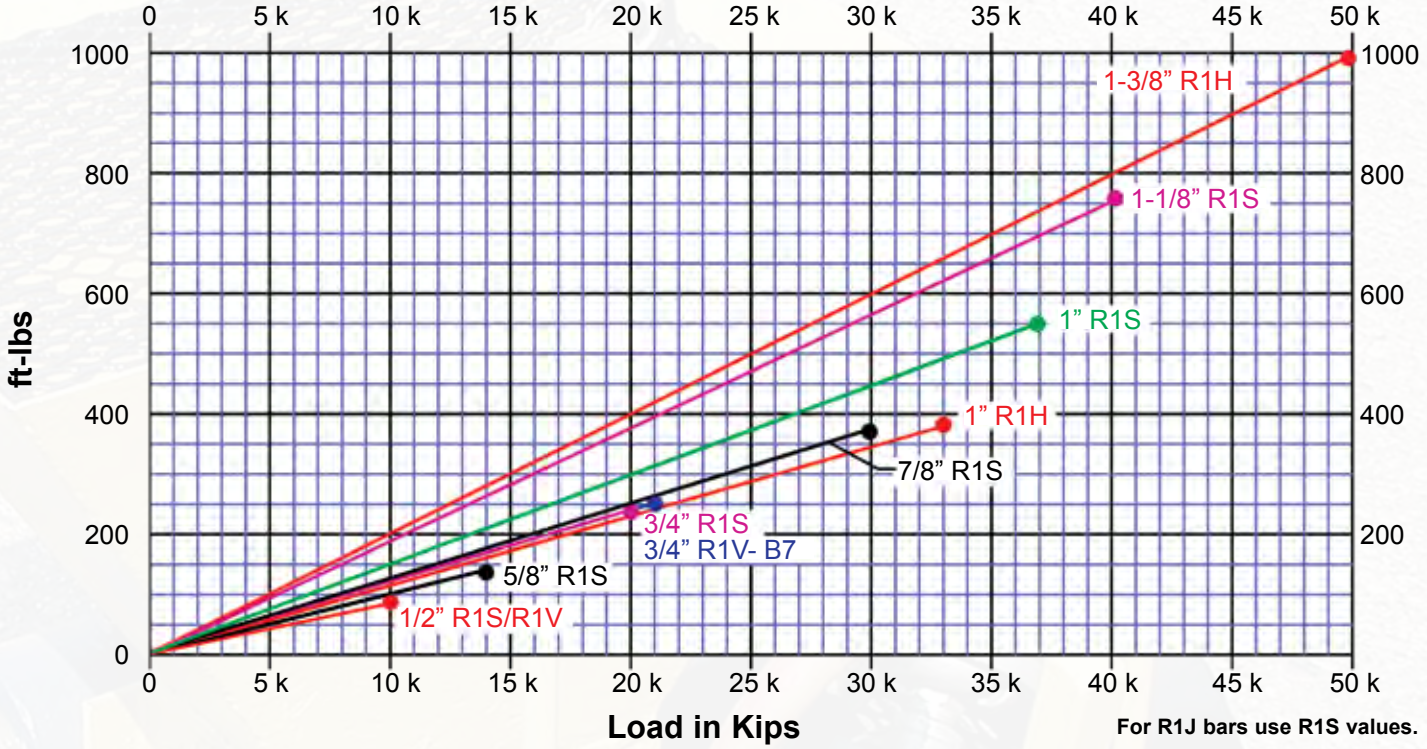




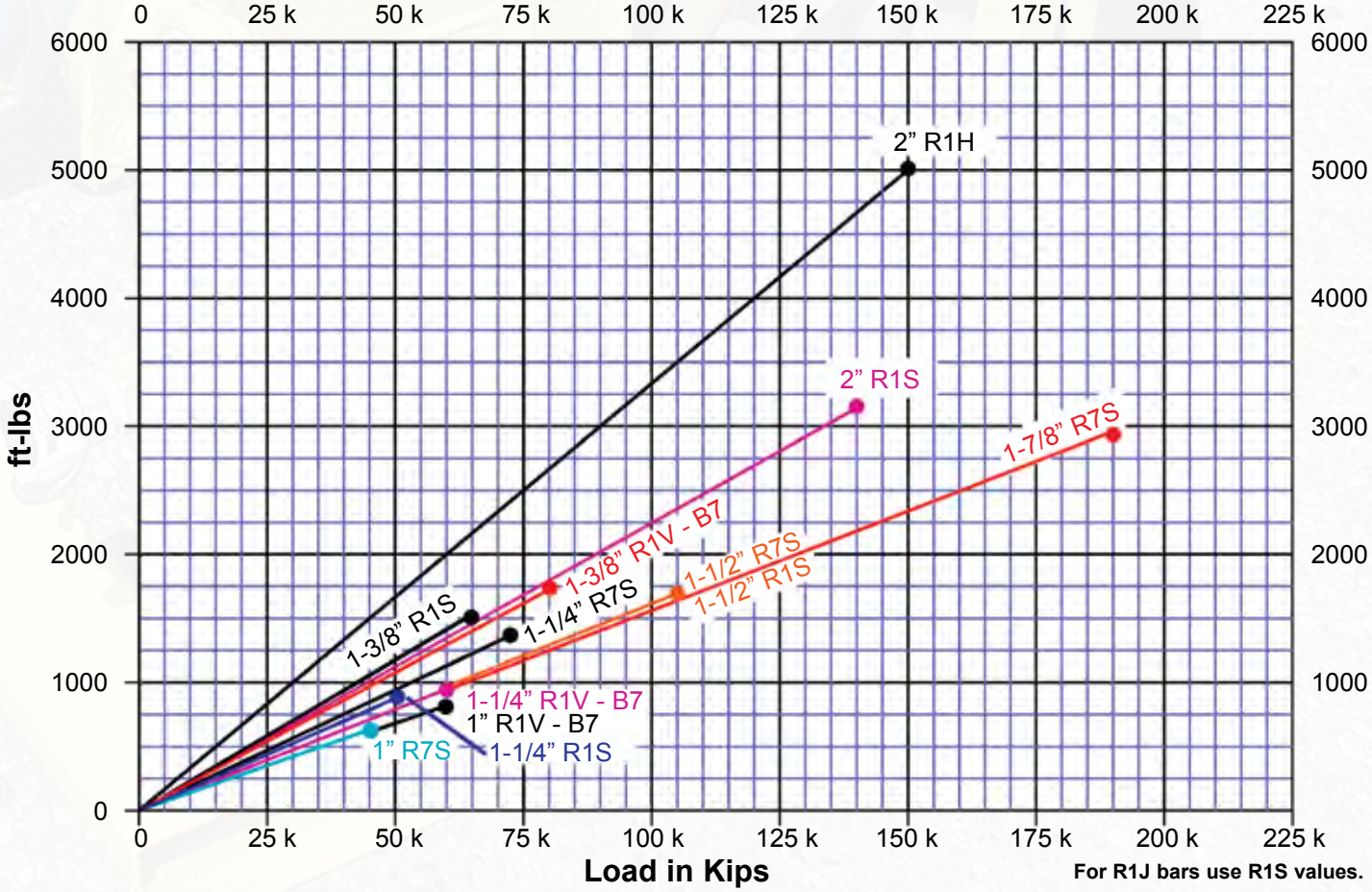
Spin-Lock Anchor Torque Tension Charts

R1H Hollow-Core, R1V High Impact, R1S High Tensile, R1J Solid Rebar & R7S 150 KSI Spin-Lock Torque Tension Chart

All data based on greased (MolyKoat GN) threads and surfaces. Torque-tension relationships should be used as a guide and are only applicable to uncoated (plain finish) bars. Actual tension can vary significantly, and should be verified in the field. If accurate tension is required, Williams recommends tensioning using a hydraulic ram.



For R1J bars use R1S values.



For R1J bars use R1S values.

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

WILLIAMS® FORM ENGINEERING CORP.

Please visit our website for the most current information
Web: www.williamsform.com
E-mail: williams@williamsform.com

Corporate Headquarters

8165 Graphic Dr.
Belmont, MI 49306
Ph: (616) 866-0815
Fax: (616) 866-1890

251 Rooney Road
Golden, CO 80401
Phone: (303) 216-9300
Fax: (303-216-9400

103 Kestrel Dr.
Collegeville, PA 19426
Phone: (610) 489-0624
Fax: (610) 489-0629

2600 Vulcan Dr.
Lithia Springs, GA 30122
Phone: (770) 949-8300
Fax: (770) 949-2377

6440 Flanders Dr.
San Diego, CA 92121
Phone: (858) 320-0330
Fax: (858) 320-0360

7601 North Columbia
Portland, OR 97203
Phone: (503) 285-4548
Fax: (503) 285-6858

25232 74th Ave. South
Kent, WA 98032
Phone: (253) 854-2268
Fax: (253) 854-2318

WILLIAMS FORM HARDWARE & ROCK BOLT (Canada) LTD.

670 Industrial Road
London, ON, N5V 1V1
Ph: (519) 659-9444
Fax: (519) 659-5880

Québec, QC
Ph: (581) 994-3156
Fax: (519) 519-3623

Vernon, BC
Ph: (250) 306-0737
Fax: (519) 659-3623

We have representation in the following organizations:

ADSC AGHP AMERICAN CLEAN POWER ASBI ASTM DFI ISM pti