SPECIAL PROVISIONS
FOR
HIGH-STRENGTH, STAINLESS STEEL BARS FOR POST-TENSIONED CONCRETE

Scott County
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THE STANDARD SPECIFICATIONS, SERIES 2015, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

150263a.01 DESCRIPTION.

This Special Provision covers high-strength, stainless steel bars intended for use in post-tensioning (P/T) applications. This work consists of manufacturing, fabricating, furnishing and handling high-strength, stainless steel, all-thread bars and hardware for use as a P/T concrete anchor at the steel arch rib interfaces with Piers 12 and 13.

The P/T bars have continuous thread surface deformations, known as Type II bars. Stainless steel hardware shall include end nuts, coupling nuts, jam nuts, custom washers, temporary jacking hardware (stressing bars, stressing nuts, and stressing end nuts) and any miscellaneous stainless steel items needed to furnish a complete P/T anchorage bar assembly.

The specified stainless steel is 2507 Duplex Stainless Steel. Bars shall have a minimum tensile strength F_{ut} of 116,000 psi.

The Engineer will not consider alternate stainless steel alloys for this application. The stainless steel alloy used for the nuts, couplers, washers and other hardware shall match the threaded bar alloy to prevent dissimilar alloy contact.

A. Ordering Information: Orders for high-strength stainless steel bars under this Special Provision shall contain the following information:

- Project Title or Reference.
- Stainless steel alloy.
- Quantity of bars, coupling nuts, end nuts, and custom washers.
- Quantity of stressing bars, stressing nuts, and end nuts (not for final use in bridge).
- Size and length.

B. Commentary: This is a new application and new type of material for high-strength, stainless steel, all-thread bars for post-tensioned (P/T) concrete. As such, the Iowa DOT commissioned a research project for the development of the material application and stainless steel alloy selection. Where

appropriate, the Iowa DOT has provided commentary from the researchers in various sections herein to relay experiences for the manufacture and fabrication of the bar. (Commentary is noted as such in parenthesis and provided in *italic* type face and highlighted in grey.)

150263a.02 DEFINITIONS.

Anchorages: An assembly of various hardware components that secures the stainless steel, all-thread-bars at their ends after they have been stressed and transfers a compressive force into the concrete or steel arch base.

Cold-Rolled Thread: A threading method that uses dies and pressure to displace rather than physically cut material to create threads. This is often used in conjunction with a slightly reduced diameter body.

Contamination: When carbon steel contacts a stainless steel, it can contaminate the stainless steel surface with free iron. This can de-passivate the protective oxide film of the stainless steel surface, leaving the material vulnerable to corrosion.

Coupling Nut: An internally threaded, longer-than-standard end nut used to connect two pieces of threaded material and develop the full tensile strength of the joined material. The threaded material engages the coupling nut for one-half the length on each end. This is also referred to as a stop-type coupling when a feature used to limit thread engagement is incorporated at the center of the nut length.

End Nut: An internally threaded product intended for use on external or male screw threads of the anchorage bar for the purpose of tightening or assembling two or more components.

Galling: A cold-welding process that can occur when the mating surfaces of male and female threads are placed under heavy pressure. During fastener tightening, high pressure can deform the mating threads and result in localized cold welding, leading to thread seizing.

Passivation: The process of forming an oxide film on a stainless steel surface by chemical treatment to improve corrosion resistance of the stainless steel material. The process is usually performed after the steel has been subjected to machining or contact with carbon steel.

Relaxation: An observed stress decrease in response to the same amount of strain generated in the structure, or simply creep within the steel under prolonged strain.

Right-Hand Thread: A screw thread that is screwed in or tightened-on clockwise. Right-hand threads are designated as RH or are not designated, as this thread pattern is most common.

Seating: Anchor seating is the total movement of a point on the post-tensioning bar during load transfer from the jack to the permanent anchorages. This is also known as seating loss in the bar, as some of the initial stressing load will be lost due to seating of the anchor plates, thread engagement and bearing within the lock-off nut, and immediate elastic relaxation of the metal.

Stop-Type Coupling: See Coupling Nut.

Stressing Nut: Similar to a coupling nut. Nut of the same stainless steel alloy as the threaded bar, used to post-tension the bar by threading on the exposed bar tail. The stressing nut usually has two or more parallel machined surfaces to allow for wrench-tightening / untightening. Nut may be hex-shaped in cross-section.

Tail: The length of threaded bar protruding from the end or lock-off nut, required to engage a temporary stressing nut used during the stressing operation.

150263a.03 MATERIALS.

A. Reference Documents.

1. ASTM International.

A276 Standard Specification for Stainless Steel Bars and Shapes
A370 Test Methods and Definitions for Mechanical Testing of Steel Products
A484 Standard Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings
A722 Standard Specification for High-Strength Steel Bars for Prestressed Concrete (*covers carbon steel only*)
A751 Standard Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products
A967 Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts
E10 Standard Test Method for Brinell Hardness of Metallic Materials
E18 Standard Test Methods for Rockwell Hardness of Metallic Materials
E23 Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
E140 Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
E328 Standard Test Methods for Stress Relaxation for Materials and Structures

2. AASHTO.

T244 Standard Method of Test for Mechanical Testing of Steel Products

B. Anchor Bar Fabricator: Furnish all components of the high-strength, stainless steel bar post-tensioning system from a single source, bar fabricator. The fabricator shall have experience in producing carbon steel P/T bars conforming to ASTM A722. Acceptable P/T bar fabricators are:

1. Dywidag Systems International (DSI), Bolingbrook, IL.

2. Williams Form Engineering Corp., Belmont, MI.

3. An approved equal.

C. Stainless Steel Supplier: Furnish all material of the high-strength, stainless steel bar post-tensioning system from a single source, supplier. Raw materials shall be sourced from a steel supplier subject to the Buy America provisions of the FHWA. Acceptable suppliers are:

1. Carpenter Technology Corporation, Philadelphia, PA. (*a contact familiar with this project is Kent Wilson, kwilson@cartech.com, 484-269-4130 cell*).

2. An approved equal.

D. All-Thread-Bars: All-thread, high-strength, stainless steel post-tensioning bars shall have the following requirements:

1. Stainless steel alloy - 2507 Duplex (UNS S32750).

2. Heat Treatment - Normal annealing as recommended by the manufacturer.

3. Minimum tensile strength, F_{ut} = 116 ksi.

4. Minimum yield strength, F_y = 80 ksi.

5. Length - as required for installation location.

6. Diameter - maximum 3 inch outside thread diameter.

7. Minimum effective tensile area – 6.14 square inches.

8. Finish - round with threads; passivated.

E. Coupling Nuts: Coupling nuts for joining two lengths of the all-thread bar shall develop the minimum specified tensile strength of the bar and have the following requirements:

1. Stainless steel alloy - 2507 Duplex (UNS S32750).

2. Heat Treatment - Normal annealing as recommended by the manufacturer.

3. Minimum tensile strength, F_{ut} = 110 ksi.

4. Minimum yield strength, F_y = 75 ksi.

5. Length - minimum of 12 inches.

6. Diameter - 5.0 inch outside diameter.

7. Finish - polished round and passivated.

8. Stop Pin - at mid-nut width and length to verify engagement of the two bar ends for stressing; pin shall be 2507 Duplex stainless steel.

F. End Nuts: End nuts for the all-thread bar shall develop the minimum specified tensile strength of the bar and have the following requirements:

1. Stainless steel alloy - 2507 Duplex (UNS S32750).

2. Heat Treatment - Normal annealing as recommended by the manufacturer.

3. Minimum tensile strength, F_{ut} = 110 ksi.

4. Minimum yield strength, F_y = 75 ksi.

5. Length - minimum of 5 inches.

6. Diameter - 5 inch outside diameter.

7. Finish - polished round and passivated.

G. Jam Nuts: Jam or stop nuts for the all-thread bar to be used at the end of the coupling nuts and end nuts shall have the following requirements:

1. Stainless steel alloy - 2507 Duplex (UNS S32750).

2. Heat Treatment - Normal annealing as recommended by the manufacturer.

3. Minimum tensile strength, F_{ut} = 110 ksi.

4. Minimum yield strength, F_y = 75 ksi.

5. Length - minimum of 3 inches.

6. Diameter - 5.0 inch outside diameter.

7. Finish - polished and passivated.

H. Stressing Nuts: Stressing nuts for joining two lengths of the all-thread bar during stressing shall develop the minimum specified tensile strength of the bar and have the following requirements:

1. Stainless steel alloy - 2507 Duplex (UNS S32750).

2. Heat Treatment - Normal annealing as recommended by the manufacturer.

3. Minimum tensile strength, F_{ut} = 110 ksi.

4. Minimum yield strength, F_y = 75 ksi.

5. Length - minimum of 12 inches.

6. Diameter - 5 inch outside diameter.

7. Finish - polished round and passivated.

8. Identification - label all stressing nuts with permanent paint in a conspicuous location to avoid their accidental use in the permanent bridge assemblies.

9. Visual Inspection Hole - provide at mid-nut thickness and length to verify engagement of the two bar ends for stressing.

I. Custom Washers: Custom washers as detailed on Drawing Sheet 139 shall have the following requirements:

1. Stainless steel alloy - 2507 Duplex (UNS S32750).

2. Heat Treatment - Normal annealing as recommended by the manufacturer.

3. Minimum tensile strength, F_{ut} = 110 ksi.

4. Minimum yield strength, F_y = 75 ksi.

5. Thickness - 1 inch.

6. Outside Diameter – 6 5/16 inches.

7. Inside Diameter - varies as 3 1/8 inches or 3 3/8 inches. Refer to drawing detail.

8. Finish - polished round and passivated.

J. Fabrication.

1. **Tolerance Levels:** The supplier shall specify minimum round bar tolerances for the plain bars to be ordered from the mill. In absence of specific tolerances for cold-finished bars, the permissible dimensional variations for cold-finished stainless steel bar shall not exceed the applicable tolerance levels or limits stated in ASTM A484 for inch-pound values.

2. **Thread Deformations**.
   a. All-thread post-tensioning bars shall have deformations spaced uniformly along the entire length of the bar. The thread deformations around the bar perimeter shall be similar in size and shape, and be continuous.

b. Threading shall be achieved by cold-rolling. The thread form, size, clearances, and tolerances shall be similar to that used in the prior bar testing research program, which was 3.5 threads per inch. Alternate thread form, size, clearance, and tolerances will require verification through full-size tension testing of the bar and nuts, and are subject to approval by the Engineer.

c. Threads on the bar and threading of the nuts shall mate to provide smooth installation of the nut on the bar with or without stress on the bar both before and after application of the pre-stretch load (refer to the Special Provision for Post-Tensioning of Arch Rib Bearings), which will cause inelastic deformation of the bar.

d. All threading shall have a right-hand (RH) thread orientation for all bars and nuts fabricated.

*(**Commentary**: Threading for the bar testing research program was performed by Dywidag Systems International (DSI). Minimum nut and coupling sizes provided in this special provision are based upon use of that thread. The stainless steel bars and nuts tested in the bar testing research program had a 3.5 threads per inch thread pitch. The various nut lengths specified above (Items D, E, F, & G) were tested and verified to develop the full-strength of the bar. Any significant deviation from the thread utilized in the bar testing research program will require approval by the Engineer. Moreover, verification by full scale tension testing of the bar and nuts to develop strength will be required for any thread form not conforming to that used during the bar testing research program. The draft final report is provided with this Special Provision for informational purposes only.)*

3. Mechanical Coupling: The bars shall have deformations arranged in a manner to permit coupling of the bars with a thread-on type coupling nut. It shall be the responsibility of the finished-bar manufacturer to demonstrate that a bar cut at any point along its length may be freely coupled to any other length of bar. Additionally, the coupled joint shall be capable of developing the minimum specified tensile strength of the coupled bars without coupler slip or thread tearing.

4. Verification / Inspection.

a. Coupling nuts shall be supplied with a 1/2 inch diameter hole at the center of the length and drilled full nut thickness. A 1/2 inch diameter, 2507 Duplex stainless steel stop pin shall be inserted and fixed in the coupler to provide a physical stop at the nut centerline to verify thread bar engagement at a splice. Welding of the stop pin is prohibited.

b. Stressing nuts shall be supplied with a 1 inch diameter, visual inspection hole at the center of the nut length and drilled full nut thickness.

5. Finish: The fabricated bars and nuts shall be free of defects injurious to the tensile properties and shall have a workmanlike finish.

6. End nuts shall have a minimum of two, parallel machined surfaces to allow for wrench-tightening, as required. As required, the top end nut shall have a hex pattern for tightening access while in the jacking frame. Indicate on the piece drawings the depth and length of the machined plane surface(s).

7. In as practical as possible, assign certain machines to fabricate stainless steels only, to prevent carbon steel contamination. Use the same preferred coolant to cut stainless steels, to the exclusion of all other metals.

K. Chemical Analysis.

1. A chemical analysis of each heat of steel shall be determined in accordance with ASTM A751. The manufacturer shall make the analysis on test samples taken during the pouring of the heat. The chemical composition determined shall be reported on the mill certificate for the heat.

2. The stainless steel shall conform to the chemical composition shown in Table 1, in accordance with ASTM A276:

Table 1 - 2507 Duplex Stainless Steel Chemical Requirements (Heat Analysis)

Element	Chemical Composition (%) [1]
Carbon (C)	0.030
Manganese (Mn)	1.20
Phosphorus (P)	0.035
Sulfur (S)	0.020
Silicon (Si)	0.80
Chromium (Cr)	24.0 to 26.0
Nickel (Ni)	6.0 to 8.0
Molybdenum (Mo)	3.0 to 5.0
Nitrogen (N)	0.24 to 0.32
Copper (Cu)	0.05

Note (1): Maximum, unless range specified.

3. In addition to the Table 1 requirements, the (% Cr) + (3.3 x % Mo) + (16 x % N) shall be greater than or equal to 41.

4. A product analysis may be made by the Engineer from the bar representing each heat of steel.

L. Mill Certification Material Analysis.

1. Tensile Testing: Tension tests shall be conducted in accordance with ASTM A370 or AASHTO T244 on machined specimens. Values reported shall include the following:
- Tensile Strength
- Yield Strength based on 0.2% offset
- Elongation in 2 inches.
- Percent Reduction in Area

2. Hardness Testing: Per Section K3 below, in accordance with ASTM E10 or E18.

3. Toughness Testing: Per Section K4 below, in accordance with ASTM E23 at -30°F or colder.

M. Fabricated Bar Verification Testing.

1. Tensile Properties.
- **a.** Tension test specimens shall be the full section of the bar as fabricated in final form. The length shall be a minimum of 12 feet. Machined-reduced section test specimens are not permitted. Tension tests shall be conducted in accordance with ASTM A370 or AASHTO T244.
- **b. Area:** All unit stress determinations shall be based on the nominal area determined from the bar weight [mass] less 3.5% for the weight [mass] of the deformations.
- **c.** Threaded bars shall develop the specified tensile strength and yield strength of the original material.
- **d.** Record the load-deformation curve up to 1% strain, using extensometers, LVDTs, or other elongation measurement means in either a 25 inch or 50 inch gage length.

2. Relaxation.
- **a.** Full-size specimens shall be tested to determine their long-term relaxation under load. In addition to the following conditions, the general test procedures described in ASTM E328, Test Method A can be referenced.

b. Gage Length: The gage length shall be at least 40 times the nominal bar diameter (**$40d_b$**).
c. The temperature of the test specimen shall be maintained at 68°F ± 3.5°F. Any deviation from this mean temperature shall be accounted for in the test through thermocouples or temperature compensating load cells. In no instance shall the temperature drop below 45°F, unless the test is being performed at a lower specified design temperature.
d. Test Duration: The relaxation test duration shall be 1000 hours.
e. The test set-up shall consist of a stiff, stationary framework. End nuts shall be long enough to prevent nut failure during the test duration.
f. The test specimen shall not be subjected to loading above 10% of its minimum breaking strength prior to the relaxation test.
g. The stressing load shall be applied uniformly over a period of not less than 3 minutes and not more than 15 minutes.
h. Load-elongation readings shall be taken when the test commences up to the target stressing load. Load-relaxation readings shall commence 1 minute after application of the total stressing load, after seating losses have occurred, if any. It shall be permitted to restress the test following initial readings to account for seating losses.
i. Load-relaxation readings shall be taken no less than once per 2 hours for the test duration.
j. Over-stressing of the test specimen beyond $0.9F_{pu}$ during application of the load shall not be permitted.
k. The initial test load (after seating loss) shall be a minimum of 368 kips (60 ksi on a stress area of 6.14 square inches). The initial test load shall not exceed 430 kips (70 ksi on a stress area of 6.14 square inches). It should be noted that higher initial test loads will produce less favorable results. This test load shall be used to verify if the stressing level and associated relaxation losses are within the limits established by the design.
l. The maximum permissible relaxation values are provided in Table 2:

Table 2 - Maximum Relaxation Values

Acceptance Criteria for 1000 Hour Relaxation Test Performed at 60 ksi Initial Stress (After Seating Losses) [1,2]	
Ratio of (100 hr Loss)/(1000 hr Loss)	**Maximum Permissible 1000 hr Loss (ksi)**
55.0%	0.95
65.0%	1.55
75.0%	2.36
85.0%	3.41

Note (1): Linear Interpolation is acceptable.

Note (2): For initial stress values exceeding 60 ksi, the maximum permissible 1000 hr loss may be increased by a ratio of (actual initial stress in test, ksi)/(60 ksi target initial stress)

m. The Engineer reserves the right to modify the final P/T stressing values of the installed bars based on this testing.
n. Failure to meet the relaxation limits above may result in rejection of the material.

3. Hardness.
a. Hardness shall be reported across the section of the threaded bar, and at the inside and outside diameter of the end nuts and coupling nuts for fabricated material.
b. Hardness testing shall be conducted in accordance with ASTM E10 or E18. Conversion factors per ASTM E140 shall be permitted to be used.
c. The maximum hardness value of the fabricated material shall not exceed the value given in Table 3:

Table 3 - Maximum Hardness Values

Hardness Type	Maximum Value
Brinell	310
Rockwell C	33

4. **Fracture Toughness.**
   a. **Fracture Critical Tension Component:** The anchorage bars shall be considered fracture critical. Test specimens shall be procured from fabricated bars and impact tested in accordance with ASTM E23.
   b. **Impact Specimens**:
      - Specimens shall be standard-size or sub-size specimens, and indicated as such in the report.
      - The longitudinal axis of each specimen shall be parallel to the final direction of rolling of the bar or parallel to the longitudinal axis of the bar.
      - A minimum of three impact tests shall be taken from the center of the fabricated anchorage bar and tested.
   c. The minimum Charpy V-notch impact test results shall be as shown in Table 4:

Table 4 - Impact Test Requirements for P/T Bars

Minimum Energy Test Value, ft-lbs	Minimum Average Energy Value, ft-lbs
160	200 at -30°F

   d. The Charpy V-notch impact test results shall be reported to verify compliance with this Special Provision.

N. Number of Tests.

1. Hardness and impact testing shall be conducted in triplicate and considered as one set of tests. The number of test specimens shall consist of one set for every lot of 150 fabricated, all-thread bar(s) produced, or fraction thereof.

2. Tension and relaxation testing shall consist of testing three full-scale fabricated bars for the entire project, unless retesting is required.

3. Furnish all material samples for QA / QC testing at no additional cost to the Contracting Authority.

4. One set of dimensional property tests including bar weight (mass), and spacing, height and projected area of deformations shall be made of each bar size rolled from each heat.

*(**Commentary**: Any thread change will require experimental verification of the end and coupling nut's length and ability to develop the full strength of the bar. Fabricator shall submit their proposed testing program to verify.)*

O. Retesting.

1. If the minimum property of any test specimen is less than that specified, a retest shall be permitted.

2. If the results of a tension test specimen fail to meet specified requirements, two additional tests shall be made. If the tensile property in either of these tests is less than the minimum specified value, that heat shall be rejected.

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

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

P. Field Passivation: The citric acid solution for field passivation shall be:

1. *CitriSurf 77*, manufactured by Stellar Solutions, Inc., McHenry, IL 60050, (847) 854-2800.

2. *CitriSurf 2210 Gel*, manufactured by Stellar Solutions, Inc.

3. *Stainless Steel Passivation Kit*, manufactured by Caswell Plating Inc., Lyons, NY, (855) CASWELL.

4. An approved equal.

Q. Lubricants: As required, thread lubricants shall be used to prevent stainless steel galling. Suitable lubricants shall be PTFE-based (Teflon), non-silicone, dry lubricants such as:

1. *WD-40 Specialist Dry Lube PTFE Spray*, by WD-40 Corporation.

2. *B'LASTER Advanced Dry Lube w/Teflon*, by B'laster Chemical Corp.

3. *Dry PTFE Lubricant*, by Rust-Oleum Industrial Products.

4. An approved equal.

150263a.04 SUBMITTALS.

A. The high-strength stainless steel bars shall have the following submittal requirements for the plain parent bar(s) from the mill:

1. Mill Certificates for all steel heats used, including but not limited, to the following:
   - **a.** Heat and / or lot number.
   - **b.** Weight of material represented by the heat number.
   - **c.** Finished bar diameter.
   - **d.** Bar length represented by the heat.
   - **e.** Report on chemical composition.
   - **f.** Tensile properties, including tensile strength, yield strength, elongation in 2 inches, and reduction of area.
   - **g.** Hardness.
   - **h.** Charpy V-notch impact test.

2. Melt source.

3. Material description.

4. The raw source material is free from radioactive contamination. The finished material is free from mercury contamination.

B. Drawing Submittals: Piece drawings shall fully depict the part or assembly in plan, elevation, or sectional views with appropriate dimensional information. At a minimum, submit the following piece drawings for the high-strength stainless steel bar assembly:

1. End nut.

2. Coupling nut with stops.

3. Jam nuts.

4. Custom washer.

5. Full-length view of the bar with hardware denoted.

6. Details of the stainless steel jacking bar and nut assembly to install the bar.

C. Verification Testing: The high-strength stainless steel bars shall have the following submittal requirements for a minimum of three, full-size, fabricated, all-thread bar(s) produced:

1. Actual tensile properties of the fabricated bar, including:
- **a.** Yield strength from the 0.2% offset
- **b.** Tensile strength
- **c.** Elongation

2. Load-elongation behavior up to 1% strain.

3. Brinell or Rockwell C hardness reported across the section of the threaded bar, and at the inside and outside diameter of the end nuts and coupling nuts.

4. Charpy V-notch test results at a temperature of -30°F. Results shall be reported for standard-size or sub-size specimens.

5. Relaxation data for the 1000 hours relaxation test, including jacking load, initial test load, load at 100 hours, and load at 1000 hours for each bar tested. A graph showing all readings for load vs. time for each bar tested.

D. Passivation Certification: After all threaded bars, coupling nuts, end nuts, jam nuts, and custom washers have been fabricated, provide evidence of shop passivation of the stainless steel.

E. Submittal Procedures: Unless noted otherwise, submit the above in advance of the start of construction to allow a 30 calendar day review period. All submittals not approved and requiring resubmission shall be subject to the above review time period, with the review time beginning anew for each such submittal. Coordinate all submittals between various subordinates (contractors, suppliers, and engineers) to allow for a reasonable distribution of the review effort required by the Engineer at any given time. Do not install the work until the submittals have been approved.

F. Lots and Identification: A lot is that parcel of components as described herein. All all-thread-bars from each mill heat of steel shipped to the site shall be assigned an individual lot number and shall be tagged in such a manner that each such lot can be accurately identified at the job site. Submit records to the Engineer identifying assigned lot numbers with the heat of material represented. All unidentified all-thread-bars received at the site will be rejected. Also, loss of positive identification of these items at any time will be cause for rejection.

G. Approval of Materials: The approval of any material by the Engineer shall not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective for any reason.

H. Clearly mark the shipping package or form with a statement that the package contains high-strength, stainless steel all-thread-bars and the type of care that is to be used in handling.

*(**Commentary**: The stainless steel alloy to be procured for this project will require sufficient lead time from the stainless steel mill manufacturer. The alloy is a special order and will likely require*

a mill order, with the appropriate end treatment. Some mills may also have a minimum order requirement. It is suggested that extra, production bars be procured to account for loss, or thread damage, etc.; the delay in procuring a small quantity of bars as the result of damage or poor planning can be significant. Moreover, the Contractor should plan to have sufficient stressing bars and nuts of the same stainless steel alloy.)

150263a.05 CONSTRUCTION.

A. Stainless Steel Passivation and Protection.

1. After fabrication, all stainless steel parts making up the anchor rod assembly shall be thoroughly cleaned with a degreaser or cleanser to remove contaminants, cutting fluids, roll-thread lubricants, etc. The stainless steel parts shall then be passivated in nitric acid per ASTM A967.

2. Following stainless steel post-tensioning bar installation, stressing, and lock-off, all exposed stainless steel parts for the final bridge anchorage shall be cleaned and field-passivated with citric acid-based solutions per ASTM A967. Parts for this treatment include the bar tails, end nuts used for lock-off, and seating plates. These parts shall be thoroughly cleaned with a degreaser or cleanser to remove contaminants, threading lubricants, etc.

3. Consult with the manufacturer of the citric acid-based solution for specific information regarding product use, concentrations, duration of treatment, and clean-up. Submit this information to the Engineer for use with field inspection.

4. Mock-Up: The Contractor shall select two bar tail regions from the installed anchor bar assembly on the abutment representative of stainless steel contamination requiring re-passivation.

a. The mock-up will be used to demonstrate the appropriate technique and methods to re-passivate the stainless steel in the field, including:
- Appropriate surface preparation.
- Thickness (gel), liquid concentration, or amount of material required.
- Means of containing the material on the sloped surface and preventing spillage on adjacent concrete, fiberglass, and (carbon) steel surfaces.
- Verification of approximate coverage rate.
- Required duration of the treatment at the given temperature.
- Clean-up and disposal procedures.

b. The mock-up shall be conducted on steel surfaces with a minimum temperature of 50°F and rising. Infrared temperature devices shall be used to verify temperature.

c. The Engineer must approve the mock-up location.

d. After successful completion of the mock-up verified means and methods for re-passivation, the Contractor shall submit the procedure for record.

e. The Contractor may wish to consider conducting additional mock-ups or tests on land prior to trials on the actual abutment face. The Contractor shall notify the Engineer and/or Department of these trials to witness the field testing.

f. The manufacturer of the citric acid solution shall be involved with any field trials of their material.

5. Citric acid-based solutions shall be stored on the job-site at temperatures between 50°F and 120°F in manufacturer-approved containers. Do not allow material to freeze.

6. Do not leave concrete or carbon steel surfaces exposed to citric acid-based solutions for any prolonged time period. Damage to these materials will occur with prolonged exposure.

B. Stainless Steel Galling Prevention.

1. As required during the stressing and lock-off operation, use a suitable lubricant to prevent stainless steel galling and aid in the turning of the end nut, coupling nut, and stressing nut.

2. The Contractor shall limit the use of a lubricant to the bar thread length actually engaging the nut. All excess lubricant on the bar tail shall be removed and stainless steel cleaned before field passivation.

3. Any lubricant used should not contain molybdenum disulfide or copper particles.

C. Handling and Storage.

1. After passivation, avoid contamination of the stainless steel surfaces with carbon steel material such as surfaces, tools, cutting debris and weld splatter. All parts shall be wood blocked, handled with nylon lifting straps, bundled with high-strength polyester strapping (i.e. *Tenax* or equivalent), etc. Contact with plain, carbon steel shall be avoided to prevent contamination.

2. Prevent contact of carbon steel tool surfaces (wrenches, pipe wrenches, etc.) with the stainless steel. As necessary, fabricate special wrenches from stainless steel to mitigate contamination of the nuts and anchor bar.

3. The transported stainless steel shall not come in direct contact with flatbed trailer surfaces without proper blocking. Tie downs on the flatbed trailer shall consist of nylon straps or chains padded with a nylon sleeve. Conventional, unprotected steel chains or steel cable tie downs are prohibited.

4. The stainless steel bars and hardware shall be stored above grade on the jobsite. Cover the bars and all hardware with tarpaulins. The Contractor shall be responsible for the security of the bars on the jobsite.

5. Any stainless steel part suspected of being contaminated or compromised during shipment, storage, or handling shall be re-passivated.

6. The Contractor shall protect the finished and exposed stainless steel post-tensioning bar installations in the abutment from contamination during the remaining construction operations on the bridge structure. This includes, but not limited to, weld splatter, steel cutting splatter, cutting, grinding, steel painting overspray, concrete placements in the vicinity of the abutment, temporary guying anchorages, etc.

7. Any installed stainless steel part suspected of being contaminated or compromised from nearby construction activities shall be cleaned and re-passivated with citric acid.

D. Field Cutting of Bars.

1. Only cut the ends of the all-thread-bars if the jacking forces and elongations are satisfactory and approval has been obtained from the Engineer.

2. Cut all-thread-bar tail protrusions that exceed 6 inches in length beyond the nut using an abrasive gas saw (i.e. *Partner Saw* or equivalent) with a blade solely dedicated to cutting the stainless steel bar.

3. After cutting, the cut surfaces should be passivated as per Section B above.

4. Flame or plasma cutting is strictly prohibited.

E. Inspection and Maintenance.

1. The Engineer shall have free entry, at all times while work on the contract is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the Engineer all reasonable facilities to satisfy him that the material is being furnished in accordance with this Special Provision.

2. All tests (except product analysis) and inspection shall be made at the place of manufacture prior to shipment. Alternately, the tests shall be conducted at a laboratory (or at laboratories) suitable to perform the tests, prior to shipment. All testing shall be witnessed by a Professional Engineer licensed in the State of Iowa.

3. The Engineer shall reserve the right to perform any of the inspection set forth in the specification where such inspections are deemed necessary to assure that the material furnished conforms to prescribed requirements.

4. The Contractor shall leave any remaining stressing bars and hardware at the jobsite for potential future use at the bridge abutments. This material shall be labeled with permanent paint in a conspicuous location (end or side) stating “I-74 Arch Bridge Abutment, 2507 Duplex, Anchor Bar Hardware.” The Contractor shall coordinate the storage location with the Department.

150263A.06 METHOD OF MEASUREMENT.

No measurement shall be made.

150263A.07 BASIS OF PAYMENT.

No separate payment will be made per this Special Provision section. The payment for the requirements of this Special Provision shall be made in accordance with the Special Provisions for Furnish and Install Arch Rib Anchorage Assembly and the Special Provisions for Post-Tensioning of Arch Rib Bearings, as applicable.