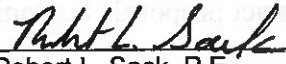


SUPERSEDED BY EB 15-031 EFFECTIVE 9/28/15		New York State Department of Transportation ENGINEERING INSTRUCTION	EI 13-004
Title: REVISIONS TO STANDARD SPECIFICATION SECTION 731 – SUBSURFACE TENSILE ELEMENTS			
Target Audience: ☐ Manufacturers (18) ☒ Local Govt. (31) ☒ Agencies (32) ☐ Surveyors (33) ☒ Consultants (34) ☒ Contractors (39) ☐ _____ ()		Approved:  Robert L. Sack, P.E. Deputy Chief Engineer (Research) 30 April 13 Date	

ADMINISTRATIVE INFORMATION:

- This Engineering Instruction (EI) is effective beginning with projects submitted for the letting of September 5, 2013.
- This EI supersedes EI 08-047 and EI 10-005.
- The revisions issued with this EI will be incorporated into the next update of the Standard Specifications.

PURPOSE: The purpose of this EI is to issue revised Standard Specification Section 731 *Subsurface Tensile Elements*.

TECHNICAL INFORMATION:

- A revision to the Standard Specification Section 211 *Internally Stabilized Cut Structures* is being issued concurrently via EI 13-003.
- A revision to Geotechnical Engineering Manual (GEM-21) *Design & Construction Guidelines for a Soil Nail Wall System* is being issued concurrently via EB 13-019.
- A revision to Geotechnical Engineering Manual (GEM-17) *Ground Anchor Inspector's Manual* is being issued concurrently via EB 13-020.
- The revisions to Standard Specification Section 731 *Subsurface Tensile Elements* include the following:
 1. A portion of Section 731 *Subsurface Tensile Elements* (originally issued via EI 08-047) is being revised. However, a previous update to this section was issued via EI 10-005. The entire section is being reprinted as part of this updated issuance of Section 731 *Subsurface Tensile Elements* to organize and minimize effective Engineering Issuances.
 2. The Materials Requirements of §731-01 and §731-02 were reorganized to separate the materials required for temporary installations and those required for permanent installations.
 3. The Material Requirements of §731-01A.1. *SNWS Nail Tendons* and §731-02A.1. *GTS Tendons* were revised to state that the use of hollow bars is not allowed.
- Hollow bars are being removed from use due to administrative and procedural issues. Administratively, the hollow bars available from Con-Tech, DYWIDAG, and Williams are manufactured outside of the U.S.A. which is a procurement issue for satisfying the requirements of §106-11 *Buy America*. Procedurally, the rotation speed and grout pressure in a hollow bar installation are critical in developing the grout body. Since production nails must be installed in the same manner as the test nails to achieve analogous results, inspection is even more critical than for the solid bars used in the drill-then-grout installations. In addition, the hollow bar installation creates a testing issue, as it is difficult to obtain an unbonded zone. These issues are

identified in *Hollow-Core Soil Nails State-of-the-Practice*, US Department of Transportation, Federal Highway Administration, Unassigned Publication No., April 2006 –

http://www.cflhd.gov/programs/techDevelopment/geotech/hollowcore/Hollow_Core_Soil_Nails_SOP.pdf. FHWA states that additional research is needed to solve these problems.

- The cost impact of the specification change is expected to be negligible

IMPLEMENTATION:

- The Main Office Design Quality Assurance Bureau will insert these standard specification revisions into contract proposals beginning with projects submitted for the letting of September 5, 2013.

TRANSMITTED MATERIALS: Revisions to Standard Specification Section 731 *Subsurface Tensile Elements*. Both metric and US Customary revisions are attached.

BACKGROUND: The general term Subsurface Tensile Elements identify engineered material components contained within the earth intended to stabilize unbalanced masses. Soil nails, grouted tiebacks, and rock bolts are subsurface tensile elements.

Soil Nails:

Soil nails are steel bars or tendons installed to reinforce or strengthen the existing ground. Soil nails are installed into an excavation as construction proceeds from the existing ground surface down to the proposed bottom of excavation. The soil nailing process creates a reinforced section that is itself stable and able to retain the ground behind it.

Although seemingly similar, the installation process (a hole is drilled and a nail is installed, grouted, and tested to a design load) for soil nails differs from that of grouted tiebacks. Specifically, soil nails are passive reinforcement which develop reinforcing action through nail-ground interactions as the ground deforms during and following construction. Soil nail walls provide some advantages over walls with grouted tiebacks by:

1. Eliminating soldier pile/sheeting installation and improving construction flexibility where overhead access is limited and/or in soils with cobbles and boulders.
2. Reducing right-of-way requirements by typically being shorter than tiebacks.
3. Having a higher system redundancy.

Grouted Tiebacks:

Grouted tiebacks consist of a steel tensioned element (a tendon, which may be multistrands or a bar) that transfers tensile forces from the ground to a structural element. In contrast to a soil nail, a grouted tieback is an active reinforcing element which is loaded and locked-off at a specific design load.

Rock Bolts:

Rock bolts consist of a steel tensioned element generally used in reinforcing a rock slope by transferring load from the unstable exterior to the confined interior of the rock mass. Rock bolts are also used as part of a rock catchment system by anchoring the catchment device.

To further develop the existing specification, the Geotechnical Engineering Bureau audited recent Departmental contracts utilizing these items to determine deficiencies. The following is an outline of the assessment:

- Organization – the specification addresses both permanent and temporary applications. The Material Requirements section is an unorganized, blended list.
- Material Acceptance - the Department has accepted a few Value Engineering Change Proposals regarding the substitution of hollow bars for the required solid bars. Inspection of exhumed installations has revealed some inefficiencies and concerns.

Specific changes to the specification are outlined in the Technical Information section.

CONTACT: Questions or comments regarding this issuance should be directed to Randall J. Romer, P.E., of the Geotechnical Engineering Bureau at (518) 457-4714, or via e-mail at randy.romer@dot.ny.gov.

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

Make the following changes to the Standard Specifications dated May 1, 2008 as modified by EI 08-047 and EI 10-005:

Under SECTION 731 – **SUBSURFACE TENSILE ELEMENTS**, Remove the entire section and **Replace** it with the following:

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

§731-01 – SOIL NAIL TENDON ASSEMBLY

SCOPE. This specification covers the material requirements for the components for assembling a soil nail tendon generally used in a Soil Nail Wall System (SNWS) to internally stabilize a cut and/or underpin a structure.

MATERIAL REQUIREMENTS.

A. SNWS Temporary. Provide materials meeting the following requirements:

1. **SNWS Nail Tendons.** Provide clean, straight, rust-free tendons meeting the following:
 - a. **Solid Bar Soil Nail (SBSN).** Provide solid bar tendons meeting AASHTO M31 of Grade 60 or 75, ASTM A722 for Grade 150. The deformed bar, continuous without splices or welds, undamaged, bare or epoxy coated or encapsulated (as shown on the approved Working Drawings), shall be threaded a minimum of 6 in. on the wall anchorage end to allow proper attachment of bearing plate and nut. Threading may be continuous spiral, deformed ribbing provided by the bar deformations (continuous threadbars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the bar shall be sized based on the net throat of the threads. Hollow bars are not allowed.
2. **SNWS Centralizers.** Provide centralizers manufactured from Schedule 80 PVC pipe or tube, steel, or any material not detrimental to the nail steel, except that wood shall not be used, and approved by the Engineer.
3. **SNWS Bar Couplers.** Provide bar couplers capable of developing 100% of the Guaranteed Ultimate Tensile Strength (GUTS) of the bar as certified by the manufacturer.

B. SNWS Permanent. Provide materials meeting the requirements §731-01 A. *SNWS Temporary* with the following additions and exceptions

1. **SNWS Nail Tendon Double Corrosion Protection.** In addition to covering the bar with grout, provide an additional level of corrosion protection consisting of:
 - a. **Epoxy Coating.** Provide epoxy coating conforming to the requirements of §709-04 *Epoxy-Coated Bar Reinforcement*. The Bend Test requirements are waived, or
 - b. **Encapsulation.** Provide a minimum 40 mil thick corrugated HDPE tube conforming to AASHTO M252 or corrugated PVC tube conforming to ASTM D1784, Class 13464-B. Encapsulation shall provide at least 3/16 in. of grout cover over the nail bar and be resistant to ultraviolet light degradation, normal handling stresses, and grouting pressures. Factory fabrication of the encapsulation is preferred. Upon the Engineer's approval, the encapsulation may be field fabricated if done in strict accordance with the manufacturer's recommendations.

SECTION 731 - SUBSURFACE TENSILE ELEMENTS

BASIS OF APPROVAL. Soil Nail Tendons will be approved based on the evaluation of the design submittal detailing the requirements of the assembly.

BASIS OF ACCEPTANCE. Soil nail centralizers, epoxy coating or encapsulation will be accepted on the basis of a material certification that the product conforms to this specification. Solid bar nail tendons and bar couplers (if allowed) will be accepted on the basis of a material certification that the product conforms to this specification and certified mill test results from each heat specifying the ultimate strength, yield strength, elongation, and composition indicating conformance to the design submittal and specification.

§731-02 - GROUTED TIEBACK ASSEMBLY

SCOPE. This specification covers the material requirements for the components for assembling a grouted tieback generally used in a Grouted Tieback System (GTS) to internally stabilize and supplement the resisting force of an external support system retaining a cut and/or underpinning a structure.

MATERIAL REQUIREMENTS.

A. GTS Temporary. Provide materials meeting the following requirements:

1. **GTS Tendons.** Provide clean, straight, rust-free tendons meeting the following:

- a. **Wire Tendons.** "Uncoated Seven-Wire Stress Relieved Strand for Prestressed Concrete" - ASTM A416, or "Uncoated Seven-Wire Compacted Stress Relieved Strand for Prestressed Concrete" - ASTM A779, or
- b. **Solid Bar.** Continuously threaded "Uncoated High-Strength Steel Bar for Prestressing Concrete" - ASTM A722. Hollow bars are not allowed.

The GTS tendons shall be of such size that the design load does not exceed 53% of the Guaranteed Ultimate Tensile Strength (GUTS) of the tendons.

2. **GTS Couplers.** Provide couplers for tendons capable of developing 100% of the GUTS.

3. **GTS Sheath.** Provide a sheath for corrosion protection encasing the entire stressing length of the tendon. Acceptable sheaths for the stressing length shall be one of the following:

- a. A polyethylene (PE) tube applied over a corrosion inhibiting grease coated strand. The polyethylene shall be Type II, III or IV as defined by ASTM D1248. The tubing shall have a minimum wall thickness of 60 mils.
- b. A hot-melt extruded polypropylene tube applied over a corrosion inhibiting grease coated strand. The polypropylene shall PP 210 B55542-11 as defined as ASTM D4101. The tubing shall have a minimum wall thickness of 60 mils.
- c. A corrugated PVC tube applied over a corrosion inhibiting grease coated strand. The PVC tube shall conform to ASTM D1784 Class 13464-B. The tubing shall have a minimum wall thickness of 60 mils.
- d. A heat shrinkable tube coated with an elastic adhesive applied over bar tendons. Prior to shrinking the tube shall have a nominal wall thickness of at least 24 mils and the elastic adhesive inside the tube shall have a nominal thickness of 20 mils. A smooth bond breaker shall be placed around the heat shrinkable tube in the free length.

SECTION 731 - SUBSURFACE TENSILE ELEMENTS

4. **GTS Grease.** Provide a grease compound for corrosion inhibiting and lubricating properties to completely cover the steel in the stressing length. Provide grease for the stressing length meeting the requirements shown in Table 731-02-1 *Grease Properties*:

TABLE 731-02-1 GREASE PROPERTIES			
Property		Test Method	Acceptance Criteria
Dropping Point		ASTM D566	Minimum 300° F
Oil Separation @ 160° F		FTMS 791B Method 321.2	0.5% Maximum by mass
Water Content		ASTM D95	0.1% Maximum
Flash Point		ASTM D92	Minimum 300° F
Accelerated Corrosion Test: 5% Salt Fog @ 100° F @ 5 mil, min. hrs, Q Panel Type S		ASTM B117	Rust Grade 7 or better after 1000 hrs. of exposure according to ASTM D610
Water Soluble Ions	Chlorides	ASTM D512	10 ppm Maximum
	Sulfides	ASTM D4500-S ² E	10 ppm Maximum
	Nitrates	ASTM D3867	10 ppm Maximum
Soak Test: 5% Salt Fog @ 100° F @ 5 mil coating, Q Panel Type S. (Immerse panels 50% in a 5% salt solution and expose to salt fog).		ASTM B117 (modified)	No emulsification of the coating after 720 hrs. of exposure.
Sheathing Compatibility: 40 days @ 150° F	Hardness Change	ASTM D4289	15% Change
	Volume Change	ASTM D4289	10% Change
	Tensile Strength Change	ASTM D638	30% Change

5. **GTS Centralizers and Spacers.** Provide centralizers and spacers consisting of plastic, steel or any material not detrimental to the tendon. Wood shall not be used. Centralizers and spacers shall permit free flow of grout. Combination centralizer/spacers will be permitted.
6. **GTS Trumpet.** Provide a trumpet integral with the bearing plate. The trumpet shall consist of an epoxy coated steel pipe or tube conforming to the requirements of ASTM A53 for pipe or ASTM A500 for tubing. The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate, and shall be long enough to accommodate movements of the structure during loading and testing. For encapsulated strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon in the stressing length to the diameter of the tendon at the anchor head without damaging the encapsulation. A seal to retain grease or grout within the trumpet shall be provided between the trumpet and the stressing length corrosion protection. If grout is used to fill the trumpet, then the seal shall be a deformable seal. If grease is used to fill the trumpet, a description of the seal shall be submitted to the Engineer for approval.

B. GTS Permanent. Provide materials meeting the requirements §731-02 A. *GTS Temporary* with the following additions and exceptions

1. **GTS Encapsulation.** Provide an additional level of corrosion protection for the GTS Tendon consisting of:
- a. **Encapsulation.** Provide encapsulation consisting of a tube of corrugated PVC, high density polyethylene or steel. The encapsulation shall have sufficient thickness to resist damage due to shipping, handling and installation.

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

BASIS OF APPROVAL. Grouted Tiebacks will be approved based on the evaluation of the design submittal detailing the requirements of the assembly.

BASIS OF ACCEPTANCE. Grouted Tieback Assembly will be accepted on the basis of a Material Certification for the grouted tieback centralizers and spacers, encapsulation, sheath, trumpet, and grease compound.

Grouted tieback tendons and couplers (if allowed) will be accepted on the basis of a material certification and certified mill test results from each heat specifying the ultimate strength, yield strength, elongation, and composition indicating conformance to the design submittal and this specification.

§731-03 – ROCK BOLT ASSEMBLY

SCOPE. This specification covers the material requirements for the components for assembling a rock bolt generally used in reinforcing a rock slope or as part of a rock catchment system. The following materials are evaluated in this specification:

731.0301 – Rock Bolt Assembly, 1 in. Diameter Steel Bar

731.0302 – Rock Bolt Assembly, 1 ¼ in. Diameter Steel Bar

MATERIAL REQUIREMENTS.

A. Bolts. Provide bolts of at least Grade 150 (ASTM A722) prestressing steel of the diameter shown in the contract documents. Bolts must have rolled thread-like deformations over the entire length.

B. Appurtenances. Provide appurtenances as recommended by the bolt manufacturer for the size and grade bolt supplied, consisting of a steel bearing plate, a hardened washer, if required, and a convex bottom anchor nut. Two beveled or wedge washers per bolt may be required. The upper, or bearing washer, shall be countersunk on the side opposite the bevel to match the bottom of the anchor nut.

C. Resin. Provide resin of the two-component type, and of two different setting times, specifically manufactured for rock bolting. Use only resin that is within the unexpired shelf life designated on the package by the manufacturer.

Provide cartridges of the appropriate diameter as recommended by the manufacturer for the bolt/drill hole/cartridge diameter combination used. Furnish sufficient fast setting resin to fill 3 ft. of annular space in the bottom of the hole. Greater amounts of fast setting resin will be necessary in some rock types to meet the pull test requirements. Furnish slower setting resin with a setting time of no less than fifteen minutes. Install enough slow setting resin in the remainder of the hole to fully encapsulate the bolt.

BASIS OF ACCEPTANCE. Rock bolts and appurtenances will be accepted on the basis of a material certification that the product conforms to this specification and certified mill test results from each heat specifying the ultimate strength, yield strength, elongation, and composition indicating conformance to the specification. Larger diameter bolts are acceptable if supplied at no additional cost to the State.

Rock bolt resin will be accepted on the basis of a material certification that the product conforms to this specification.

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

Make the following changes to the Standard Specifications dated May 4, 2006 as modified by EI 08-047 and EI 10-005:

Under SECTION 731 – **SUBSURFACE TENSILE ELEMENTS**, **Remove** the entire section and **Replace** it with the following:

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

§731-01 – SOIL NAIL TENDON ASSEMBLY

SCOPE. This specification covers the material requirements for the components for assembling a soil nail tendon generally used in a Soil Nail Wall System (SNWS) to internally stabilize a cut and/or underpin a structure.

MATERIAL REQUIREMENTS.

A. SNWS Temporary. Provide materials meeting the following requirements:

2. **SNWS Nail Tendons.** Provide clean, straight, rust-free tendons meeting the following:
 - a. **Solid Bar Soil Nail (SBSN).** Provide solid bar tendons meeting AASHTO M31 of Grade 420 or 520, ASTM A722 for Grade 1035. The deformed bar, continuous without splices or welds, undamaged, bare or epoxy coated or encapsulated (as shown on the approved Working Drawings), shall be threaded a minimum of 150 mm on the wall anchorage end to allow proper attachment of bearing plate and nut. Threading may be continuous spiral, deformed ribbing provided by the bar deformations (continuous threadbars) or may be cut into a reinforcing bar. If threads are cut into a reinforcing bar, the bar shall be sized based on the net throat of the threads. Hollow bars are not allowed.
2. **SNWS Centralizers.** Provide centralizers manufactured from Schedule 80 PVC pipe or tube, steel, or any material not detrimental to the nail steel, except that wood shall not be used, and approved by the Engineer.
3. **SNWS Bar Couplers.** Provide bar couplers capable of developing 100% of the Guaranteed Ultimate Tensile Strength (GUTS) of the bar as certified by the manufacturer.

B. SNWS Permanent. Provide materials meeting the requirements §731-01 A. *SNWS Temporary* with the following additions and exceptions

2. **SNWS Nail Tendon Double Corrosion Protection.** In addition to covering the bar with grout, provide an additional level of corrosion protection consisting of:
 - a. **Epoxy Coating.** Provide epoxy coating conforming to the requirements of §709-04 *Epoxy-Coated Bar Reinforcement*. The Bend Test requirements are waived, or
 - b. **Encapsulation.** Provide a minimum 1 mm thick corrugated HDPE tube conforming to AASHTO M252 or corrugated PVC tube conforming to ASTM D1784, Class 13464-B. Encapsulation shall provide at least 5 mm of grout cover over the nail bar and be resistant to ultraviolet light degradation, normal handling stresses, and grouting pressures. Factory fabrication of the encapsulation is preferred. Upon the Engineer's approval, the encapsulation may be field fabricated if done in strict accordance with the manufacturer's recommendations.

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

BASIS OF APPROVAL. Soil Nail Tendons will be approved based on the evaluation of the design submittal detailing the requirements of the assembly.

BASIS OF ACCEPTANCE. Soil nail centralizers, epoxy coating or encapsulation will be accepted on the basis of a material certification that the product conforms to this specification. Solid bar nail tendons and bar couplers (if allowed) will be accepted on the basis of a material certification that the product conforms to this specification and certified mill test results from each heat specifying the ultimate strength, yield strength, elongation, and composition indicating conformance to the design submittal and specification.

§731-02 – GROUTED TIEBACK ASSEMBLY

SCOPE. This specification covers the material requirements for the components for assembling a grouted tieback generally used in a Grouted Tieback System (GTS) to internally stabilize and supplement the resisting force of an external support system retaining a cut and/or underpinning a structure.

MATERIAL REQUIREMENTS.

A. GTS Temporary. Provide materials meeting the following requirements:

1. **GTS Tendons.** Provide clean, straight, rust-free tendons meeting the following:

a. **Wire Tendons.** "Uncoated Seven-Wire Stress Relieved Strand for Prestressed Concrete" - ASTM A416, or "Uncoated Seven-Wire Compacted Stress Relieved Strand for Prestressed Concrete" - ASTM A779, or

b. **Solid Bar.** Continuously threaded "Uncoated High-Strength Steel Bar for Prestressing Concrete" - ASTM A722. Hollow bars are not allowed.

The GTS tendons shall be of such size that the design load does not exceed 53% of the Guaranteed Ultimate Tensile Strength (GUTS) of the tendons.

2. **GTS Couplers.** Provide couplers for tendons capable of developing 100% of the GUTS.

3. **GTS Sheath.** Provide a sheath for corrosion protection encasing the entire stressing length of the tendon. Acceptable sheaths for the stressing length shall be one of the following:

a. A polyethylene (PE) tube applied over a corrosion inhibiting grease coated strand. The polyethylene shall be Type II, III or IV as defined by ASTM D1248. The tubing shall have a minimum wall thickness of 1.5 mm.

b. A hot-melt extruded polypropylene tube applied over a corrosion inhibiting grease coated strand. The polypropylene shall PP 210 B55542-11 as defined as ASTM D4101. The tubing shall have a minimum wall thickness of 1.5 mm.

c. A corrugated PVC tube applied over a corrosion inhibiting grease coated strand. The PVC tube shall conform to ASTM D1784 Class 13464-B. The tubing shall have a minimum wall thickness of 1.5 mm.

d. A heat shrinkable tube coated with an elastic adhesive applied over bar tendons. Prior to shrinking the tube shall have a nominal wall thickness of at least 0.6 mm and the elastic adhesive inside the tube shall have a nominal thickness of 0.5 mm. A smooth bond breaker shall be placed around the heat shrinkable tube in the free length.

4. **GTS Grease.** Provide a grease compound for corrosion inhibiting and lubricating properties to completely cover the steel in the stressing length. Provide grease for the stressing length meeting the requirements shown in Table 731-02-1 *Grease Properties*:

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

TABLE 731-02-1 GREASE PROPERTIES			
Property		Test Method	Acceptance Criteria
Dropping Point		ASTM D566	Minimum 149° C
Oil Separation @ 71° C		FTMS 791B Method 321.2	0.5% Maximum by mass
Water Content		ASTM D95	0.1% Maximum
Flash Point		ASTM D92	Minimum 149° C
Accelerated Corrosion Test: 5% Salt Fog @ 38° C @ 0.13 mm, min. hrs, Q Panel Type S		ASTM B117	Rust Grade 7 or better after 1000 hrs. of exposure according to ASTM D610
Water Soluble Ions	Chlorides	ASTM D512	10 ppm Maximum
	Sulfides	ASTM D4500-S ² E	10 ppm Maximum
	Nitrates	ASTM D3867	10 ppm Maximum
Soak Test: 5% Salt Fog @ 38° C @ 0.13 mm coating, Q Panel Type S. (Immerse panels 50% in a 5% salt solution and expose to salt fog).		ASTM B117 (modified)	No emulsification of the coating after 720 hrs. of exposure.
Sheathing Compatibility: 40 days @ 66° C	Hardness Change	ASTM D4289	15% Change
	Volume Change	ASTM D4289	10% Change
	Tensile Strength Change	ASTM D638	30% Change

5. **GTS Centralizers and Spacers.** Provide centralizers and spacers consisting of plastic, steel or any material not detrimental to the tendon. Wood shall not be used. Centralizers and spacers shall permit free flow of grout. Combination centralizer/spacers will be permitted.

6. **GTS Trumpet.** Provide a trumpet integral with the bearing plate. The trumpet shall consist of an epoxy coated steel pipe or tube conforming to the requirements of ASTM A53 for pipe or ASTM A500 for tubing. The trumpet shall have an inside diameter equal to or larger than the hole in the bearing plate, and shall be long enough to accommodate movements of the structure during loading and testing. For encapsulated strand tendons, the trumpet shall be long enough to enable the tendon to make a transition from the diameter of the tendon in the stressing length to the diameter of the tendon at the anchor head without damaging the encapsulation. A seal to retain grease or grout within the trumpet shall be provided between the trumpet and the stressing length corrosion protection. If grout is used to fill the trumpet, then the seal shall be a deformable seal. If grease is used to fill the trumpet, a description of the seal shall be submitted to the Engineer for approval.

B. GTS Permanent. Provide materials meeting the requirements §731-02 A. *GTS Temporary* with the following additions and exceptions

1. **GTS Encapsulation.** Provide an additional level of corrosion protection for the GTS Tendon consisting of:

a. **Encapsulation.** Provide encapsulation consisting of a tube of corrugated PVC, high density polyethylene or steel. The encapsulation shall have sufficient thickness to resist damage due to shipping, handling and installation.

BASIS OF APPROVAL. Grouted Tiebacks will be approved based on the evaluation of the design submittal detailing the requirements of the assembly.

SECTION 731 – SUBSURFACE TENSILE ELEMENTS

BASIS OF ACCEPTANCE. Grouted Tieback Assembly will be accepted on the basis of a Material Certification for the grouted tieback centralizers and spacers, encapsulation, sheath, trumpet, and grease compound.

Grouted tieback tendons and couplers (if allowed) will be accepted on the basis of a material certification and certified mill test results from each heat specifying the ultimate strength, yield strength, elongation, and composition indicating conformance to the design submittal and this specification.

§731-03 – ROCK BOLT ASSEMBLY

SCOPE. This specification covers the material requirements for the components for assembling a rock bolt generally used in reinforcing a rock slope or as part of a rock catchment system. The following materials are evaluated in this specification:

731.0301 – Rock Bolt Assembly, 26 mm Diameter Steel Bar

731.0302 – Rock Bolt Assembly, 32 mm Diameter Steel Bar

MATERIAL REQUIREMENTS.

A. Bolts. Provide bolts of at least Grade 1035 (ASTM A722M) prestressing steel of the diameter shown in the contract documents. Bolts must have rolled thread-like deformations over the entire length.

B. Appurtenances. Provide appurtenances as recommended by the bolt manufacturer for the size and grade bolt supplied, consisting of a steel bearing plate, a hardened washer, if required, and a convex bottom anchor nut. Two beveled or wedge washers per bolt may be required. The upper, or bearing washer, shall be countersunk on the side opposite the bevel to match the bottom of the anchor nut.

C. Resin. Provide resin of the two-component type, and of two different setting times, specifically manufactured for rock bolting. Use only resin that is within the unexpired shelf life designated on the package by the manufacturer.

Provide cartridges of the appropriate diameter as recommended by the manufacturer for the bolt/drill hole/cartridge diameter combination used. Furnish sufficient fast setting resin to fill 900 mm of annular space in the bottom of the hole. Greater amounts of fast setting resin will be necessary in some rock types to meet the pull test requirements. Furnish slower setting resin with a setting time of no less than fifteen minutes. Install enough slow setting resin in the remainder of the hole to fully encapsulate the bolt.

BASIS OF ACCEPTANCE. Rock bolts and appurtenances will be accepted on the basis of a material certification that the product conforms to this specification and certified mill test results from each heat specifying the ultimate strength, yield strength, elongation, and composition indicating conformance to the specification. Larger diameter bolts are acceptable if supplied at no additional cost to the State.

Rock bolt resin will be accepted on the basis of a material certification that the product conforms to this specification.