



**SPECIAL PROVISIONS
FOR
POST-TENSIONING OF ARCH RIB BEARINGS**

**Scott County
IM-NHS-074-1(198)5--03-82**

**Effective Date
April 25, 2017**

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.

This is a complete rewrite of the previous version of this special provision. No changes are indicated by shading or strikethrough.

150215a.01 DESCRIPTION.

- A.** This work consists of installing the upper portion of the Alloy 2507 Duplex Stainless Steel all-thread-bars (S.S. all-thread-bars), including the top anchorage, as well as post-tensioning, cutting, and grouting the S.S. all-thread-bars at the arch rib interfaces at Piers 12 and 13.
- B.** Furnishing and fabricating the S.S. all-thread-bars and anchorages is not included with this item. See the Special Provisions for Furnish and Install Arch Rib Anchorage Assembly.

150215a.02 QUALIFICATIONS AND INSPECTION.

- A.** Perform all post-tensioning field operations under the direct supervision (crew foreman) of a qualified post-tensioning technician.
- B.** Provide a crew foreman with the following:
 - A minimum of 5 years bridge construction experience, including 2 years in post-tensioning-related operations,
 - A minimum of 1 year as a foreman in responsible charge of post-tensioning-related operations, and
 - Certification according to the "Post-Tensioning Training Course" of the Post-Tensioning Institute (PTI), or other equivalent and recognized alternative course.
- C.** Provide a grouting supervisor with the following:
 - ASBI certification for grout technician,
 - 3 years of experience on previous projects involved grouting of a similar type and magnitude,

- At least four previous, satisfactorily completed projects.

D. All grouting operations shall be performed by personnel that have received instructional training and are under the immediate control of the grouting supervisor.

150215a.03 TERMINOLOGY.

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

Duct: Material forming a conduit to accommodate S.S. all-thread-bar installation and provides an annular space for the grout.

Fluidity: A measure of time, expressed in seconds necessary for a stated quantity of grout to pass through the orifice of a flow cone.

Grout: A mixture of cementitious materials and water, with or without mineral additives or admixtures, proportioned to produce a pumpable consistency without segregation of the constituents, when injected into the duct to fill the space throughout the S.S. all-thread-bar, anchorages, and duct.

Grout Inlet: Tubing, port, or duct used for injection of the grout into the duct.

Grout Outlet: Tubing, port, or duct to allow the escape of air, water, grout and bleed water from the duct.

Job Site: The location where the post-tensioning is to be performed. Also called the "site".

Post-tensioning: A method of prestressing, where tensioning of the tendons occurs after the concrete has reached a specified strength.

Pre-stretch Load: Tensioning load applied to the S.S. all-thread-bar in order to increase the elastic region limits of the material by strain hardening.

Set (also Anchor Set): Anchor set is the total movement of a point on the post-tensioning bar during load transfer from the jack to the permanent anchorages.

Tendon: A complete assembly consisting of anchorages, S.S. all-thread-bar, and ducts with grout.

150215a.04 MATERIAL.

A. Description.

Grouts shall be prepackaged in moisture-proof containers. Grout bags shall indicate date of manufacture, lot number and mixing instructions. Any change of materials or material sources requires retesting and certification of the conformance of the grout with this Special Provision. A copy of the Quality Control Data Sheet for each lot number and shipment sent to the job site shall be provided to the Contractor by the grout supplier and furnished to the Engineer. Materials with a total time from manufacture to usage in excess of 6 months shall be tested and certified by the supplier that the product meets the QC Control Specifications before use or the material shall be removed and replaced.

B. Product Approval.

Post-tensioning grout components sources will need written approval for use and shall be materials which conform to this Special Provision and the requirements prescribed in Section 2407 of the Standard Specifications, for the particular kind and type of material specified.

Manufacturers of post-tensioning grout seeking evaluation of their product shall submit an application in accordance with Materials I.M. 409 and include certified test reports from an audited and independent Cement Concrete Research Laboratory (CCRL) which shows the material meets all the requirements specified herein. Compliance with the requirements stated in the Accelerated Corrosion Test Method (ACTM) may be by written manufacturer's certification.

C. Grout Properties.

1. Gas Generation.

The grout shall not contain aluminum or components, which produce hydrogen, carbon dioxide or oxygen gas.

2. Laboratory Test.

The grout shall meet or exceed the specified physical properties stated herein as determined by the following standard and modified ASTM test methods. Conduct all grout tests with grout mixed to produce the minimum time of efflux. Establish the water content to produce the minimum and maximum time of efflux.

Property	Test Value	Test Method
Total Chloride Ions	Max. 0.08% by weight of cementitious material	ASTM C1152
Fine Aggregate (if utilized)	99% passing the No. 50 Sieve	ASTM C136*
Hardened Height Change @ 24 hours and 28 days.	0.0% to + 0.2%	ASTM C1090**
Expansion	≤ 2.0% for up to 3 hours	ASTM C940
Wet Density – Laboratory	Report max. and min obtained test value, lb/ft ³	ASTM C185
Wet Density – Field	Report max. and min obtained test value, lb/ft ³	ASTM C138
Compressive Strength 28 day (Average of three cubes)	≥7000 psi	ASTM C942
Initial Set of Grout	Min. 3 hours Max 12 hours	ASTM C953
Time of Efflux*** (a) immediately after mixing	Min. 20 sec. Max. 30 sec. or Min 9 sec., Max. 20 sec.	ASTM C939 ASTM C939****
(b) 30 minutes after mixing with remixing for 30 sec.	Max. 30 sec. or Max. 30 sec.	ASTM C939 ASTM C939****
Bleeding @ 3 Hours	Max 0.0%	ASTM C940*****
Permeability @ 28 days	Max. 2500 coulombs at 30 V for 6 hours	ASTM C1202

* Use ASTM C 117 procedure modified to use a No. 50 sieve. Determine the percent passing the No. 50 sieve after washing the sieve.

** Modify ASTM C1090 to include verification at both 24 hours and 28 days.

*** Adjustments to flow rates will be achieved by strict compliance with the manufacturer's recommendations. The time of efflux is the time to fill a 1 liter container placed directly under the flow cone.

**** Modify the ASTM C 939 test by filling the cone to the top instead of to the standard level.

***** Modify ASTM C 940 to conform with the wick induced bleed test as follows:

(a) Use a wick made of a 20 inch length of ASTM A416 seven wire 0.5 inch diameter strand. Wrap the strand with 2 inch wide duct or electrical tape at each end prior to cutting to avoid splaying of the wires when it is cut. Degrease (with acetone or hexane solvent) and wire brush to remove any surface rust on the strand before

- temperature conditioning.
- (b) Condition the dry ingredients, mixing water, prestressing strand and test apparatus overnight at 65°F to 75°F.
 - (c) Mix the conditioned dry ingredients with the conditioned mixing water and place 800 ml of the resulting grout into the 1000 ml graduated cylinder. Measure and record the level of the top of the grout.
 - (d) Completely insert the strand into the graduated cylinder. Center and fasten the strand so it remains essentially parallel to the vertical axis of the cylinder. Measure and record the level of the top of the grout.
 - (e) Store the mixed grout at the temperature range listed above in (b).
 - (f) Measure the level of the bleed water every 15 minutes for the first hour and hourly for two successive readings thereafter.
 - (g) Calculate the bleed water, if any, at the end of the 3 hour test period and the resulting expansion per the procedures outlined in ASTM C940, with the quantity of bleed water expressed as a percent of the initial grout volume. Note if the bleed water remains above or below the top of the original grout height. Note if any bleed water is absorbed into the specimen during the test.

D. Accelerated Corrosion Test Method (ACTM).

Perform the ACTM as outlined in Appendix B of the "Specification for Grouting of Post-Tensioned Structures" published by the Post-Tensioning Institute. Report the time to corrosion for both the grout being tested and the control sample using a 0.45 water-cement ratio neat grout. A grout that shows a longer average time to corrosion in the ACTM than the control sample, and the time to corrosion exceeds 1000 hours, is considered satisfactory.

150215a.05 SUBMITTALS.

A. General.

1. Submit detailed shop drawings, calculations, and manuals for all work related to post-tensioning. Provide shop drawings and calculations that are sealed by a Professional Engineer licensed in the state of Iowa. Do not commence work until the submittals have been approved by the Engineer.
2. All shop drawings are to accurately detail the actual methods, materials, equipment, etc., that will be used in the field on the project. Deviation is not permitted unless approved by the Engineer.

B. Submittals.

At a minimum, submit the following information:

1. Details covering the assembly of the upper portions of the S.S. all-thread-bars.
2. Details of the sequence of the stressing of the S.S. all-thread-bars.
3. Details of the post-tensioning jacking forces and elongation of each tendon, including stressing end seating losses at each stage of erection for all post-tensioning.
4. Elongation calculations and tolerances.
5. Equipment to be used in the post-tensioning operation.
6. Calculations for anticipated anchor set and long-term effects.
7. Calculations to substantiate the post-tensioning system and procedures to be used. These calculations shall show a typical tendon force after applying the anticipated losses for the

stressing system to be used, including anchor set, elastic shortening, and long-term effects.

8. Details of grout, grouting equipment and methods for injecting grout.
9. Any manufacturer's literature, where applicable.
10. Safety procedures.
11. Record of stressing operations. Submit within 7 days following completion and acceptance of the post-tensioning operations at each arch rib bearing.
12. Grouting operations plan. Submit at least 45 days prior to commencing grouting operations.
13. Qualifications and certifications for the crew foreman, grouting supervisor, and grouting personnel as described herein.

C. 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 resubmittal 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.

150215a.06 CONSTRUCTION.

A. S.S. All-Thread-Bar Installation (Upper Portion)

1. General.

- a. Handle S.S. all-thread-bars in accordance with the Special Provisions for High-Strength, Stainless Steel Bars for Post-Tensioned Concrete.
- b. Steel isolation washers that exhibit cracked, scratched, or otherwise compromised dielectric coating shall be replaced. Use only steel isolation washers that have a complete, intact, and undamaged dielectric coating.

2. Installation Procedure.

- a. Remove temporary duct covers and insert the upper portions of the S.S. all-thread-bars into the ducts of arch rib segment R0 and thread the bars into the stop-type couplings in accordance with the manufacturer's recommendations.
- b. Confirm the PE Liners in within the ducts of arch rib segment R0 remain properly positioned after installation of the upper portion of the S.S. all-thread-bars. Reposition the PE liners if required.
- c. Install the Isolation Sleeves into the holes of the top anchor bearing plates.
- d. Install the top anchor bearing plate, steel isolation washers, and S.S. custom washer as shown in the plans.
- e. Install temporary covers to protect the ducts and S.S. all-thread-bars from contamination until post-tensioning is performed.

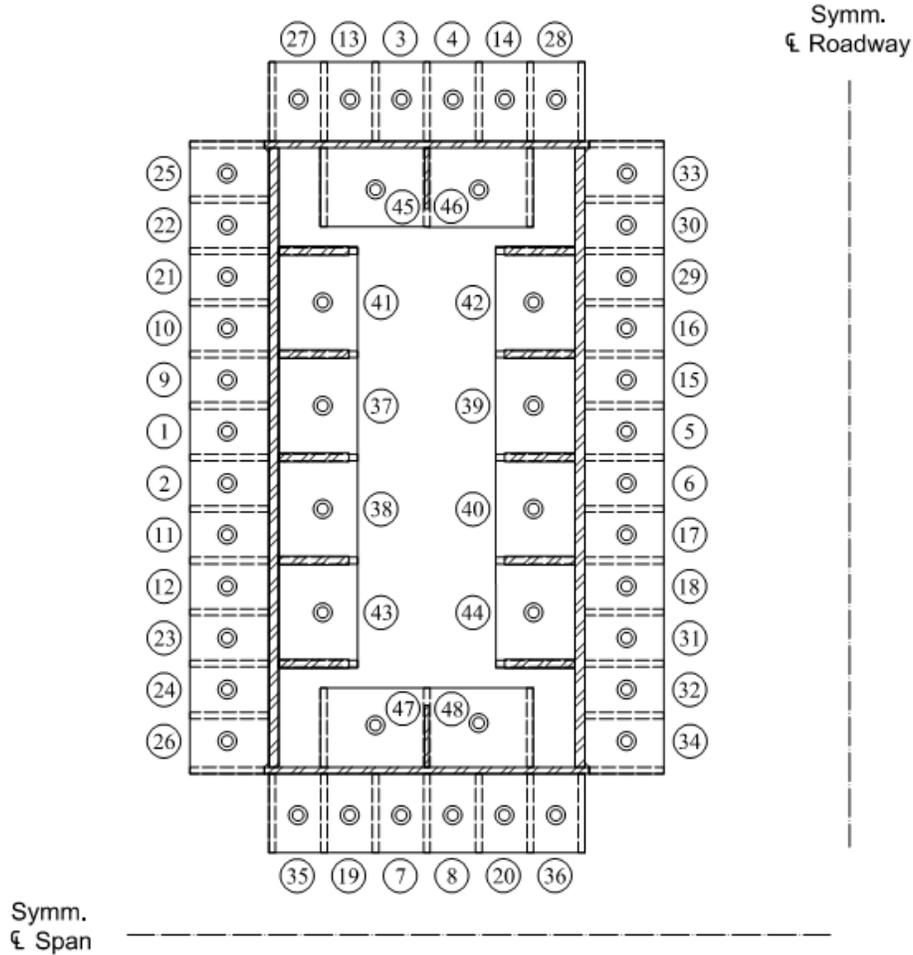
B. Post-Tensioning Operations.

1. General.

Do not apply post-tensioning forces until the concrete has attained the specified compressive strength as determined by cylinder tests and attained a minimum age of 21 days since final placement. Conduct all stressing operations in the presence of the Engineer.

2. Stressing Procedure.

- a.** For each post-tensioning operation listed below, tension and lock off the bars in the sequence illustrated below. For the final post-tensioning operation, repeat the pattern of stressing two or more times to ensure correct tension in all bars, and to eliminate the elastic shortening losses. Tension the bars using hydraulic jacks.
- b.** The pre-stretch load for the Alloy 2507 Duplex Stainless Steel all-thread-bars will be taken as 90 ksi (553 kips per bar).
- c.** Perform initial tensioning of all bars by jacking each bar to between 138 kips and 193 kips (30% +/- 5% of the pre-stretch load) and locking off the force by tightening the S.S. end nut.
- d.** After initial tensioning has been completed, perform inelastic tensioning on all bars by: jacking each bar to 553 kips (100% of the pre-stretch load), holding at that force for 5 minutes, reducing the jacking force to 497 kips (90% of the pre-stretch load) and locking off the force by tightening the S.S. end nut.
- e.** After inelastic tensioning has been performed on all bars, wait a minimum of 4 days prior to proceeding to the final tensioning operation. The purpose of the waiting period is to allow creep of the concrete and relaxation of the prestressing steel to occur in order to control losses.
- f.** Perform final tensioning on all bars by jacking the bar to 473 kips (77 ksi) and locking off the force by tightening the S.S. end nut. Verify that the steel isolation washers, S.S. custom washer, and top anchor bearing plate are centered about the S.S. all-thread-bar prior to tightening the S.S. end nut during final lock off and after load has been fully transferred to the S.S. all-thread-bar. It is anticipated that the force in the bars immediately after transfer will be between 366 kips and 438 kips.
- g.** Prior to grouting operations, perform surface preparation and field passivation of the end anchorage parts as indicated in the Construction Section of the Special Provisions for High-Strength, Stainless Steel Bars for Post-Tensioned Concrete.
- h.** Complete full grouting off all tendons within 7 days of the start of final tensioning. If grouting is not completed within this time period, final tensioning shall be repeated. Only begin grouting operations if it is anticipated that complete grouting of all tendons can be completed within the required timeframe. Only begin grouting operations after all tensioning operations are complete.



3. Stressing Equipment.

Only use equipment furnished by the manufacturer of the post-tensioning system.

a. Stressing Jacks and Gauges.

Equip each jack with a pressure gauge for determining the jacking pressure. Provide a pressure gauge with an accurately reading dial at least 6 inch in diameter with display increments of 100 psi.

b. Calibration of Jacks and Gauges.

- 1) Within 30 days prior to use, calibrate each jack and its gauge as a unit with the cylinder extension in the approximate position it will be in at the final jacking force. Perform calibration when the jack is connected to the equipment (pumps and gauges) in the identical configuration as will be used on the job site, e.g. with the same length hydraulic lines. Initial calibration of the jacks and gauges shall be performed by an independent laboratory using a proven load cell. For each jack and gauge unit used on the project, furnish certified calibration charts from the independent laboratory prior to stressing the first S.S. all-thread-bar. The jack and its gauge shall be used together in the field.
- 2) Perform certified calibration at the start of the work or as requested by the Engineer. Calibrations subsequent to the initial calibration with a load cell may be accomplished by the use of a master gauge. Supply the master gauge to the Engineer in a protective waterproof container capable of protecting the calibration of the master gauge during shipment to a laboratory. Provide a quick-attach coupler next to the permanent gauge in the hydraulic lines to enable quick and easy installation of the

master gauge to verify the permanent gauge readings. The master gauge will be calibrated by, and remain in the possession of, the Engineer for the duration of the project.

- 3) Any jack repair, such as replacing seals or changing the length of the hydraulic lines, is cause for recalibration using a load cell.
 - 4) No extra compensation will be allowed for the initial or subsequent calibrations or for the use and required calibrations of the master gauge.
- c. Elongations and Agreement with Forces.**
- 1) Ensure that the forces being applied to the tendon and the elongation of the post-tensioning tendon can be measured at all times.
 - 2) Tension all tendons to a preliminary force as necessary to eliminate any take-up in the tensioning system before elongation readings are started. This preliminary force shall be between 5% and 25% of the estimated jacking force. Measure the initial force by a dynamometer, or by another approved method, so that its amount can be used as a check against elongation as computed and as measured. Each S.S. all-thread-bar shall be marked prior to final stressing to permit measurement of elongation.
 - 3) Measure elongations to the nearest 1/32 inch.
 - 4) For the required force, the observed elongation shall agree within 7% of the theoretical elongation or the entire operation shall be checked and the source of error determined and remedied to the satisfaction of the Engineer before proceeding further. Do not overstress the tendon to achieve the theoretical elongation.

C. Cutting of S.S. All-Thread-Bars.

Only cut the ends of the S.S. all-thread-bars if the jacking forces and elongations at the end of the final post-tensioning operation are satisfactory and approval has been obtained from the Engineer. Only cut the ends of the S.S. all-thread-bars if grouting operations will be completed within the timeframe required following final tensioning. Cut S.S. all-thread-bar protrusions that exceed 6 inches in length as indicated in the Special Provisions for High-Strength, Stainless Steel Bars for Post-Tensioned Concrete.

D. Tendon Protection.

Within 4 hours after stressing, temporarily install the top caps and seal all other openings. If acceptance of the S.S. all-thread-bar is delayed, seal all openings and temporarily weatherproof the open ends. If contamination of the S.S. all-thread-bar occurs, remove and replace the S.S. all-thread-bar.

E. Grouting Operations.

1. General.

When final stressing has been completed and the stressed tendons have been accepted by the Engineer, grout the annular space between the S.S. all-thread-bars and the duct at the locations indicated in the plans and as indicated herein. Conduct grouting operations in the presence of the Engineer. Conduct grouting operations within the timeframe given in the stressing procedure.

2. Grouting Operations Plan.

- a. Do not commence grouting operations without prior approval of the grouting operation plan by the Engineer.
- b. At a minimum, provide the following items in the grouting operations plan:
 - 1) Names, training, and experience records for the grouting crew and the grouting supervisor in conformance with this Special Provision;
 - 2) Type, quantity, and brand of materials used in grouting including all certifications required;
 - 3) Type of equipment furnished, including capacity in relation to demand and working condition, as well as back-up equipment and spare parts;

- 4) General grouting procedure;
 - 5) Duct pressure test and repair procedure;
 - 6) Method to be used to control the rate of flow within the ducts;
 - 7) Theoretical grout volume calculations per tendon;
 - 8) Mixing and pumping procedures;
 - 9) Direction of grouting.
 - 10) Sequence of use of the grout inlets and outlets;
 - 11) Procedures for handling blockages;
 - 12) Procedures for post grouting repair, including repair of any grout voids detected;
 - 13) Method(s) for sealing and protecting ducts at all connections, vents, splices, etc.;
 - 14) Types and locations of grout inlets and outlets;
 - 15) Duct cleaning methods prior to grouting;
 - 16) Samples of Contractor QC forms that are to be signed daily by the grouting supervisor.
- c. Before grouting operations begin, conduct a joint meeting of the grouting supervisor, grouting personnel, grout manufacturer's field representative and the Engineer to discuss the grouting operation plan, required testing, corrective procedures, and any other issues requested by the Engineer.
 - d. The time between the first installation of the upper portion of the S.S. all-thread-bar in the duct and the completion of the grouting operations shall not exceed 28 calendar days.
 - e. All ducts shall be clean and free of deleterious materials that would impair bonding of the grout, if applicable, or interfere with grouting procedures.
 - f. All ducts shall be flushed within 72 hours of grouting operations. All water used for flushing ducts shall contain either quick lime, calcium oxide, or slaked lime, calcium hydroxide, in the amount of 0.1 lbs/gal. All drains shall be opened during flushing and remain open for a sufficient time after flushing to insure that all free moisture has been drained from all ducts.
 - g. Use oil-free, compressed air to blow out ducts immediately prior to grouting.
3. **Grout Inlet and Outlets.**
Ensure the connections from the grout pump hose to the inlets are free of dirt and air-tight. Inspect valves to be sure that they can be opened and closed properly.
4. **Supplies.**
Before grouting operations begin, provide an adequate supply of water and compressed air for clearing and testing the ducts and mixing and pumping the grout. Where water is not supplied through the public water system, provide a water storage tank of sufficient capacity.
5. **Equipment.**
 - a. **General.**
 - 1) Provide grouting equipment consisting of measuring devices for water, a high-speed shear colloidal mixer, a storage hopper (holding reservoir) and a pump with all the necessary connecting hoses, valves, and pressure gauges. Provide pumping equipment with sufficient capacity to ensure that the post-tensioning ducts to be grouted can be filled and vented without interruption at the required rate of injection in not more than 30 minutes.
 - 2) Provide an air compressor and hoses with sufficient output to perform the required functions.
 - 3) Provide vacuum grouting equipment (volumetric measuring type) and experienced operators within 48 hours notice.
 - b. **Mixer and Storage Hopper.**
 - 1) Provide a high speed shear colloidal mixer capable of continuous mechanical mixing producing a homogeneous and stable grout free of lumps and undispersed cement. The colloidal grout machinery will have a charging tank for blending and a holding tank. The blending tank must be equipped with a high shear colloidal mixer. The holding tank must be kept agitated and at least partially full at all times during the

pumping operation to prevent air from being drawn into the post-tensioning duct.

- 2) Add water during the initial mixing by use of a flow meter or calibrated water reservoir with a measuring accuracy equal to one percent of the total water volume.
- 3) The material shall be mixed in accordance with the manufacturer's recommendations.

c. Grout Pumping Equipment.

- 1) Provide pumping equipment capable of continuous operation which will include a system for circulating the grout when actual grouting is not in progress.
- 2) The equipment will be capable of maintaining pressure on completely grouted ducts and will be fitted with a valve that can be closed off without loss of pressure in the duct.
- 3) Grout pumps will be positive displacement type, will provide a continuous flow of grout, and will be able to maintain a discharge pressure of at least 145 psi.
- 4) Pumps will be constructed to have seals adequate to prevent oil, air or other foreign substances entering the grout and to prevent loss of grout or water. The capacity will be such that an optimal rate of grouting can be achieved.
- 5) A pressure gauge having a full scale reading of no more than 300 psi will be placed at the grout inlet. If long hoses (in excess of 100 feet) are used, place two gauges, one at the pump and one at the grout inlet.
- 6) The diameter and rated pressure capacity of the grout hoses must be compatible with the pump output.

d. Vacuum Grouting Equipment.

Provide vacuum grouting equipment consisting of the following:

- 1) Volumeter for the measurement of void volume.
- 2) Vacuum pump with a minimum capacity of 10 cubic feet per minute and equipped with flow-meter capable of measuring amount of grout being injected.
- 3) Manual colloidal mixers and/or dissolvers (manual high speed shear mixers), for voids less than 5.28 gallons in volume.
- 4) Standard colloidal mixers, for voids 5.28 gallons and greater in volume.

e. Stand-by Equipment.

- 1) During grouting operations, provide a stand-by colloidal grout mixer and pump.
- 2) Under normal conditions, the grout equipment must be capable of continuously grouting the longest tendon on the project in not more than 20 minutes.

6. Grouting.

a. General.

- 1) Perform test to confirm the accuracy of the volume-measuring component of the vacuum grouting equipment each day when in use before performing any grouting operations. Use either water or grout for testing using standard testing devices with volumes of 0.5 gallons and 6.5 gallons and an accuracy of equal to or less than 4 ounces. Perform one test with each device. The results must verify the accuracy of the void volume-measuring component of the vacuum grouting equipment within 1% of the test device volume and must verify the accuracy of the grout volume component of the vacuum grouting equipment within 5% of the test device volume. Ensure the Engineer is present when any tests are performed.
- 2) Grout tendons in accordance with the procedures set forth in the approved grouting operations plan.

b. Temperature Considerations.

Maximum grout temperature must not exceed 90°F at the grout inlet. Use chilled water and/or pre-cooling of the bagged material to maintain mixed grout temperature below the maximum allowed temperature. Grouting operations are prohibited when the ambient temperature is below 40°F or is 40°F and falling. Postpone grouting operations if freezing temperatures are forecasted within the next two days and it is expected that the concrete temperature surrounding the duct will fall below 40°F.

c. Mixing and Pumping.

- 1) Mix the grout with a metered amount of water. The materials will be mixed to

produce a homogeneous grout. Continuously agitate the grout until grouting is complete.

- 2) The material shall be mixed in accordance with the manufacturer's recommendations.

d. Grout Production Test.

- 1) During grouting operations, the fluidity of the grout must be strictly maintained within the limits established by the grout manufacturer. A target fluidity rate will be established by the manufacturer's representative, based on ambient weather conditions. Determine grout fluidity by use of either test method found in elsewhere in this Special Provision. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious material ratio. Do not use grout which tests outside the allowable flow rates.
- 2) Prior to performing repair grouting operations with vacuum grouting, condition the grout materials to limit the grout temperature at the inlet end of the grout hose to 85°F. Check the temperature of the grout at the inlet end of the grout hose hourly.
- 3) At the beginning of each day's grouting operation, obtain a representative sample of grout from the first production batch of grout and perform a wick induced bleed test in accordance with elsewhere in this Special Provision using this sample. Begin grouting operations after the sample is obtained. If zero bleed is not achieved in the wick induced bleed test at any time during the required test time period, complete the grouting of any partially grouted tendons and do not begin grouting of any new or additional tendons until the grouting operations have been adjusted and further testing shows the grout meets the specified requirements.

e. Grout Operations.

- 1) Open all grout outlets before starting the grouting operation. Grout tendons in accordance with the grouting operation plan.
- 2) Unless otherwise approved by the Engineer, pump grout at a rate of 16 feet to 50 feet of duct per minute. Conduct normal grouting operations at a pressure range of 10 psi to 50 psi measured at the grout inlet. Do not exceed the maximum pumping pressure of 145 psi at the grout inlet for round ducts.
- 3) Use grout pumping methods which will ensure complete filling of the ducts and complete encasement of the steel. Grout must flow from the first and subsequent outlets until any residual water or entrapped air has been removed prior to closing the outlet.
- 4) Inject grout into the duct steadily and consistently at the bottom grout inlet. When grout flow through the first intermediate outlet is of a consistency of that being injected and is free of all slugs of air or water, the first outlet may be closed. Continue injection until the same flow is obtained from the next outlet in turn, whereupon it shall be closed. Continue grouting injection until all intermediate outlets have been closed and at least 2 gallons of grout flows from the bottom anchorage outlet. Continue grouting until consistent grout has been discharged through the top cap outlet. If, during injection, the actual grouting pressure exceeds the maximum allowed at the inlet, then close the inlet and inject the grouting in the next available vent, provided that the grout has already flowed from the vent.
- 5) For each tendon, immediately after uncontaminated uniform discharge begins, perform a fluidity test using the flow cone on the grout discharged from the top cap outlet. The measured grout efflux time will not be less than the efflux time measured at the pump or minimum acceptable efflux time as established in Section 2. Alternately, check the grout fluidity using the Wet Density method contained in Section 2. The density at the final outlet must not be less than the grout density at the inlet. If the grout fluidity is not acceptable, discharge additional grout from the bottom anchorage outlet and test the grout fluidity. Continue this cycle until an acceptable grout fluidity is achieved. Discard grout used for testing fluidity. After all outlets have been bled and sealed, elevate the grout pressure to 75 psi, seal the inlet valve, and wait two minutes to determine if any leaks exist. If leaks are present, fix the leaks using methods approved by the Engineer. Repeat the above stated process until no

leaks are present. If no leaks are present, bleed the pressure to 5 psi and wait a minimum of ten minutes for any entrapped air to flow to the top cap outlet. After the minimum 10 minutes period has expired, increase the pressure as needed and discharge grout at the top cap outlet to eliminate any entrapped air or water. Complete the process by locking a pressure of 30 psi into the tendon.

- 6) If the actual grouting pressure exceeds the maximum allowed, the inlet will be closed and the grout will be pumped at the next outlet, which has just been, or is ready to be closed as long as a one-way flow is maintained. Grout will not be pumped into a succeeding outlet from which grout has not yet flowed. If this procedure is used, the inlet, which is to be used for pumping will be fitted with a positive shut-off and pressure gauge.
 - 7) When complete grouting of the tendon cannot be achieved by the steps stated herein, stop the grouting operation. After waiting 48 hours, fill the tendon with grout in accordance with the procedure outlined elsewhere in this Special Provision.
- f. Operations Causing Vibrations.**
During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from all sources where grouting is taking place.
- g. Grouting Report.**
- 1) Provide a grouting report signed by the Contractor and/or the Subcontractor within 72 hours of each grouting operation for review by the Engineer.
 - 2) Report the theoretical quantity of grout anticipated as compared to the actual quantity of grout used to fill the duct. Notify the Engineer immediately of shortages or overages.
 - 3) Information to be noted in the records must include but not necessarily be limited to the following: identification of the tendon; date grouted; number of days from tendon installation to grouting; type of grout; injection end and applied grouting pressure, ratio of actual to theoretical grout quantity; summary of any problems encountered and corrective action taken.

F. Repair of Grout Inlets and Outlets.

Place threaded plastic caps in all inlet/outlet locations. Repair inlets/outlets using an epoxy grout. Prepare the surface to receive the epoxy material in strict compliance with the manufacturer's recommendations.

G. Record of Stressing Operations.

1. Keep a record of the following post-tensioning operations for each tendon installed:
 - a. Project name;
 - b. Contractor and/or subcontractor;
 - c. Tendon location, size and type;
 - d. Date S.S. all-thread-bar was first installed in ducts;
 - e. Heat number for S.S. all-thread-bars;
 - f. S.S. all-thread-bar cross-sectional area;
 - g. Modulus of elasticity;
 - h. Date and time S.S. all-thread-bar was stressed;
 - i. Jack and gauge numbers per end of S.S. all-thread-bar;
 - j. Required jacking force;
 - k. Gauge pressures;
 - l. Elongations (theoretical and actual);
 - m. Anchor sets (anticipated and actual);
 - n. Stressing sequence (i.e. S.S. all-thread-bars to be stressed before and after);
 - o. Stressing mode (one end);
 - p. Witnesses to stressing operation (Contractor and inspector);
 - q. Date grouted;
 - r. Any comments about events that occurred during the stressing operation – such as failures, popping noises, etc.

2. Provide the Engineer with a complete copy of all stressing and grouting operations.

150215a.07 METHOD OF MEASUREMENT.

Lump Sum. No method of measurement.

150215a.08 BASIS OF PAYMENT.

- A. Payment for the post-tensioning of arch rib bearings is full compensation for installing the upper portion of the S.S. all-thread-bars, including the top anchorage, and for post-tensioning, cutting, and grouting the S.S. all-thread bars of the arch rib bearings.
- B. No additional payment will be made for extra post-tensioning necessitated by approved modifications to the structure for the purposes of the construction methods.
- C. No separate payment will be made for furnishing and installing the post-tensioning grout.