S.P. 27-753-13; SP 141-020-112
CSAH 153 ; C.P. 041603
Minn. Proj. TCSP-STP10 09MN(005)
January 10, 2011

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DIVISION "SB"

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SPECIAL PROVISIONS

DIVISION SB

SPECIAL REQUIREMENTS

SB-1 (1706) EMPLOYEE HEALTH AND WELFARE

The provisions of Mn/DOT 1706 are supplemented as follows:

The Contractor shall submit a plan, at the preconstruction conference, for providing all OSHA required safety equipment (safety nets, static lines, false decks, etc.) for all work areas whose working surface is 6 feet or more above the ground, water, or other surfaces. Submittal of this plan will in no way relieve the Contractor of his/her responsibility for providing a safe working area.

All safety equipment, in accordance with the Contractor's plan, must be inplace and operable in adequate time to allow Mn/DOT personnel to perform their required inspection duties at the appropriate time. No concrete shall be placed in any areas affected by such required inspection until the inspection has been completed.

The installation of safety lines, safety nets, or other systems whose purpose is to reduce the hazards of bridge work may require the attachment of anchorage devices to beams, girders, diaphragms, bracing or other components of the structure. Clamp type anchorage systems which do not require modification of structural members may be used provided they do not interfere with proper execution of the work; however, if the Contractor desires to use an anchorage system which requires modification of structural members, s/he shall request approval, in writing, for plan modification as provided in Mn/DOT Specifications. Requests to install systems which require field welding or drilling of primary stress carrying members of a bridge will not be approved. The Contractor shall indicate any portions of anchorage devices which will remain permanently in the structure.

On both ends of each pier cap extending 6 feet or more above the ground, the Contractor shall install an insert or other suitable anchorage to which safety lines can be attached. Any portion of said device extending outside the finished lines of the pier cap shall be removed unless otherwise approved by the Engineer. Any void or cavity resulting from the installation or removal of this device shall be repaired or sealed to prevent the ponding or entry of water as directed by the Engineer.

Approved anchorage systems shall be furnished, installed, and removed at no increased cost to the State for materials, fabrication, erection, or removal of the bridge component or anchorage system.

SB-2 (2401) CONCRETE BRIDGE CONSTRUCTION

The provisions of Mn/DOT 2401 are modified and/or supplemented with the following:

Delete the first sentence of the first paragraph of 2401.3G:

Cure newly placed concrete by providing protection against rapid loss of moisture, freezing temperatures, high temperatures, abrupt temperature changes, vibration exceeding a normal or reasonable limit as described in the Bridge Construction Manual Chapter 5, Section 393.362, shock waves, and prematurely applied loads.

Add the following to the end of the second paragraph of 2401.3G:

All sections not included in superstructures……..……. 45
Pier 4 closure diaphragm……..……..…… 80

SB-2.1 Concrete Aggregate for Bridges

The provisions of 2401.2A shall apply except as modified herein:

Delete the second paragraph of 2401.2A and substitute the following therefor:

Class A or Class C coarse aggregate, as defined in 3137.2B, shall be used in all concrete for bridge superstructures, except that coarse aggregate requirements for precast concrete members fabricated under 2405 shall be as specified in 2461.2D.

SB-2.2 Falsework & Forms, & Bridge Slab/Superstructure Placement

Delete paragraphs 2, 3 and 4 of 2401.3B2 and substitute the following:

At least six weeks before starting construction of the superstructure falsework for Span 1B or Spans 2-4, the Contractor shall supply the Engineer with three copies of the detailed Plans and Specifications and two copies of the associated calculations of the proposed system for constructing the superstructure falsework and forms.

Design of the falsework and forms shall be in accordance with AASHTO "Guide Design Specifications for Bridge Temporary Works". The Plans and Specifications shall be prepared by an engineer, thoroughly checked by a second engineer for completeness and accuracy, and certified by one of the aforementioned professional engineers licensed in the State of Minnesota. The documents shall include sufficient details so that construction of the proposed system can be completed solely by reference to the Plans and Specifications. The design criteria shall be shown on the first sheet of the Plans.

As a minimum, falsework plans shall contain the following:

1. The size of all load-supporting members and all transverse and longitudinal bracing. Connection details for load-supporting members must be included. For box girder structures, the drawings must show the falsework members supporting sloping exterior girders, deck overhangs and any attached construction walkways.

2. All design-controlling dimensions must be shown, including beam length and spacing; post location and spacing; overall height of falsework bents; vertical distance between connectors in diagonal bracing; and similar dimensions that are critical to the design.

3. The location and method by which the falsework will be adjusted to final grade must be shown.

4. Unless a concrete placing schedule is specified in the Contract, the falsework plans must include a superstructure placing diagram showing the proposed concrete placing sequence and/or the direction of pour, whichever one is applicable, and the location of all construction joints. (For relatively simple structures, this requirement may be satisfied by a note on the Plans.)

Add the following to 2401.3B4:

The Contractor will not be permitted to place the concrete for the superstructure until (1) Plans and Specifications meeting the above requirements have been provided to the Engineer; (2) the engineer who has certified plans and specifications for the falsework and forms has inspected the falsework after erection; and (3) the engineer inspecting the as-constructed falsework certifies in writing that all details are approved.

Add the following to 2401.3B8:

The removal of the falsework and forms supporting the Spans 2-4 superstructure will not be permitted until the bearings at Pier 4 have been set and the concrete placed in the Pier 4 closure diaphragm has achieved at least 80 percent of the anticipated 28-day design strength.

The formwork for the webs and deck inside the Spans 2-4 box girders may be removed prior to the Pier 4 closure diaphragm achieving the required strength, provided that this formwork will not be required to support the overall spans. Details of the form removal sequence will be shown in the falsework plan as required by these Specifications.

Add the following to 2401.3E:

Horizontal construction joints may be made without keys, except when keys are shown on the Plans. Surfaces of fresh concrete at horizontal construction joints shall be rough floated sufficiently to thoroughly consolidate the concrete at the surface without completely removing surface irregularities.

Construction joints shall be cleaned of surface laitance, curing compound and other foreign materials before fresh concrete is placed against the surface of the joint. Abrasive blast methods shall be used to clean horizontal construction joints to the extent that clean aggregate is exposed. Construction joints shall be flushed with water and allowed to dry to a surface dry condition immediately prior to placing concrete.

Add the following to 2401.3F3b(1):

At least two weeks in advance of casting Bridge Slab concrete, the Contractor shall provide the Engineer with detailed plans for placing the concrete, including the Contractor's scheme for supporting screed rails for the Bridge Slab and schedules setting forth the rate of concrete delivery. The minimum rate of concrete placement shall be 70 cubic yards per hour.

If concrete is cast by means of a pumping operation, the Contractor shall maintain a standby pump or crane capable of delivering an uninterrupted flow of concrete in case of a pump breakdown.

SB-2.3 Placement Of Concrete In West Abutment, Piers 1A and 1B and the Approach Parapet

To reduce the effects of shrinkage in concrete placed in the West Abutment, Piers 1A and 1B and the Approach Parapet, there shall be a 72-hour delay between concrete pours of adjacent sections that have vertical construction joints.

SB-2.4 Joint Filler and Sealing

The provisions of 2401.3J1 are supplemented as follows:

Prior to installation of sealing materials, concrete curing shall be completed. A minimum of 7 days drying is required prior to application of sealers. Sawcut joints shall be sandblasted, blown clean, and the concrete surfaces shall be dry at the time sealer is installed.

Preformed joint shall be as detailed in the Plans and in conformance with the following requirements.

1. Bituminous felt shall comply with AASHTO M33, modified to the extent that the load required to compress the test specimen to 50 percent of its thickness before test shall not be more than 1200 psi.

2. Cork shall comply with Mn/DOT 3702 and AASHTO M153 Type II.

3. Polyethylene Foam shall comply with the following:

Density, ASTM D 3575	2 PCF
Color	Grey
Tensile Strength, ASTM D3575/ASTM D412	
Machine Direction	60 PSI
Cross Direction	44 PSI
Compression Set (25%), ASTM D3575	
(22-hour Compression @ 73° F ± 3° F)	
(24-hour Recovery @ 73° F ± 3° F)	41.54 PSI
Thermal Stability, ASTM D3575	
(24 hours @ 158° F + 3° F)	
(2-hour cooling period @ 73.4° F + 3.6° F)	5% + shrinkage
Recovery, ASTM D3575	95% ± 1%

4. Polystyrene shall comply with the following:

Type	Minimum Compressive Strength (5 percent deflection)	Characteristics
A	30 psi	Closed Cell Expanded Polystyrene
B	10 psi	Molded Polystyrene

Testing for compressive strength of polystyrene shall be in accordance with ASTM D 1621. The Contractor shall, if requested by the Engineer, furnish evidence that the material meets these requirements.

All polystyrene, polyethylene, and preformed joint filler shown on the Plans shall be considered incidental to the adjacent concrete, and no additional compensation will be made.

SB-2.5 Architectural Concrete Texture (Bush Hammer)

Description of Work

This work consists of applying a bush hammered concrete texture on the Pier 1A & 1B Bridge Head in accordance with the provisions of Mn/DOT 2401, the Plan details and the following:

Architectural Concrete Texture

A. The concrete surface shall be formed using a form lining system made of high-strength urethane elastomer capable of withstanding anticipated concrete pour pressures without leakage or causing physical defects. Form liners shall attach easily to forms and be removable without causing concrete surface damage. The liners shall be designed to form surfaces conforming to the design intent including the shape, lines, and dimensions shown in the plans and to avoid visible pattern repeats. Match pattern features at form liner joints to minimize visible pattern repeats and make the formed concrete surface appear uniform and continuous without visible seams and form marks. When joints are unavoidable, make joints along main features of the pattern.

   Form liners shall produce a textured effect of a bush hammered concrete surface. Surfaces having a smooth, slick or shiny surface will be rejected. Texture relief shall be 1/2 inch in depth. The height of the pattern shall match the dimensions shown in the plans. Surface texture shall match the form liner used in the construction of Bridge No. 27B60 (Phase I).

   Form liner manufacturer must have five years minimum experience making liners used to create formed concrete surfaces.

   Form liner materials may be obtained from one of the following manufacturers:

   1. Scott System, Inc.
   2. Milestones Inc.
   3. Custom Rock International
   4. Other manufacturers approved by the Engineer.

B. All form ties shall be made of non-corrosive materials when the portion permanently embedded in the concrete is less than ¾" from the finished surface.

C. Form release agents shall be fully compatible with the form liner material and the special surface finish to be applied to the textured surfaces.

Submittals

A. For product data, submit manufacturer's technical information and use instructions for form-liner placement and release.

B. Submit actual samples of form ties that will be permanently embedded in the concrete.

C. Submit qualification data for firms and person specified below under Quality Assurance to demonstrate their capabilities and experience. Include a list of completed projects with project names, addresses, names of architects, engineers and owners, plus any other pertinent information.

D. Submit drawings indicating form liner layout and termination details. Indicate backup, rustication. Reveal, and chamfer strip locations. Include jointing, form tie location, pattern placement, pattern match details, and end, edge and other special conditions. Indicate tolerances and procedures of installation and separation.

Quality Assurance

A. Manufacturer's Qualifications: The form liner manufacturer must have five (5) years minimum experience making liners used to create formed concrete surfaces matching the pattern designated in the plans.

B. Installer Qualifications: The form liner installer shall have had a minimum of five (5) consecutive years of experience in textured formed concrete construction.

Construction Requirements

Surface Preparation: All conventionally formed concrete surfaces to receive bush hammer texture shall be water blasted to break the surface film and to remove all laitance detrimental to the finish coating system performance. Sandblasting will not be allowed for cleaning concrete surfaces, as it will reduce the architectural concrete texture specified in this Special Provision. Pressure washing with water at a pressure of 3000 psi at a rate of 3 to 4 gallons per minute using a fan nozzle held perpendicular to the surface at a distance of one to two feet shall be used.

Match pattern features at form liner joints to make the formed concrete surface appear uniform and continuous without grout leakage at the joints. When vertical construction joints are required, match form liner across the joint, or as approved by the Engineer. Following removal of forms, finish minor defects to blend with the balance of the pattern surface texture. Filling of "bug holes" or other similar deformities in the texture surface that are 1/2 inch or less in diameter or depth is not required. No visible vertical and horizontal seams or conspicuous form marks

created by butt-joining form liners will be allowed. Where it is not possible to locate a vertical groove at a construction joint, the concrete surface shall be finished to reduce visibility of the construction joints.

Strip formwork in accordance with the form liner manufacturer's recommendations to avoid concrete surface deterioration or weakness planes in the substrate. Finish form tie holes in accordance with 2401.3F2a using approved patching materials. Following removal of forms, finish minor defects to blend with the balance of the pattern surface. Visible vertical or horizontal seams or conspicuous form marks shall be repaired at the Contractor's expense to the satisfaction of the Engineer.

Clean and repair surfaces of form liners to be reused. Split, frayed, delaminated or otherwise damaged form liner material will not be acceptable for exposed surfaces. Form liners shall be cleaned and free of concrete buildup prior to each pour. Do not use "patched" forms for exposed concrete surfaces unless acceptable to the engineer.

Method of Measurement

Measurement for "Architectural Concrete Texture (Bush Hammer)" will be made by the plan area in square feet of the finished surface area constructed to the limits shown and noted in the Plans.

Basis of Payment

Payment for texturing will be made under Item No. 2411.618 "Architectural Concrete Texture (Bush Hammer)", at the Contract bid price per square foot, which shall be compensation in full for all costs incidental thereto, including the additional concrete required to achieve the specified texture relief.

SB-2.6 Architectural Surface Finish (Single Color)

A. Description of Work

This work consists of applying an architectural surface finish to all exposed concrete surfaces of the Architectural Concrete Texture (Bush Hammer) on Bridge 27B60 (Phase 2). The work shall be performed in accordance with the applicable provisions of Mn/DOT 2401, the Plans, and the following:

Architectural Surface Finish (Single Color) shall be applied to the Pier 1A & 1B Bridge Head so designated in the Plans to receive Architectural Concrete Texture (Bush Hammer).

Architectural Surface Finish (Single Color) shall be a single color stain. The color shall match Federal Standard 595 B No. 26622 pearl grey, adjusted by field testing as required to match to the color of the Special Surface Finish.

B. Surface Color

The surface coloring for the Architectural Surface Finish described above shall be performed using approved stains or paint systems applied in a manner consistent with the aesthetic design requirements of the Project.

For Architectural Surface Finish (Single Color), the color shall be provided by a two-coat stain application. The application of the base coat shall follow ordinary concrete finish operations and be by air or airless sprayer. Allow to thoroughly dry before applying topcoat. The topcoat shall be applied in a uniform manner, moving in one direction, 5.5 to 6.5 mils wet film thickness equivalent to 1.5 to 2.0 mils dry film thickness. Use sufficient material to provide color uniformity, but avoid buildups and runs.

C. Stain Materials

Stain shall be a 100 percent acrylic; water-repellant, semi-opaque, tinted emulsion sealer designed for concrete and masonry surfaces. Acceptable products shall allow moisture and vapor transmission, be formulated for exterior application with resistance to freeze/thaw, moisture, alkali, acid and mildew, mold or fungus, discoloration or degradation and meet the following requirements:

1. Physical or performance properties:

- Volume Solids .....29-31 percent (Calculated Lab Value)
- Weight Solids .....44-46 percent (Calculated Lab Value)
- Viscosity .....65-85 KU (Calculated Lab Value)
- Accelerated Weathering .....1,000 Hours Minimum (ASTM G-26)

2. Color pigments for tinted products shall be derived from synthetic mineral oxides.

3. Subject to compliance with requirements, provide colored concrete finishing products from one of the following manufacturers:

- The Sherwin-Williams Company
- Tamms Industries
- Chem-Rex
- Other approved sources

To the greatest practical extent, all concrete finishing products shall be obtained from a single source.

All materials shall be furnished, prepared, applied, cured and stored according to the product manufacturer's directions and as specified herein. Special attention shall be given to the recommended temperature range for application.

D. Submittals by Contractor

Within 60 calendar days of execution and approval of the Contract, the Contractor shall submit the following to the Engineer for approval:

1. Product data including manufacturer's technical information, label analysis, and application instructions for each material proposed for use.

2. Laboratory test reports showing that materials proposed for use meet physical or performance property requirements.

3. 1 foot x 1 foot square samples of the Color System on the textured surface pattern. Final color selections will be based upon comparison to a Color Chip in the color specified above.

E. Surface Preparation

Following removal of forms, all exposed textured concrete surfaces shall receive an ordinary surface finish in accordance with Mn/DOT 2401.3F2a prior to the surface preparation described below. Minor defects shall be finished to blend with the balance of the textured surfaces. The Contractor shall make every effort to match the surface texture of patched surfaces with the surrounding textured surface. Visible vertical or horizontal seams or conspicuous form marks shall be repaired to the satisfaction of the Engineer and at the Contractor's expense.

All formed concrete surfaces to receive Architectural Surface Finish (Single Color) shall be water-blasted to break the surface film and to remove all laitance detrimental to the color system performance. Sandblasting will not be allowed for cleaning concrete surfaces, as it will reduce the architectural surface treatment texture. Pressure washing with water at a pressure of 3,000 pounds per square inch at a rate of 3 to 4 gallons per minute using a fan nozzle held perpendicular to the surface at a distance of 12 inches to 24 inches shall be used.

F. Application

The concrete to which the architectural surface finish is to be applied must be a minimum of 28 days old. All surfaces that are to receive an architectural surface finish shall be thoroughly flushed with clean water not more than 24 hours before commencing with the finishing.

The finish color effect for the bridges and structures involves an application of a two coats of stain, uniformly applied over the entire textured surface. The color application shall meet the requirements of the product manufacturer for both thickness and coverage. Stain products used to complete the work shall not be diluted with water or other solvents in any way.

G. Basis of Payment

Payment for Architectural Surface Finish (Single Color) shall be made under Item No. 2411.618, "Architectural Surface Finish (Single Color)", at the Contract bid price per square foot, which shall be compensation in full for all costs incidental thereto.

SB-2.7 Finish of Concrete Surfaces

Cure concrete for a minimum of 28 days or as recommended by the manufacturer prior to applying special surface finish (SSF) or acrylic paint. Thoroughly flush all surfaces that are to receive SSF with clean water not more than 24 hours before commencing with the SSF finishing.

A. Special Surface Finish

The provisions of 2401.3F2c apply except as modified herein:

Apply SSF on the exposed concrete surfaces of Bridge No. 27B60 (Phase 2), including Retaining Walls A and B, except for the top surface of the bridge deck, barrier railing, medians, and precast concrete girders.

Provide a finish color for all SSF matching Federal Standard 595 B No. 26622, pearl gray. Provide paint free of toxic metals and toxic pigments.

Provide a test area, 3 foot x 3 foot, for final color selection and have the Engineer approve the test area after the color has been added to it.

Add the following sentence after the fourth sentence in the second paragraph of 2401.3F2c:

Furnish only one approved system of mortar, bonding agent, water, and 100% acrylic paint (meeting Mn/DOT 3584) from the Approved/Qualified Product Lists of Special Surface Finish" (http://www.dot.state.mn.us/products/index.html) to produce the color(s) specified in this special provision.

B. Finishing Roadway Faces and Tops of Barrier Railing

1. Finish conventionally formed roadway faces, tops of barrier railings, medians, and exposed portions of the concrete parapet–type special, as per 2401.3F2d and the following:

a) Plan and execute concrete placement, form removal, and finishing operations so that the surface finishing can be started immediately after forms are removed. Remove the roadway face forms as soon as the concrete can retain its molded shape. In no case shall the elapsed time between concrete placement and initial surface finishing exceed 24 hours.

b) After completion of the curing period, paint the roadway faces and tops of the barrier railings (and median) with an approved acrylic paint conforming to 3584. The color of the acrylic paint shall conform to Federal Standard 595 B, No. 26622 pearl grey. Apply the paint at a rate of 300 ft^2 per gallon. Commence or suspend the painting operation when the air and surface temperature meet or exceed the manufacturer's recommendations.

C. Finishing Precast Concrete Girders

Apply 100% acrylic paint (Mn/DOT 3584) on the exposed concrete surfaces of the Span 1A Precast Concrete Girders as designated below:

1. Outside face of fascia girder

2. Bottom of bottom flange of fascia girder

3. Bottom of bottom flange of all girders

Provide a finish color for acrylic paint matching Federal Standard 595 B No. 26622 pearl gray.

Apply the paint at a rate of 300 ft^2 per gallon. Commence or suspend the painting operation when the air and surface temperature meet or exceed the manufacturer's recommendations.

D. Basis of Payment

Finishing of concrete surfaces, except as otherwise provided in these special provisions, special surface finish, application of topcoat, and painting are considered an incidental expense to the respective concrete mixes for this construction, and no additional compensation will be made for this work.

SB-2.8 Curing Bridge Slab

Delete the 13th paragraph of 2401.3G and substitute the following:

Bridge slab shall have conventional wet curing applied immediately following the finishing machine or air screed. The conventional wet curing shall consist of **pre-wetted** burlap covered with white plastic sheeting. The burlap shall cover 100% of the deck area with no visible openings, the only exception being that area of the deck, which will be located beneath the permanent barrier. The wet curing shall be placed **no later than 30 minutes** after the finishing machine has completed final strike-off of the concrete surface. If, at any time, the Contractor fails to place the wet curing within the 30 minute time period, and to the satisfaction of the Engineer, the Contractor will be assessed **a non-compliance charge of $500.00 for every 5 minute period or any portion thereof**, which the Engineer determines that the Contractor has not complied. The non-compliance charge, set forth above, may be assessed more than once. The slab surface shall be kept continuously wet for an initial curing period of at least 7 days. The Contractor must provide adequate personnel to ensure the burlap is maintained in a wet condition on weekends and/or holidays. **In order to comply with the wet curing requirement a work bridge following the finish machine may be required, and an additional center rail may be required on wide bridges.**

A slab placement and curing plan for each bridge shall be submitted to the Engineer for approval at least 2 weeks prior to placement. The Contractor's plan shall include detailed information regarding the anticipated concrete delivery rates, estimated start and finish time, and material, labor and equipment that will be used to place, finish and to cure the deck segment in accordance with specifications, including placement of wet burlap, and soaker hose or other system to maintain the deck in a moist condition during the curing period. Information supplied shall also include the number of "work" bridges that will be used, and the number of people responsible for the various tasks. The plan should also discuss bulkheading methods and materials that will be used if it is determined that proposed concrete placement rates cannot be maintained.

A pre-placement meeting shall be held 2-4 days prior to the slab placement to review the information and details provided in the placement and curing plan.

The meeting shall be attended by the Contractor, Engineer, and if required by the Engineer, the concrete supplier and/or concrete pump supplier.

SB-2.9 Mass Concrete

A. Description of Work

This work shall consist of mass concrete construction. Concrete bridge elements shown on the plans that have a minimum dimension exceeding 5 feet (including Pier 2, Pier 3, and superstructure diaphragms at Piers 2 and 3) shall be constructed as mass concrete. The work shall be performed in accordance with the plans, the applicable provisions of Mn/DOT 2401 and 2461, and these Special Provisions.

B. Thermal Control Plan

The Contractor shall submit a Thermal Control Plan prior to mass concrete construction of each element in accordance with the requirements of 1502 and these Special Provisions.

The Thermal Control Plan shall show complete details and determine the maximum allowable temperature differentials between the hottest point of the concrete and the exterior faces based on the design assumption that cracking as a result of heat of hydration shall not occur. As a minimum, the Thermal Control Plan shall include the following:

1. Thermal design calculations.
2. Mix design.
3. Duration and method of curing.
4. Procedures to control concrete temperature at time of placement.
5. Methods of controlling temperature differentials.
6. Temperature sensor types and locations.
7. Temperature monitoring and recording system.
8. Field measures to ensure conformance with the maximum concrete temperature and temperature differential requirements.

The Contractor shall submit 5 sets of the Thermal Control Plan for the Engineer's approval.

C. Construction

Prior to mass concrete placement, an engineer for the Contractor who is registered as a Civil Engineer in the State of Minnesota shall inspect and test the temperature monitoring and recording system. The Contractor's registered engineer shall be present at the jobsite when the mass concrete operation is in progress and shall report to the Engineer in writing on a daily basis the progress of the operation. A copy of the daily report shall be available at the jobsite, and delivered to the County's representative.

Mechanical cooling systems may be used to control the internal temperature of mass concrete during curing.

If the Contractor elects to use a mechanical cooling system, the mechanical cooling system shall be designed in conformance with the Thermal Control Plan and the following requirements:

1. The mechanical cooling system shall be embedded within mass concrete elements and surface connections to cooling pipes shall be removable to a depth of 4 inches from the surface.

2. Forms shall be designed so that removal of the forms shall not disrupt the cooling or temperature monitoring.

3. Cooling pipes shall not break and deform during mass concrete placement and shall be secured to prevent movement. Damaged cooling pipes shall be removed and replaced immediately.

4. The mechanical cooling system shall be pressure tested at 30 psi for 30 minutes for leaking prior to mass concrete placement. Coolant circulation shall be in progress at the time that concrete placement begins.

5. After cooling is completed, cooling pipes shall be fully grouted under pressure with a non shrink grout mixture in conformance with ASTM Designation: C 1107 and ASTM Designation: C 827 for 0.0 percent shrinkage, and 0.0 percent minimum and 4.0 percent maximum expansion. The placement of non shrink grout shall be in conformance with the manufacturer's recommendations.

6. After surface connections to the cooling pipes are removed, the holes shall be reamed and filled with grout.

The temperature monitoring and recording system for mass concrete shall consist of temperature sensors connected to a data acquisition system capable of printing, storing, and downloading data to a computer.

Temperature sensors shall be located such that the maximum temperature difference within a mass concrete element can be monitored. As a minimum, concrete temperatures shall be monitored at the calculated hottest location, on at least 2 outer faces, 2 corners, and top surfaces. Sensors near the exterior shall be placed 2 inches inside of the exterior surface.

Temperature readings shall be automatically recorded on an hourly or more frequent basis. A redundant set of sensors shall be installed near the primary set. Provisions shall be made for recording the redundant set, but records of the redundant sensors need not be made if the primary set is operational. The hourly temperature recording may be discontinued when the maximum internal temperature is falling, the difference between the interior concrete temperature and the average daily air temperature is less than the allowable temperature difference for three consecutive days, and there are no mass concrete elements to be cast adjacent. Data shall be printed and submitted to the Engineer daily.

Methods of concrete consolidation shall prevent damage to the temperature monitoring and recording system. Wiring from temperature sensors cast into the concrete shall be protected to prevent movement. Wire runs shall be kept as short as possible. The ends of the temperature sensors shall not come into contact with either a support or concrete form, or bar reinforcing steel.

When any equipment used in the temperature control and monitoring and recording system fails during the mass concrete construction operation, the Contractor shall take immediate measures to correct the situation as specified in the Thermal Control Plan. Failure to conform to the temperature requirements will be cause for rejection of the concrete.

All components of the post-tensioning system such as ducts, grout inlets, grout outlets, and vents at mass concrete elements that will be in place during mass concrete construction shall be comprised of metal. Plastic materials for post-tensioning components shall not be used at these locations.

D. Acceptance

Mass concrete shall conform to Mn/DOT 2401 and the following temperature requirements:

1. The maximum allowable temperature of mass concrete shall not exceed 160°F.

2. The maximum temperature differential of mass concrete shall not exceed the following:

First 24 hours	30°F
24 to 48 hours	40°F
2 to 7 days	50°F
7 to 14 days	60°F

If cracks in mass concrete occur that are greater than 0.060 inch in width, the Engineer will determine whether these cracks compromise the integrity of the design. If the Engineer determines that the cracks can be repaired without compromising the integrity of the design, the Contractor shall submit a repair plan to the Engineer for approval. If the Engineer determines that the cracks cannot be repaired, the mass concrete elements will be rejected. The rejected mass concrete shall be removed at the Contractor's expense.

If the Contractor fails to conform to any of the temperature requirements above or if cracks in mass concrete occur that are greater than 0.060 inch, the Contractor shall modify the Thermal Control Plan for the elements involved and design calculations to correct the problem and resubmit the revised Thermal Control Plan.

The Contractor shall allow the Engineer fifteen (15) working days for review and approval of the revised Thermal Control Plan. Mass concrete placement shall not begin until the Engineer has approved the revised Thermal Control Plan. No extension of time or compensation will be made for any rejected mass concrete element or revisions of the Thermal Control Plan.

E. Crack Repair

The Contractor shall seal all mass concrete cracks between 0.010 inch and 0.020 inch in width with a Mn/DOT approved epoxy crack sealant applied in accordance with the manufacturer's recommendations.

Mass concrete cracks between 0.020 inch and 0.060 inch in width shall be filled using a Mn/DOT approved epoxy injection system and materials. The epoxy injection operation shall be in accordance with the material and equipment manufacturer's recommendations.

Mass concrete cracks greater than 0.060 inch in width shall be evaluated by the Engineer as described above.

F. Measurement and Payment

Mass concrete construction shall be considered as an incidental expense to the items of work involved with no direct compensation to the Contractor.

SB-2.10 Grout

The following grout specifications do not apply to the grout used in the post tensioning systems.

Use only non-shrink, high strength, pre-packaged grouts that are applicable to the location required. Grouts shall have a minimum compressive strength of 125% of the adjacent specified concrete strength or 7500 psi at 28 days whichever is greater.

Grout shall be transported, stored, and mixed in accordance with the manufacturer's recommendations. Grout shall be placed in accordance with Mn/DOT sections 2401 and 2461.

Payment for Grout shall be considered incidental to payment for the element for which the grout is required or is to be applied and shall be full compensation for furnishing, fabricating, transporting, and placing, and for all materials, labor, tools, equipment and incidentals necessary for completing the work in accordance with Contract requirements.

SB-2.11 Locking Cover for Box Girder Access Opening

This work shall consist of furnishing and installing the Locking Covers and Grate Hatches for Box Girder Access Slab Openings in accordance with the applicable provisions of 2402, 2471, the Plans and the following. The Contractor is responsible for communicating all applicable specifications, special provisions and requirements to all subcontractors.

A. Materials

All materials shall be in accordance with the Plan details. All steel shall comply with 3306. All fasteners shall comply with 3391.2A. Galvanize all steel in accordance with 3394. Threaded rods, bolts, nuts, and washers shall meet 3391 and shall be galvanized in accordance with 3392.

B. Submittals

Shop drawings for the Locking Covers shall be submitted to the Engineer for approval in accordance with the requirements of 2471.3B.

C. Basis of Payment

Payment for the Locking Covers shall be incidental to bid price for Item No. 2401.501 "STRUCTURAL CONCRETE (3U36 MODIFIED).

SB-3 POST TENSIONING SYSTEM

GENERAL

This work shall be performed, as directed by the Engineer, in accordance with the applicable provisions of Mn/DOT 2401, the Plans, and the following:

A. Description

Furnish and install all post-tensioning systems and any other pertinent items necessary for the particular prestressing system used, including but not limited to ducts, anchorage assemblies and local zone reinforcement. All post-tensioning shall comply with the requirements of this Section. Furnish all components of the post-tensioning system, including steel pipes, from a single supplier. Prestressing steel can be obtained from any approved supplier.

Install prestressing steel strands through ducts in the concrete. Stress to a predetermined load and anchor directly against the hardened concrete. De-tension temporary prestressing and remove material not incorporated into the final work. Grout permanent ducts to fill all voids and install protection at end anchorages.

Submit shop and working drawings and manuals in accordance with this Specification and Mn/DOT Section 1502. An engineer for the Contractor who is registered in the State of Minnesota shall, sign and seal all shop drawings related to post-tensioning.

B. Qualifications and Inspection

Perform all post-tensioning field operations under the direct supervision (crew foreman) of a qualified post-tensioning and grouting technician. Provide project personnel, a crew foreman and crew members in accordance with Mn/DOT Section 1802.

Conduct all stressing and grouting operations in the presence of the Engineer.

C. Shop Drawings

Prepare shop drawings to address all requirements stated in the plans and the requirements stated herein. Indicate the approved post-tensioning systems to be used. Show tendon geometry and locations complying with the Plans and the limitations of the selected post-tensioning system. Show all inlets, outlets, high point outlet inspection details, coupler details, anchorage inspection details and permanent grout caps, protection system materials and application limits.

D. Alternate Post-Tensioning Designs

The design shown in the Plans has been detailed based on the use of seven wire, 0.6 inch, diameter, low-relaxation strands. Standard tendon sizes used for design consist of 0.6 inch diameter strand in ducts/anchorages containing 4 or 27 strands.

Alternate designs using a post-tensioning scheme other than that shown on the plans may be submitted for the Engineer's approval provided that the proposed alternate scheme fulfills the following requirements:

(1) The prestress system is a type described in and meeting the requirements of this Specification.

(2) The net compressive stress in the concrete after all losses is at least as large as that provided by the post-tensioning shown on the Plans.

(3) The distribution of individual tendons at each cross section generally conforms to the distribution shown on the Plans.

(4) The ultimate strength of the structure with the proposed post-tensioning scheme meets the requirements of Section 5 of the "AASHTO LRFD Bridge Design Standard Specifications" and shall be equivalent to or greater than the service and strength limit states provided by the original design.

(5) Stresses in the concrete and prestressing steel at all sections and at all stages of construction meet the requirements of the Design Criteria noted on the Plans.

(6) All provisions of the Design Criteria noted on the Plans shall be satisfied.

(7) The Contractor fully designs and details, the elements where the alternate post-tensioning scheme is proposed to be used.

(8) The Contractor submits five sets of complete shop drawings including post-tensioning scheme and system, reinforcing steel, and concrete cover; and design calculations (including short and long term pre-stress losses) for the Engineer's approval.

(9) Alternative post-tensioning shall be designed and sealed by the Contractor's engineer who is a registered civil engineer in the State of Minnesota.

E. Material Storage

Store all materials in a weatherproof building, shed or container until time of use.

SB-3.1 Certification of Post-Tensioning Systems

The Contractor shall submit test results to the Engineer and include certified test reports from an independent laboratory audited by AASHTO Materials Reference Laboratory (AMRL) which shows the post-tensioning system meets all the requirements specified herein. Test plastic components in a certified independent laboratory accredited through the laboratory accreditation program of the Geosynthetic Accreditation Institute (GAI) or the American Association for Laboratory Accreditation (A2LA). Certification of test reports may be performed by an independent laboratory located outside the U.S., if the independent laboratory is approved by the State. If any component of the post-tensioning system is modified or replaced, the appropriate component test and entire system test, if needed, must be retested in accordance with the requirements herein and an updated submittal made to the Engineer containing the test reports and revised system drawings. Before attempting to change post-tensioning system components contact the Owner for direction.

The Contractor shall perform certification test for plastic ducts on a sample formed or cut from the finished product. Provide the Engineer with certification that the plastic from the duct sample complies with all requirements of the specified cell class, stress crack rating and the specified amount of antioxidant. Certify to the Engineer that the post-tensioning system being furnished is in compliance with all requirements stated herein.

All components of a system shall be stamped with the suppliers name, trademark model number and size corresponding to catalog designation. Post-tensioning systems consist of an assembly of components for various sizes of strands assembled and pressure tested. Post-tensioning systems shall be developed and tested.

Prior to the installation of any post-tensioning (PT) hardware, the proposed PT system shall be approved by the Owner. Additionally, the Contractor shall

furnish the Engineer with a list of the system components and drawings. Upon completion of post-tensioning installation, provide a certification that the PT system supplied was installed without modification and met the requirements of the contract documents.

SB-3.2 MATERIALS

A. Prestressing Steel

Unless otherwise noted on the Plans, use uncoated strand meeting requirements of Mn/DOT Section 3348 (Grade 270, low relaxation 7-wire strand meeting the requirements of ASTM A416).

B. Post-Tensioning System

Use approved post-tensioning systems of the proper size and type to construct tendons shown in the Contract Documents. Substitution of components in approved post-tensioning systems is not permitted. Use only post-tensioning systems that utilize tendons fully encapsulated in anchorages and ducts. Systems which transfer prestress force by bonding the prestress steel strand directly to concrete are not permitted. Strand couplers shall not be permitted.

(1) Post-Tensioning Anchorages

Ensure that the anchorages develop at least 96% of the actual ultimate tensile strength of the prestressing steel, when tested in an unbonded state, without exceeding the anticipated set.

Anchorages shall be designed so that the average concrete bearing stress is in compliance with the “AASHTO LRFD Bridge Design Specifications”. Test and provide written certification that anchorages meet or exceed the testing requirements in the AASHTO LRFD Bridge Construction Specifications.

Galvanize the embedded body of the anchorage in accordance with ASTM 123. Other components of the anchorage including wedges, wedge plate and local zone reinforcement are not required to be galvanized. Construct the bearing surface and wedge plate from ferrous metal. Equip all anchorages with a permanent grout cap that is vented and bolted to the anchorage.

Provide wedge plates with centering lugs or shoulders to facilitate alignment with the bearing plate.

Cast anchorages with grout outlets suitable for inspection from either the top or front of the anchorage. The grout outlet will serve a dual function of grout outlet and post-grouting inspection access. The geometry of the grout outlets must facilitate being drilled using a 3/8-inch diameter straight bit to facilitate endoscope inspection directly behind the anchor plate. Anchorages may be fabricated to facilitate both inspection locations or may be two separate anchorages of the same type each providing singular inspection entry locations.

Trumpets associated with anchorages will be made of either ferrous metal or polypropylene plastic material conforming to the requirements of the "Corrugated Plastic Duct" section of these Specifications. The thickness of the trumpet at the transition location (choke point) will not be less than the thickness of the duct as established in the "Corrugated Plastic Duct" section of these Specifications. Alternately, the trumpet material may be polyolefin containing antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours.

(2) Inlets, Outlets, Valves and Plugs

Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A240 Type 316 stainless steel, nylon or polyolefin materials. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Products made from polyolefin shall contain antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of not less than 20 minutes. Perform OIT test on samples taken from the finished product. Test the remolded finished polyolefin material for stress crack resistance using ASTM F 2136 at an applied stress of 348 psi resulting in a minimum failure time of 3 hours. All inlets and outlets will be equipped with pressure rated mechanical shut-off valves or plugs. Inlets, outlets, valves and plugs will be rated for a minimum pressure rating of 150 psi. Use inlets and outlets with a minimum inside diameter 3/8 inch for four-strand duct and 3/4 inch for all other locations.

Provide dual mechanical shutoff valves when performing vertical grouting. Specifically designate temporary items, not part of the permanent structure, on the PT System drawings. Temporary items may be made of any suitable material.

(3) Permanent Grout Caps

Use permanent grout caps made from approved polymer or ASTM A240 Type 316L stainless steel. The approved resins used in the polymer shall be nylon, Acrylonitrile Butadiene Styrene (ABS) or polyester. For products made from nylon, the cell class of the nylon according to ASTM D5989 shall be S-PA0141 (weather resistant), S-PA0231 or S-PA0401 (ultimate strength not less than 10,000 psi with UV stabilizer added). Seal the cap with "O" ring seals or precision fitted flat gaskets placed against the bearing plate. Place a grout vent on the top of the cap. Grout caps must be rated for a minimum pressure rating of 150 psi. Use ASTM A240 Type 316L stainless steel bolts to attach the cap to the anchorage. When stainless steel grout caps are supplied, provide certified test reports documenting the chemical analysis of the steel.

(4) Duct and Pipe

(a) General

Use only plastic duct, steel pipe, corrugated steel duct or a combination of plastic duct, steel pipe, and corrugated steel duct. Ensure that all connectors, connections and components of post-tensioning system hardware are air and water tight and pass the pressure test requirements herein. Use corrugated plastic or steel duct in all post-tensioning systems used for all internal tendons except where steel pipe is required. **Plastic duct is not permitted in longitudinal webs of box girders**. The Contractor's attention is directed to the "Mass Concrete" section of these Specifications for limitations on the use of plastic ducts.

(b) Duct or Pipe Minimum Diameter

For multi-strand tendons, provide ducts with a minimum cross-sectional area 2 1/2 times the cross-sectional area of the prestressing steel.

(c) Connection Tolerance between Pipe and Duct

Steel pipe, plastic duct, and corrugated steel duct may be connected directly to each other when the outside diameters do not vary more than ± 0.08 inch. Use a reducer when the diameters of the steel pipe and the plastic duct are outside of this tolerance.

(d) Steel Pipes:

Use galvanized schedule 40 steel pipes where required.

(e) Corrugated Plastic Duct

Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts. Use corrugated duct manufactured from non-colored, unfilled polypropylene meeting the requirements of ASTM D4101 "Standard Specification for Polypropylene Plastic Injection and Extrusion Materials" with a cell classification range of PP0340B14541 to PP0340B67884. The duct shall be white in color containing antioxidant(s) with a minimum Oxidation Induction Time (OIT) according to ASTM D 3895 of 20 minutes and containing a non-yellowing light stabilizer. Perform OIT test on samples from the finished product. Furnish duct with a minimum thickness as defined in the following table:

Duct Shape	Duct Diameter	Duct Thickness
Flat	any size	0.08 inch
Round	0.9 inch	0.08 inch
Round	2.375 inches	0.08 inch
Round	3.0 inches	0.10 inch
Round	3.35 inches	0.10 inch
Round	4.0 inches	0.12 inch
Round	4.5 inches	0.14 inch
Round	5.125 inches	0.16 inch
Round	5.71 inches	0.16 inch

(e)(1) Testing Requirements for Corrugated Plastic Duct

Ensure that the duct system components and accessories meet the requirements of Chapter 4, Articles 4.1 through 4.1.8 of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, titled "Corrugated Plastic Duct for Internal Bonded Post-Tensioning" as modified herein.

The requirements in FIB Technical Report, Bulletin 7, are modified as follows: Conduct the lateral load resistance test (FIB 4.1.4), without the use of a duct stiffener plate, using a load of 150 lbs. for all sizes; Wear resistance of duct (FIB 4.1.7) must not be less than 0.06 inch for duct up to

3.35 inches in diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter; Bond length test (FIB 4.1.8) must achieve 40 % MUTS in a maximum length of 16 duct diameters.

(e)(2) Minimum Bending Radius for Corrugated Plastic Duct

In addition to the component testing stated herein, the manufacturer shall establish, through testing, the minimum bending radius for the duct. The test consist of a modified duct wear test as described in Chapter 4, Article 4.1.7 of FIB Technical Report, Bulletin 7, titled "Corrugated Plastic Duct for Internal Bonded Post-Tensioning". The test apparatus shall be identical to the wear test apparatus with the same clamping force as a function of the number of strands in the duct; however, modify the procedure as follows: do not move the sample along the strand to simulate wear; the test duration will be 7 days. Upon completion of the test duration, remove the duct and the minimum wall thickness along the strand path must not be less than 0.06 inch for duct up to 3.35 inches diameter and not less than 0.08 inch for duct greater than 3.35 inches in diameter.

(e)(3) Corrugated Duct Connections and Fittings

Make all splices, joints, couplings and connections to anchorages with devices or methods (i.e., mechanical couplers, plastic sleeves in conjunction with shrink sleeve) producing a smooth interior alignment with no lips or kinks. Design all connections and fittings to be airtight. Duct tape is not permitted to join or repair duct connections.

Construct connections and fittings from polyolefin materials containing antioxidant stabilizer(s) meeting the requirements established in the "Inlets, Outlets, Valves and Plugs" Section or the "Corrugated Plastic Duct" Section of this Specification.

(f) Smooth Duct

Use smooth duct manufactured from 100% virgin polyethylene resin meeting the requirements of ASTM D 3350 with a minimum cell class of 344464C. Use resin containing antioxidant(s). Perform OIT test on samples taken from the finished product resulting in a minimum Oxidative Induction Time (OIT) according to ASTM D 3895 of 40 minutes. Manufacture duct with a dimension ratio (DR) of 17.0 or less as established by either ASTM D 3055 or ASTM F 714 as appropriate for the manufacturing process used.

Use smooth duct meeting the minimum pressure rating (working pressure) of 100 psi and manufactured to either of the following Specifications: ASTM D 3035 "Standard Specifications for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter" or ASTM F 714 "Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter".

(f)(1) External Smooth Duct Connections

Use heat welding techniques to make splices between sections of plastic duct, in accordance with the duct manufacturer's instructions or make connections with electro-fusion coupler or other mechanical couplers meeting the material requirements of this Specification. Ensure all connections have a minimum pressure rating (working pressure) of 100 psi, produce a smooth interior alignment and a connection with no lips or kinks.

Ensure all connections between steel pipe embedded in concrete and plastic duct are made by using a mechanical coupler or a circular sleeve made of Ethylene Propylene Deine Monomer (EPDM), having a minimum pressure rating (working pressure) of 100 psi. Use EPDM materials having 100 % quality retention as defined by ASTM D 1171 Ozone Chamber Exposure Method B.

Use EPDM sleeves having a minimum wall thickness of 3/8 inch and be reinforced with a minimum of four ply polyester reinforcement. Use a 3/8 inch wide power seated band and clamps constructed from 316 stainless steel on each end of the boot to seal against leakage of grout. Install the band with an 80 to 120 lb seating force.

(g) Corrugated Steel Ducts

Corrugated steel ducts shall be rigid ferrous metal, galvanized, and mortar tight. Corrugated steel ducts shall be fabricated with either welded or interlocked seams. Galvanizing of the welded seam will not be required. Ducts shall have sufficient strength to maintain their correct alignment during placing of concrete. Joints between sections of duct shall be positive metallic connections which do not result in angle changes at the joints. Waterproof tape shall be used at the connections. Ducts shall be bent without crimping or flattening. Transition couplings connecting the ducts to anchoring devices shall be either ferrous metal or polyolefin. Ferrous metal transition couplings shall be galvanized.

(h) Shipping and Storage of Ducts

Furnish duct with end caps to seal the duct interior from contamination. Ship in bundles which are capped and covered during shipping and storage. Protect ducts against ultraviolet degradation, crushing, excessive bending, dirt contamination and corrosive elements during transportation, storage and handling. Do not remove end caps supplied with the duct until the duct is incorporated into the bridge component. Store duct in a location that is dry and protected from the sun. Storage must be on a raised platform and completely covered to prevent contamination. If necessary, wash duct before use to remove any contamination.

(5) Internal Duct Mechanical Couplers, O-Rings, and Heat Shrink Sleeve Requirements

(a) Mechanical Couplers

Construct mechanical internal duct couplers with stainless steel, plastic or a combination of these materials. Use plastic resins meeting the requirements of the "Inlets, Outlets, Valves and Plugs" Section or the "Corrugated Plastic Duct" Section of this Specification to construct plastic couplers. Use ASTM A 240 Type 316 stainless steel to make metallic components.

(b) O-rings

Provide O-ring duct coupling assemblies made from plastic resins meeting the requirements of the "Inlets, Outlets, Valves and Plugs" Section or the "Corrugated Plastic Duct" Section of this Specification

Furnish standard O-ring material (diameter < 0.25 inch) conforming to the following requirements:

Mechanical Properties:	
Shore hardness, A ASTM D2240	50-75
Ultimate elongation %, ASTM D412	250% Min.
Tensile strength, ASTM D412	1400 psi Min.

Accelerated Testing:	
Thermal Deterioration	70 hours @ 257 ºF, ASTM D573
Change in tensile strength	± 30 %
Change of elongation	-50 %

Change of hardness	± 15 points
Compression Set Method B 22 hrs @257 ºF, ASTM D395	50%
Volume change due to absorption of H2O, Method D, for 70 hours @ 212 ºF, ASTM D471	+ 10 %

Environmental Resistance:

Ozone Resistance Exposure Method B, ASTM D1171	Pass
Low Temp. Non-brittle after 3 Min. @ -40 ºF, ASTM D2137	Pass

(c) Heat Shrink Sleeves

Furnish heat shrink sleeves having unidirectional circumferential recovery manufactured specifically for the size of the duct being coupled consisting of an irradiated and cross linked high density polyethylene backing for external applications and linear-density polyethylene for internal applications. Furnish adhesive having the same bond value to steel and polyolefin plastic materials. Ensure the heat shrink sleeves have an adhesive layer that will withstand 160° F operating temperature and meet the requirements of the following table:

Property	Test Method	Minimum Requirements	
		Internal Application	External Application
Minimum Fully Recovered Thickness		92 mils	111 mils
Peel Strength	ASTM D 1000	29 pli	46 pli
Softening Point	ASTM E 28	162 ºF	216ºF
Lap Shear	DIN 30 672M	87 psi	58 psi
Tensile Strength	ASTM D 638	2,900 psi	3,480 psi
Hardness	ASTM D 2240	46 Shore D	52 Shore D
Water Absorption	ASTM D 570	Less than 0.05%	Less than 0.05%
Color		Yellow	Black
Minimum Recovery	Heat Recovery Test	33%	23%

Install heat shrink sleeves using procedures and methods in accordance with the manufacturer's recommendations.

(6) System Test Requirements

For each family of post-tensioning systems, assemble systems and perform the pressure test defined herein. For each family of post-tensioning systems test two assemblies (largest and smallest) from the family. The post-tensioning assembly includes at least one of each component required

to make a tendon from grout cap to grout cap. If applicable, include plastic duct to steel pipe connections.

(a) Grouting Component Assembly Pressure Test

Assemble anchorage and grout cap with all required grouting attachments (grout tube, valves, plugs, etc.). Seal the opening in the anchorage where the duct connects. Condition the assembly by maintaining a pressure of 150 psi in the system for 3 hours. After conditioning, the assembly must sustain a 150 psi internal pressure for five minutes with no more than 15 psi reduction in pressure. For systems using the same anchorages, grout caps and grouting attachments as a previously approved system, the Grouting Component Assembly Pressure Test may include documentation from a previous submittal with written certification that the same components are being utilized in both anchorages.

(b) Internal Duct Systems

Perform a system test of the assembly for compliance with the requirements of Chapter 4, Article 4.2, Stage 1 and Stage 2 Testing contained in FIB Technical Report, Bulletin 7, titled "Corrugated Plastic Duct for Internal Bonded Post-tensioning".

C. Grout

Use only grouts that meet the requirements of the "POST-TENSIONING GROUT" portion of this Specification. Select the post-tensioning grout for use by the proper application either repair, horizontal or vertical. Grout will be mixed with potable water. Maintain grout fluidity in strict compliance with the grout manufacturer's recommendations and test with a flow cone.

(1) Grout Storage

Store grout in a location that is both dry and convenient to the work. Storage in the open must be on a raised platform and with adequate waterproof covering to protect the material. On site storage of grout is limited to a maximum period of one month.

D. Samples for Testing and Identification

(1) General

Testing must conform to the applicable ASTM Specifications for the prestressing material used.

Furnish all material samples for testing at no cost to the Owner.

Consider the job site or site referred to herein, as the location where the prestressing steel is to be installed.

(2) Prestressing Steel

Furnish samples for testing as described below for each manufacturer of prestressing strand to be used on the project.

With each sample of prestressing steel strand furnished for testing, submit a certification stating the manufacturer's Minimum Ultimate Tensile Strength (M.U.T.S) of the sample furnished.

The Engineer will sample the following materials, at the plant or jobsite, from the prestressing steel used for post-tensioning operations:

(a) For strand: three randomly selected samples, 5 feet long, per manufacturer, per size of strand, per shipment, with a minimum of one sample for every ten reels delivered.

One of each of the samples furnished to represent a LOT, will be tested. The remaining sample(s), properly identified and tagged, will be stored by the Engineer for future testing. In the event of loss or failure of the component the stored sample will be utilized to evaluate for minimum strength requirements. For acceptance of the LOT represented, test results must show 100% of the Minimum Ultimate Tensile Strength.

(3) LOTs and Identification

A LOT is that parcel of components as described herein. All strand from each manufactured reel to be shipped to the site must be assigned an individual LOT number and must 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, or reel of material represented. All unidentified prestressing steel received at the site will be rejected. Also, loss of positive identification of these items at any time will be cause for rejection.

Provide a copy of the grout Quality Control Data Sheet to the Engineer, from the manufacturer, for each LOT number and shipment sent to the job site. Materials with a total time from manufacturer, in excess of six months, must be retested and

certified by the supplier before use or be removed from the project and replaced.

E. Approval of Materials

The approval of any material by the Engineer will not preclude subsequent rejection if the material is damaged in transit or later damaged or found to be defective.

SB-3.3 Protection of Prestressing Steel

A. Shipping, Handling and Storage

Protect all prestressing steel against physical damage and corrosion at all times, from manufacturer to final grouting or encasing in the concrete. The Engineer will reject prestressing steel that has sustained physical damage.

Carefully inspect any reel that is found to contain broken wires during use and remove and discard lengths of strand containing broken wires. The wire must be bright and uniformly colored, having no foreign matter or pitting on its surface.

Prestressing steel must be packaged in containers for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents rust, must be placed in the package, or be incorporated in a corrosion inhibitor carrier type packaging material. The corrosion inhibitor must have no deleterious effect on the steel or the concrete or bond strength of steel to concrete. Inhibitor carrier-type packaging material must conform to the provisions of Federal Specification MIL-P-3420. Immediately replace or restore packaging damaged from any cause, to the original condition.

The shipping package must be clearly marked with a statement that the package contains high-strength prestressing steel, the care to be used in handling, and the type, kind and amount of corrosion inhibitor used, including the date when placed, safety orders and instructions for use. Specifically designate low relaxation (stabilized) strands per requirements of ASTM A 416. Strands not so designated will be rejected.

B. During Installation in the Structure

The time between the first installation of the prestressing steel in the duct and the completion of the stressing and grouting operations shall not exceed ten calendar days. Any light surface corrosion forming during this period of time will not be cause for rejection of the prestressing steel.

Flushing of grout is not permitted and vacuum grouting is required to repair all voids and blockages as defined in the "Grouting" section of this Specification. Flushing of ducts is only permitted as defined in the "Installing Tendons" section of this Specification. When flushing is permitted, use flush water containing slack lime (calcium hydroxide) or quicklime (calcium oxide) in the amount of 0.17 lb/gal.

Except when waived by the Engineer in writing, the Contractor shall propose mitigation measures, subject to approval by the Engineer, if the grouting of tendons exceeds the ten calendar days specified above.

SB-3.4 Fabrication

A. General

Accurately and securely fasten all post-tensioning anchorages, ducts, inlet and outlet pipes, miscellaneous hardware, reinforcing bars, and other embedments at the locations shown on the plans or on the approved Shop or Working Drawings or as otherwise approved by the Engineer. Construct tendons using the minimum number of duct splices possible.

B. Ducts

Accurately align ducts and position at the locations shown on the plans or according to the approved Shop or Working Drawings or as otherwise approved by the Engineer. Securely fasten all internal ducts in position at regular intervals not exceeding 30 inches for steel pipes and corrugated steel ducts, 24 inches for round plastic ducts and 12 inches for flat ducts to prevent movement, displacement or damage from concrete placement and consolidation operations. Show the method and spacing of duct supports on appropriate Shop Drawings.

Ensure that all alignments, including curves and straight portions, are smooth and continuous with no lips, kinks or dents. This also applies to curves in pre-bent steel pipe.

Carefully check and repair all ducts as necessary before placing any concrete.

After installing the ducts and until grouting is complete, ensure that all ends of ducts, connections to anchorages, splices, inlets, and outlets are sealed at all times. Provide an absolute seal of anchorage and duct termination locations by using plumber's plugs or equal. Grout inlets and outlets shall be installed with plugs or valves in the closed position. Leave low point outlets open. The use of duct tape is not permitted.

C. Splices and Joints

All splices, joints, couplings, connections (inlet and outlet) and valves shall be part of the approved post-tensioning system. Approved shrink-sleeve material may be used to repair duct. The use of any tape to repair or seal duct is not permitted.

D. Location of Grout Inlets and Outlets

Place grout inlets and outlets at locations as shown on the plans and shop drawings. Equip all grout inlets and outlets with positive shut-off devices. At a minimum, grout inlets and outlets shall be placed in the following positions:

(a) Top of the tendon anchorage;

(b) Top of the grout cap;

(c) At the high points of the duct when the vertical distance between the highest and lowest point is more than 20 inches;

(d) At a location 3 feet past high points of the duct on the downstream side opposite the direction of grouting;

(e) At all low points;

(f) At major changes in the cross section of the duct;

(g) At other locations required by the Engineer.

Extend grout tubes a sufficient distance out of the concrete member to allow for proper closing of the valves.

E. Tolerances

Ensure that post-tensioning ducts in their final position are within the following tolerances:

Table of Duct Position Tolerances		
Tolerances	Vertical position Inches	Lateral position Inches
Horizontal tendons in slabs or in slab regions of larger members:	±1/4	± 1/2
Longitudinal draped super-Structure tendons in webs: Tendon over supports or in middle third of span	±1/4	±1/4
Tendon in middle half of web depth	±1/2	±1/4
Longitudinal, generally horizontal, superstructure tendons usually in top or bottom of member:	±1/4	±1/4
Horizontal tendons in substructures and foundations:	± 1/2	± 1/2
Vertical tendons in webs	Longitudinal position ±1	Transverse position ±1/4
Vertical tendons in pier shafts	±1/2	±1/4

In all other cases, ensure that tendons are not out of position by more than ± 1/4 inch in any direction.

Ensure entrance and exit angles of tendon paths at anchorages and/or at faces of concrete are within ± 3 degrees of desired angle measured in any direction and any deviations in the alignment are accomplished with smooth transitions without any kinks.

Angle changes at duct joints must not be greater than ± 3 degrees in any direction and must be accomplished with smooth transitions without any kinks.

Locate anchorages within ± 1/4 inch of desired position laterally and ± 1 inch along the tendon except that minimum cover requirements must be maintained.

Position anchorage confinement reinforcement in the form of spirals, multiple U shaped bars or links, to be properly centered around the duct and to start within 1/2 inch of the back of the main anchor plate.

If conflicts exist between the reinforcement and post-tensioning duct, the position of the post-tensioning duct shall prevail and the reinforcement shall be adjusted locally with the Engineer’s approval.

F. Internal Duct Pressure Test

Pressure test each different type and size of duct assembly at the sight of casting before its first time use on the project. Pressure test all assemblies used in a single component constructed for the first time on the project, and thereafter, in groups of not more than 50 components, the Engineer shall randomly select one component per group, but not less than a total of two per project, for testing. Types of components include all post-tensioned components including but not limited to transversely post-tensioned decks, transversely post-tensioned diaphragms, and longitudinally post-tensioned girders. Test the assemblies in their final position just prior to concrete placement by sealing them at their anchorage or construction joint termini and then by applying compressed air to determine if the assembly connections are pressure tight. In the presence of the Engineer, pressurize the duct to 1.5 psi and lock-off the outside air source then record the pressure loss for a duration of one minute. If the pressure loss exceeds 0.15 psi, find and repair the leaks in the duct assembly using repair methods approved by the Engineer and retest.

SB-3.5 Placing Concrete

A. Precautions

Use methods to place and consolidate concrete which will not displace or damage any of the post-tensioning ducts, anchorage assemblies, splices and connections, reinforcement or other embedments. Fabricate all duct splices to prevent duct kinks during concrete placement. Use mandrels as needed to maintain duct alignment and shape.

B. Proving of Post-Tensioning Ducts

Upon completion of concrete placement, prove that the post-tensioning ducts are free and clear of any obstructions or damage and are able to accept the intended post-tensioning strands by passing a torpedo through the ducts. Use a torpedo that has the same cross-sectional shape as the duct and that is1/4 inch smaller all around than the clear, nominal inside dimensions of the duct. Make no deductions to the torpedo section dimensions for tolerances allowed in the manufacture or fixing of the ducts. For straight ducts, use a torpedo at least 2 feet long. For curved ducts, determine the length so that when both ends touch the outermost wall of the duct, the torpedo is 1/4 inch clear of the innermost wall. If the torpedo will not travel completely through the duct, the Engineer will reject the member, unless a workable repair can be made to clear the duct.

The torpedo must pass through the duct easily, by hand, without resorting to excessive effort or mechanical assistance.

C. Problems and Remedies

The Engineer will reject ducts or any part of the work found to be deficient. Perform no remedial or repair work without the Engineer's approval.

SB-3.6 Installing Strands

For tendons subjected to contamination with chlorides (construction location in an aggressive environment), flush the duct before placing the prestressing strands, with lime treated potable water and test for presence of chlorides and oils. Chlorides in the water must be less than 600 ppm. If chloride levels are in excess of 600 ppm, continue to flush the duct until the chloride level is below 250 ppm. Blow oil-free compressed air through the duct to remove any excess water in the duct.

Push or pull post-tensioning strands through the ducts to make up a tendon using methods which will not snag on any lips or joints in the ducts. Strands which are pushed should be rounded off the end of the strand or fitted with a smooth protective cap. During the installation of the post-tensioning strand into the duct, the strand shall not be intentionally rotated by any mechanical device.

Alternatively, strands may be assembled to form the tendon and pulled through the duct using a special steel wire sock ("Chinese finger") or other device attached to the end. The ends of the strands may not be electric arc welded together for this purpose. Strands may be brazed together for pulling as long as 1 foot of strand from the brazed end is removed after installation. Round the end of the pre-assembled tendon for smooth passage through the duct. Cut strands using an abrasive saw or equal. Flame cutting is not allowed.

SB-3.7 Post-Tensioning Operations

A. General

Do not apply post-tensioning forces until the concrete has attained the specified compressive strength as determined by cylinder tests. Conduct all stressing operations in the presence of the Engineer.

B. Stressing Tendons

Tension all post-tensioning steel with hydraulic jacks so that the post-tensioning force is not less than that required by the plans or approved

shop drawings, or as otherwise approved by the Engineer. Do not utilize monostrand jacks to stress tendons with five or more strands.

(1) Maximum Stress at Jacking

The maximum temporary stress (jacking stress) in the post-tensioning steel must not exceed 75% of its specified minimum ultimate tensile strength. Do not overstress tendons to achieve the expected elongation.

(2) Initial and Permanent Stresses

The post-tensioning steel must be anchored at initial stresses that will result in the long term retention of permanent stresses or forces of no less than those shown on the plans or the approved shop drawings. Unless otherwise approved by the Engineer, the initial stress after anchor set must not exceed 70% of the specified ultimate tensile strength of the post-tensioning steel.

Permanent stress and permanent force are the stress and force remaining in the post-tensioning steel after all losses, including long term creep and shrinkage of concrete, elastic shortening of concrete, relaxation of steel, losses in the post-tensioning steel from the sequence of stressing, friction and unintentional wobble of the ducts, anchor set, friction in the anchorages and all other losses peculiar to the post-tensioning system.

(3) Stressing Sequence

Unless otherwise approved by the Engineer, all tendons for Bridge No. 27B60 (Phase II) shall be single end stressed.

For longitudinal tendons, no more than 1/2 the prestressing force in any girder (web) may be applied before an equal force is applied in the adjacent girders (webs). The maximum force variation between girders shall also not exceed the prestressing force of the largest tendon used in all girders. At no time during stressing operations will more than 1/6 of the total prestressing force be applied eccentrically about the centerline of the structure.

For transverse deck slab and intermediate diaphragm tendons, the stressing end shall be alternated such that adjacent tendons are not stressed from the same side edge of deck.

C. Stressing Equipment

Only use equipment furnished by the supplier of the post-tensioning system (tendons, hardware, anchorages, etc.).

(1) Stressing Jacks and Gauges

Each jack must be equipped with a pressure gauge for determining the jacking pressure. The pressure gauge must have an accurate reading gauge with a dial at least 6 inches in diameter.

(2) Calibration of Jacks and Gauges

Calibrate each jack and its gauge(s) as a unit. The calibration must consist of three test cycles with the cylinder extension of the jack in various positions (i.e., 2 inch, 4 inch, 8 inch stroke). At each pressure increment, average the forces from each test cycle to obtain an average force. Perform the calibration with the equipment (jack, pump, hoses, etc.) setup in the same configuration that is intended to be used at the job site. The post-tensioning supplier or an independent laboratory shall perform initial calibration of jacks and gauge(s). Use load cells calibrated within the past 12 months to calibrate stressing equipment. For each jack and gauge unit used on the project, furnish certified calibration charts and curves to the Engineer prior to stressing. Supply documentation denoting the load cell(s) calibration date and tractability to NIST (National Institute of Standards and Technology) along with the jack/gauge calibration.

Provide the Engineer with certified calibration charts and curves prior to the start of the work and every six months thereafter, 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 hydraulic manifold to enable quick and easy installation of the master gauge to verify the permanent gauge readings. The master gauge shall be calibrated and provided to the Engineer. The master gauge will remain in the possession of the Engineer for the duration of the project.

Any jack repair, such as replacing seals or changing the length of the hydraulic lines, is cause for recalibration using a load cell. No extra compensation will be allowed for the initial or subsequent

calibrations or for the use and required calibrations of the master gauge.

D. Elongations and Agreement with Forces

Ensure that the forces being applied to the tendon and the elongation of the post-tensioning tendon can be measured at all times.

Elongations shall be measured to the nearest 1/16 inch.

For the required tendon force, the observed elongation must agree within 7% of the theoretical elongation or the entire operation must 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.

E. Friction

The Contract Plans were prepared based on the assumed friction, wobble coefficients, and anchor set noted on the plans. Submit calculations and show a typical tendon force diagram, after friction, wobble, and anchor set losses, on the shop drawings based upon the expected actual coefficients and values for the post-tensioning system to be used. Coefficients and values shall also be shown on the shop drawings. Calculations for the tendon force diagram shall be submitted with the shop drawings.

If, in the opinion of the Engineer, the actual friction significantly varies from the expected friction, revise post-tensioning operations so the final tendon force is in agreement with the Plans.

When friction must be reduced, graphite may be used as a lubricant, subject to the approval of the Engineer.

F. Wire Failures in Post-Tensioning Tendons

Multi-strand post-tensioning tendons, having wires which fail, by breaking or slippage during stressing, may be accepted provided the following conditions are met:

(a) The completed structure must have a final post-tensioning force of at least 98% of the design total post-tensioning force.

(b) Any single tendon must have no more than a 5% reduction in cross-sectional area of post-tensioning steel due to wire failure.

Any of the above conditions may be waived with approval of the Engineer, when conditions permit the Contractor to propose acceptable alternative means of restoring the post-tensioning force lost due to wire failure.

G. Cutting of Post-Tensioning Steel

Cut post-tensioning steel with an abrasive saw or plasma torch within 3/4 to 1 1/2 inches away from the anchoring device. Flame cutting of post-tensioning steel is not allowed.

H. Record of Stressing Operations

Keep a record of the following post-tensioning operations for each tendon installed:

(a) Project name, Financial Project ID;
(b) Contractor and/or subcontractor;
(c) Tendon location, size and type;
(d) Date tendon was first installed in ducts;
(e) Reel number for strands;
(f) Tendon cross-sectional area;
(g) Modulus of elasticity;
(h) Date Stressed;
(i) Jack and Gauge numbers per end of tendon;
(j) Required jacking force;
(k) Gauge pressures;
(l) Elongations (theoretical and actual);
(m) Anchor sets (anticipated and actual);
(n) Stressing sequence (i.e. tendons to be stressed before and after;
(o) Stressing mode (one end/ two ends/ simultaneous);
(p) Witnesses to stressing operation (Contractor and inspector);
(q) Date grouted

Record any other relevant information. Provide the Engineer with a complete copy of all stressing and grouting operations.

I. Duct Pressure Field Test

After stressing and before grouting internal or external tendons, install all grout caps, inlets and outlets and test the tendon with compressed air to determine if duct connections require repair. In the presence of the Engineer, pressurize the tendon to 50 psi and lock-off the outside air

source. Record pressure loss for one minute. A pressure loss of 25 psi is acceptable for tendons having a length of equal to or less than 150 feet and a pressure loss of 15 psi is acceptable for tendons longer than 150 feet. If the pressure loss exceeds the allowable, repair leaking connections using methods approved by the Engineer and retest.

J. Tendon Protection

Within four hours after stressing, install grout caps and seal all other tendon openings. If acceptance of the tendon is delayed, seal all tendon openings and temporally weatherproof the open ends of the anchorage. If tendon contamination occurs, remove and replace the tendon.

SB-3.8 Grouting Operations

A. Grouting Operations Plan

Submit a grouting operations plan for approval at least six weeks in advance of any scheduled grouting operations. Written approval of the grouting operations plan by the Engineer is required before any grouting of the permanent structure takes place.

At a minimum, the plan will address and provide procedures for the following items:

(a) Names and proof of training for the grouting crew and the crew supervisor in conformance with this specification;
(b) Type, quantity, and brand of materials used in grouting including all certifications required;
(c) Type of equipment furnished, including capacity in relation to demand and working condition, as well as back-up equipment and spare parts;
(d) General grouting procedure;
(e) Duct pressure test and repair procedures;
(f) Method to be used to control the rate of flow within ducts;
(g) Theoretical grout volume calculations;
(h) Mixing and pumping procedures;
(i) Direction of grouting;
(j) Sequence of use of the inlets and outlet pipes;
(k) Procedures for handling blockages;
(l) Procedures for possible post grouting repair;
(m) Clean up and material recovery plan.

Before grouting operations begin, a joint meeting of the Contractor, grouting crew and the Engineer will be conducted. At the meeting the grouting operation plan, required testing, corrective procedures and any other relevant issues will be discussed.

B. Grout Inlets and Outlets

Ensure the connections from the grout pump hose to inlets are free of dirt and are air- tight. Inspect valves to be sure that they can be opened and closed properly.

C. Supplies

Before grouting operations start, provide an adequate supply of water and compressed air for clearing and testing the ducts, mixing and pumping the grout. Where water is not supplied through the public water supply system, a water storage tank of sufficient capacity must be provided.

D. Equipment

(1) General

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 gauge. 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.

Provide an air compressor and hoses with sufficient output to perform the required functions.

Provide vacuum grouting equipment (volumetric measuring type) and experienced operators within 48 hours notice.

(2) Mixer, Storage Hopper

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. 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) Grout Pumping Equipment

Provide pumping equipment capable of continuous operation which will include a system for circulating the grout when actual grouting is not in progress.

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.

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.

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.

A pressure gauge having a full scale reading of no more than 300 psi will be placed at the duct inlet. If long hoses (in excess of 100 feet) are used, place two gauges, one at the pump and one at the inlet.

The diameter and rated pressure capacity of the grout hoses must be compatible with the pump output.

(4) Vacuum Grouting Equipment

Provide vacuum grouting equipment consisting of the following:

(a) Volumeter for the measurement of void volume.

(b) Vacuum pump with a minimum capacity of 10 cfm (0.283 m^3m) and equipped with flow-meter capable of measuring amount of grout being injected.

(c) Manual colloidal mixers and/or dissolvers (manual high speed shear mixers), for voids less than 5.28 gal. (20 liters) in volume.

(d) Standard colloidal mixers, for voids 5.28 gal. (20 liters) and greater in volume.

(5) Stand-by Equipment

During grouting operations, provide a stand-by colloidal grout mixer and pump.

E. Grouting

(1) General

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 of0.5 gal and 6.5 gal and an accuracy of equal to or less than 4 oz.

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 devise volume and must verify the accuracy of the grout volume component of the vacuum grouting equipment within 5% of the test devise volume. Ensure the Engineer is present when any tests are performed.

Grout tendons in accordance with the procedures set forth in the approved grouting operation plan.

(2) 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 the concrete temperature surrounding the duct will fall below 40°F.

(3) Mixing and Pumping

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.

(4) Grout Production Test

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 the "POST-TENSIONING GROUT" section of these Specifications. Perform fluidity test for each tendon to be grouted and maintain the correct water to cementitious ratio. Do not use grout which tests outside the allowable flow rates.

Prior to grouting empty ducts, condition the grout materials as required to limit the grout temperature at the inlet end of the grout hose to 90°F. 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.

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 "POST-TENSIONING GROUT" section of these Specifications 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.

(5) Grout Operations

Open all grout outlets before starting the grouting operation. Grout tendons in accordance with the Grouting Operations Plan.

Unless approved otherwise 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 and 75 psi for flat ducts in deck slabs.

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.

Pump grout through the duct and continuously discharge it at the anchorage and grout cap outlets until all free water and air are discharged and the consistency of the grout is equivalent to that of the grout being pumped into the inlet. Close the anchorage outlet and discharge a minimum of 2 gallons of grout from the grout cap into a clean receptacle. Close the grout cap outlet.

For each tendon, immediately after uncontaminated uniform discharge begins, perform a fluidity test using the flow cone on the grout discharged from the anchorage 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 the "POST-TENSIONING GROUT" section of these Specifications. Alternately, check the grout fluidity using the Wet Density method contained in the "POST-TENSIONING GROUT" section of these Specifications. The measured density must fall within the values established in the sections above. 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 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 high points. After the minimum ten minutes period has expired, increase the pressure as needed and discharge grout at each high point outlet to eliminate any entrapped air or water. Complete the process by locking a pressure of 30 psi into the tendon.

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 outlet/inlet, which is to be used for pumping will be fitted with a positive shut-off and pressure gage.

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 in the "Grouting" section of these Specifications.

(6) Construction Traffic and Operations Causing Vibrations

During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from all sources such as moving vehicles, jackhammers, compressors, generators, pile driving operations, soil compaction, etc., that are operating within 300 feet down-station and 300 feet up-station of the ends of the span in which grouting is taking place.

(7) Post-Grouting Operations and Inspection

Do not remove or open inlets and outlets until the grout has cured for at least 24 hours. Remove all outlets located at anchorages and high points along the tendon to facilitate inspection and perform inspections within one hour after the removal of the inlet/outlet. Drill and inspect all high points along the tendon as well as the inlets or outlets located at the anchorages. Depending on the geometry of the grout inlets, drilling may be required to penetrate to the inner surface of the trumpet or duct. Use drilling equipment that will automatically shut-off when steel is encountered. Unless grout caps are determined to have voids by sounding, do not drill into the cap. Perform inspections in the presence of the Engineer using endoscopes or probes. Within four hours of completion of the inspections, fill all duct and anchorage voids using the volumetric measuring vacuum grouting process.

Seal and repair all anchorage and inlet/outlet voids that are produced by drilling for inspection purposes with an epoxy grout. Remove the inlet/outlet to a minimum depth of 2 inches. Use an injection tube to extend to the bottom of the drilled holes for backfilling with epoxy.

Post grouting inspection of tendons having a length of less than 150 feet may utilize the following statistical frequency for inspection:

(a) For the first 20 tendons, inspect all outlets located at anchors and tendon high points by drilling and probing with an endoscope or probe. If one or more of the inspection locations are found to contain a defect (void), continue testing all tendons until 20 consecutive tendons have been inspected and no voids have been found.

(b) When no defects are detected as defined in No. 1 above, the frequency of inspection can be reduced to inspect every other tendon (50%). If a defect is located, inspect the last

five tendons grouted. Return to step 1 above and renew the cycle of 100% tendon inspection.

If tendon grouting operations were prematurely terminated prior to completely filling the tendon, drill into the duct and explore the voided areas with an endoscope. Probing is not allowed. Determine the location and extent of all voided areas. Install grout inlets as needed and fill the voids using volumetric measuring vacuum grouting equipment.

(8) Grouting Report

Provide a grouting report signed by the Contractor and/or the Subcontractor within 72 hours of each grouting operation for review by the Engineer.

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.

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.

SB-3.9 Protection of Post-Tensioning Anchorages

As soon as possible but not to exceed 14 days after tensioning and grouting is completed, exposed end anchorages, strands, other metal accessories and concrete in and around blockout shall be cleaned by sandblasting or equal of rust, misplaced mortar, grout, and other such materials. The surfaces of concrete against which concrete encasement over anchorage assemblies is to be placed shall be abrasive blast cleaned and aggregate exposed. Immediately following the cleaning operations, the entire surface of the anchorage recess (all metal and concrete) shall be thoroughly dried and permanent grout caps shall be placed on each anchor head. A heavy unbroken coating of "wet-to-dry" epoxy bonding compound, per AASHTO M235, Class II, shall then be applied to all surfaces against which concrete or grout will
be cast.

At the Pier 1B diaphragm blockouts only, the following shall apply: Epoxy coated mesh shall be placed across the anchor head blockout and tied to the inplace reinforcement with plastic coated wire ties. Concrete shall then be placed in the anchorage blockouts per the Plan. After the concrete has cured, an

approved epoxy paint (which does not delaminate) shall be placed over the concrete blockout. The entire blockout plus at least 1 foot all around shall be covered as approved by the Engineer. This epoxy paint shall be applied in a manner and thickness as recommended by the manufacturer.

SB-3.10 Final Cleanup

Before Final Acceptance, the Contractor shall clean the interior of the concrete box girders of all rubbish, excess materials, loose concrete, grout, dirt, and debris. The interior of the box girders shall then be swept out. The final clean up shall be performed after all work on the interior of the box girders, including grouting of all tendons and electric work, has been completed.

SB-3.11 Basis of Payment

Payment for Item No. 2405.616 "POST-TENSIONING SYSTEM" will be made at the Contract Price per System and shall be full compensation for furnishing, installing, testing, shop drawings, stressing and grouting all post-tensioning tendons in accordance with the requirements of this Section. Payment includes anchorage assemblies, additional reinforcement for supporting ducts, lubricants, cleaning of ducts, grout and grouting, testing, anchorage protection systems, labor, materials, tools, equipment and incidentals necessary for completing the work in accordance with Contract requirements.

SB-4 (2402) STEEL BRIDGE CONSTRUCTION

This work shall be performed in accordance with the provisions of Mn/DOT 2402 except as modified below:

SB-4.1 Expansion Joint Devices

The following consists of fabricating waterproof expansion devices in accordance with 2402 and installing them at the locations shown in the Plan.

A. The Contractor shall:

1. Furnish a single diaphragm unreinforced neoprene gland whose physical and chemical properties conform to 3721 except:

(a) Do not use the requirements and test methods for the Compression-Deflection Characteristics and the Recovery Under Deflection specified in 3721.2A3 and

(b) Substitute Durometer requirement of 60 plus or minus 5 for that which is shown in 3721.2A3.

2. Make the gland ¼ inch thick, subject to a minimum thickness of 7/32 inch.

3. Submit 12 inches of seal material from each lot of material for testing if required by the Project Engineer.

4. Furnish certified test results from the manufacturer attesting to the physical and chemical properties of the expansion joint devices in accordance with 1603. Provide copies of the test results for the Project Engineer, the Materials Engineer, and the Structural Metals Engineer.

B. Provide only one of the devices shown on the Department's "Approved/Qualified Product Lists for Bridge Products, "Expansion Joint System" (http://www.dot.state.mn.us/products). For products not on the Department's prequalified list, provide information as required on the web site.

C. The Fabricator will be permitted to weld pre-galvanized sections of expansion device steel rail, complete with anchorages. If the steel rail is pregalvanized, the Fabricator shall:

1. Provide roadway sections that are not less than 10 feet long.

2. Provide an anchorage within 9 inches of each end of the sections. This may require inclusion of additional anchorages.

3. Bevel abutting ends ¼ inch on 3 edges and de-burr the edges.

4. Prepare the surfaces to be welded as per 2471.3F2.

5. Groove weld the sections on 3 sides and take care to prevent weld metal from entering the gland groove.

6. Grind the weld smooth that is across the top of the extrusion.

7. Repair the welded surface as per 2471.3L1.

D. Unless the gland is shop installed, the Fabricator shall install filler material in the gland groove in the steel rail to protect against entry of dirt and debris. Filler material shall be installed at the fabrication shop prior to storage or transportation of completed expansion device.

E. The Contractor shall:

1. Remove filler material and clean all neoprene to steel contact areas

of all dirt, oil, grease, or other contaminants before installing the neoprene gland.

2. Lightly sandblast the contact areas so as to roughen but not damage the galvanized surface just before applying the lubricant adhesive.

3. Apply lubricant adhesive on both neoprene and steel contact areas when installing the gland.

4. Install the gland with tools recommended by the manufacturer for gland installation (use of other tools is prohibited).

F. Lubricant Adhesive

The lubricant adhesive shall conform to the requirements of ASTM D 4070. Provide only one of the approved lubricant adhesives shown on the Department's "Approved/Qualified Product Lists for Bridge Products, "Expansion Joint Lubricant Adhesive" (http://www.dot.state.mn.us/products). For lubricant adhesives not on the Department's prequalified list, provide information as required on the web site.

G. All expansion joint cover plates on pedestrian bridges and sidewalk areas shall be raised pattern plate.

SB-4.2 Modular Bridge Joint System / Install Expansion Joint Devices

This work consists of furnishing and installing a waterproof modular bridge joint system (MBJS) at the expansion joint at Pier 1B and installing a modular bridge joint (furnished under the Phase I Contract) at Pier 4 on Bridge No. 27B60 (Phase 2). Perform the work in accordance with 2402, the Plans and the following:

A. General

These support bars are suspended over the joint opening by sliding on bearings contained within steel support boxes attached to the edge beams and cast into the bridge deck. A MBJS consists of preformed elastomeric expansion joint seals mechanically held in place by steel edge and center beams. Center beams are supported by solid steel support bars. MBJS can be classified as multiple or single-support bar and swivel joint systems. For Bridge No. 27B60, a multiple-support bar system shall be provided.

B. Acceptable Systems

Only manufacturers who have successfully completed fatigue and performance testing will be permitted to supply the MBJS. Submit final results of all required tests to the Engineer for approval prior to manufacture.

Provide only one of the devices shown on the Department's "Approved/Qualified Product Lists for Bridge Products, "Modular Bridge Joint System" (http://www.dot.state.mn.us/products). For products not on the Department's prequalified list, provide information as required on the web site.

C. Pre-qualification Testing Requirements

Before a MBJS can be accepted for installation on this Project, the design must be pre-qualified by the manufacturer through successful fatigue and performance testing administered by an independent testing laboratory. Fatigue and Performance testing shall be done in accordance with Section 9, Appendix A19 of the AASHTO LRFD Bridge Construction Specifications.

All testing shall be performed on a test specimen(s) of a model similar to that required of this Project. Successful testing will prequalify that model—with allowable variations—for the Project and no further testing will be required.

D. Materials

Materials for the MBJS shall meet the following physical and chemical properties:

1. Structural steel for the edge beams, center beams and support bars shall conform to 3309. Support boxes and anchorages shall conform to either 3306 or 3309. (Sidewalk and (railing) cover-plates shall conform to 3306). No aluminum components or hardware shall
be used.

2. Stainless steel sheet for the sliding surfaces of support bars shall conform to ASTM A 240, Type 304. The surface shall be polished to a Number 8 mirror finish.

3. Fasteners shall conform to the same requirements as those used in the prequalification tests.

4. Welded studs for anchorage purposes shall conform to ASTM A108.

5. Each elastomeric sealing element shall be a single-diaphragm unreinforced neoprene gland. Basic physical and chemical properties of the elastomer shall be in accordance with the requirements of ASTM D 5973.

   Each gland shall be ¼-inch thick, subject to a minimum thickness of 7/32-inch and shall provide a minimum of 3 inches of movement.

6. Polytetrafluoroethylene (PTFE) shall be unfilled 100% virgin material, woven fabric or dimpled sheet conforming to the requirements of Section 18.8 of the AASHTO LRFD Bridge Construction Specifications.

7. The same material composition and formulation, manufacturer, fabrication procedure and configuration of bearings and springs must be used as was used in the Pre-qualification tests.

8. Provide only one of the approved lubricant adhesives shown on the Department's "Approved/Qualified Product Lists for Bridge Products, "Expansion Joint Lubricant Adhesive" (http://www.dot.state.mn.us/products). For lubricant adhesives not on the Department's prequalified list, provide information as required on the web site. Lubricant/adhesive shall conform to ASTM D 4070.

9. Control springs shall be a urethane foam product that conforms to the requirements of ASTM D 3574.

E. Design and Detailing Requirements

1. Loading and Movement

   The MBJS shall be designed in accordance with Article 14.5 of the AASHTO LRFD Bridge Design Specifications.

   The theoretical longitudinal expansion joint movement for the full design ambient temperature range of 150°F, creep, and shrinkage is approximately 12 inches at Pier 1B and Pier 4.

   The MBJS shall be designed to accommodate the values shown on the plans. There shall be no physical contact of any beams at the minimum opening, and the maximum opening between beams shall be 3 inches measured perpendicular to the edge beams under

any condition.

2. Edge Beams

The edge beam cross-section shall be the same as the section used for the Seal Push Out Test for the performance testing.

Concrete anchorages for the devices shall be as shown in the Plans, or as modified by the manufacturer to be compatible with the devices furnished.

Modified anchorages shall be designed to resist vertical and horizontal forces from traffic, including impact. Horizontal elements of the edge beams shall also be anchored to resist the upward-acting impact (rebound) from wheel loads. If the skew is greater than 20 degrees, horizontal forces from impact from snowplows shall be considered in the design of the anchorages.

3. Support Boxes

Support boxes shall be made from steel plate or tubing with a minimum thickness of 3/8 inch. If the support boxes are greater than 16 inches wide, the thickness of the top plate shall be increased so that the width-to-thickness ratio does not exceed 45 unless stiffening ribs are used. For support boxes composed of nested steel tubes, the diameter or width-to-thickness ratio of each tube shall not exceed 45.

4. Bearings and Springs

The MBJS shall be designed to allow removal and replacement of the support bearings, bearing springs, control springs and elastomeric seal elements. A procedure for removal and replacement of these elements shall be given on the shop drawings.

Support bar bearings shall be positively locked into the support boxes with a non-metallic dowel or pin. The connection must permit removal and replacement of the bearing components.

Control springs for the equidistance control shall be situated on the MBJS so that the direction of resistance will be parallel to the direction of movement, and shall accommodate the full range of design movement without distress.

Replacement of parts subject to wear shall be provided for in the design. Submit a written maintenance and parts replacement plan

prepared by the MBJS manufacturer for the Engineer's approval. Include a list of parts and instructions for maintenance inspection, acceptable wear tolerances, methods for determining wear, and procedures for replacing worn parts.

5. Elastomeric Seals

Seals shall extend beyond the ends of the edge and center beams by, at least, 2 inches.

6. Field Splices in Edge and Center Beams

Each MBJS shall be fabricated and shipped to the Project site as a single unit unless any or all of the following conditions apply:

(a) The bridge will be constructed in stages with longitudinal construction joints.

(b) The full length of a MBJS would make shipping impractical.

(c) Other factors unique to the Project that would require field splices.

Only field splice details that have been designed in accordance with AASHTO LRFD Bridge Design Specifications can be used for the MBJS. Splices should be located away from wheel tracks and in areas of least live load stress. Edge beams may be field-welded with fillet welds covering only part of the beam profile.

Center beam splices shall be bolted connections consisting of side plates set in recesses machined out of the center beam profiles and cross-bolted with, at least, four bolts. After field assembly, the nuts shall be tack-welded to the bolt to prevent the nuts from backing off.

The span—between support beams—in which the field splices are located, shall be a maximum length of 3 feet.

If the MBJS contains only a single center beam, a welded field splice may be used in lieu of a bolted splice. Fillet or partial-penetration welds are not permitted.

The design of the MBJS shall take into account any different installation procedures required under conditions that require field

splices. Such procedures shall be clearly indicated on the shop drawings.

7. Lifting and Preset Opening Devices

Lifting devices shall be provided for the MBJS. Other devices to maintain the preset openings shall be provided at a uniform spacing not greater than 15 feet along its length. At least, three such devices shall be used per fabricated segment.

F. Submittals

1. In accordance with 1603, the Contractor shall furnish Certificates of Compliance to the Owner.

The Certificates of Compliance shall include the following additional information:

a. Certification that the control springs are produced by the same manufacturer with the same process and in the same configuration as those used in the OMV Test. Certification that the same lubricant adhesive used for the Seal Push Out Test was also used to assemble the MBJS. These certifications shall include the manufacturer's name and contact information as well as production date and lot identifiers;

b. Certification that MBJS sub-assemblies with similar center beam and support bar cross-sections and joints have passed pre-qualification testing requirements described in this section.

c. Design calculations sealed by a Licensed Professional Engineer;

d. A written maintenance and part replacement plan prepared by the MBJS manufacturer. This plan shall include a list of parts and instructions for maintenance inspection, acceptable wear tolerances, methods for determining wear, and procedures for replacing worn parts;

e. Method of installation including, but not limited to, sequence, installation gap setting for various temperatures, support during placement of the concrete, and installation at curbs;

f. Any required changes to the blockout reinforcement in order to accommodate the MBJS; and

g. A temporary bridging plan for any MBJS for which construction (and public) traffic is anticipated following installation.

2. The Contractor shall submit a 12-inch section of elastomeric seal material from each lot of material furnished, and samples of the PTFE sheet, size 2 inches x 3 inches x 1/8-inch from the production material; to the Engineer for testing.

3. Shop drawings for the MBJS shall be submitted in accordance with the requirements of 2471.3B and shall include, but not be limited to, the following additional items:

a. Plans and section views of the MBJS for each movement rating and roadway width showing dimensions and tolerances;

b. All welded center beam-to-support bar joints shall be shown;

c. All welded shop splices, and all welded and/or bolted field splices shall be shown;

d. Complete details of all components and sections showing all material incorporated into the MBJS;

e. All appropriate material designations (Mn/DOT, ASTM, AASHTO. etc.);

f. Corrosion protection system;

g. Lifting locations and lifting mechanisms for installation; and

h. Opening adjustment devices for temperature variations and opening dimensions relative to temperature.

G. Fabrication Requirements

All MBJS components shall be fabricated by the same manufacturer.

All structural steel surfaces, except those made of stainless steel, shall be galvanized after fabrication per 3394.

Stainless steel sheet shall be welded at each end to the steel substrate by the tungsten-arc welding process in accordance with the current AWS specification. The stainless steel sheet shall be clamped down to have full contact with the substrate during welding. Welds shall not protrude beyond the sliding surface of the stainless steel. Intermittent fillet welds will not be allowed.

The full-penetration weld that connects the center beam to the support bar shall be ultrasonically inspected in accordance with 2471 and AWS D1.1. Twenty-five percent of the center beam-to-support bar welds shall be tested, or as directed otherwise by the Engineer. If ultrasonic inspection reveals at least one rejectable weld defect, the fabricator shall then ultrasonically inspect another 25% of the center beam-to-support bar welds (25% of the original total of welds.) If rejectable defects are found in the second 25% set of welds (50% of total), all remaining non-inspected welds shall then be inspected. Each weld that is rejected by ultrasonic inspection shall be repaired using a welding procedure approved by the Engineer. The repaired welds shall then be retested by ultrasonic inspection in accordance with the original requirements.

The fabricator will be permitted to shop-weld pre-galvanized sections of the edge and center beams. If the steel beams are pre-galvanized, the fabricator shall:

1. Provide roadway sections that are not less than 10 feet long.

2. Bevel abutting ends ¼-inch and deburr the edges.

3. Groove-weld sections with care taken to prevent weld metal from entering the seal groove. All galvanizing shall be completely removed from the weld area. The weld across the top of the beams shall be ground smooth. All areas of galvanizing damaged by welding operations shall be repaired in accordance with 2471.3L1.

4. Attach anchorages and support boxes to the edge beam section prior to galvanizing. Provide an anchorage within 9 inches of each end of each pre-galvanized section.

(If field splices will be used, the ends of the edge and center beams shall be staggered so that they are not at the same point on each beam.)

Each MBJS shall be completely assembled at the fabrication shop. All elastomeric seals shall be installed at the shop. Seals shall be continuous for the full length of each MBJS. Lubricant adhesive shall be applied to all elastomer-to-steel contact areas for seal installation.

H. Installation Requirements

To aid in assuring proper installation of the MBJS, the manufacturer shall furnish technical assistance to the Contractor and Engineer through a technical representative who is a full-time employee of the manufacturer. The representative shall be accessible to the Engineer and shall be at the site during the work that involves the setting of all parts of each device.

The Contractor shall be responsible for informing the representative of the date of installation.

Immediately prior to installation, the MBJS and the blockout will be inspected by the Engineer for 1) proper alignment, 2) complete bond between the seals and the edge/center beams, and 3) placement and effectiveness of the anchorage devices. Bends, kinks, disconnected seals, and other deficiencies, in the judgment of the Engineer, shall be corrected by the Contractor before installation, and at no expense to the owner. Perform an audio hammer test on the welded stud anchors. Studs that do not emit a ringing sound when struck lightly with a hammer, shall be replaced as ordered by the Engineer.

The clearance shown in the Plans and/or shop drawings between the bottoms of the support boxes and the tops of the beams shall be maintained.

Reinforcement bars that are cast into the deck and abutment shall be repositioned, if possible, in lieu of cutting to provide a minimum of 2 inches of clearance to the support boxes, anchorage devices and edge beams. Also, a minimum of 2 inches of clearance shall be maintained for reinforcement bars placed during installation of the MBJS. Bar spacing shown in the Plans may be altered to clear the MBJS.

If welded field splices are used for the edge and center beams, care must be exercised to prevent weld metal from entering the seal retainer grooves.

Each MBJS shall be installed at the joint opening given on the shop drawings for a specific ambient temperature, or as adjusted by the manufacturer's installation technician for the temperature at time of installation. Tops of the edge and center beams shall be in the same plane with a maximum tolerance of 1/8 inch difference in elevation among the tops of the center beams or edge beams. This variation shall be measured vertically from a straight line connecting the top of the deck profile on each side of the MBJS. There shall be no more than 1/2 inch longitudinal difference among gap widths at either end of a seal or among multiple gaps.

Formwork for the blockout concrete shall prevent entry of concrete into the support boxes, and not allow concrete to impede free movement of the MBJS.

Fully support the MBJS during placement of the concrete in the blockout. Grout pads under the support boxes are not recommended, but if used, shall terminate beyond the sides of the support boxes.

No concrete shall be poured until the MBJS installation and joint opening(s)--at the time of the pour--has (have) been inspected and approved by the Engineer.

If there is a vertical grade on the bridge, concrete shall be placed on the down-grade side of the blockout first. The concrete shall be vibrated thoroughly so as to adequately consolidate the concrete underneath the support boxes and against the backside of the edge-beams.

Construction loads will not be allowed on the MBJS for at least 72 hours after installation, including concreting, is complete. If necessary to cross the joint during that 72-hour period, the Contractor shall bridge over the MBJS in a manner approved by the Engineer.

The complete MBJS installation shall be watertight at all points and shall be so tested by filling the joint opening, or portions thereof, as designated by the Engineer, with water and observing the results over a period of not less than one hour.

I. Installation of Joint at Pier 4

The Phase II Contractor shall install any reinforcement, not installed by the Phase I Contractor, in the Span 5 modular joint blockout as specified in the Phase I Plans and Rebar Shop/Placing Drawings. This reinforcement shall be provided by the Phase I Contractor for installation by the Phase II Contractor.

The Phase II Contractor shall install the joint to the movement setting as shown in the Phase II Contract Documents.

Concrete placed in the Span 5 blockout shall be provided by the Phase II Contractor and installed per the requirements of the Phase I Contract Documents. (Contract Documents and Shop Drawings will be supplied as necessary.) Concrete placed in the Span 4 blockout shall be provided by the Phase II Contractor and installed per the requirements of the Phase II Contract Documents

Concrete placed under the Phase II Contract shall be bonded to inplace concrete in accordance with 2404.2C.

The grout shall be brushed or scrubbed into the inplace concrete immediately prior to placement of new concrete.

New concrete shall be wet cured, in accordance with 2401.3G, until the concrete has reached 45 percent of the anticipated compressive strength. All strength gain percentages shall be derived from the strength gain chart

in Table 2401-1. The Engineer may allow control cylinders to be used to determine required strength gain, but in no case shall any curing be considered completed in less than 72 hours.

J. Method of Measurement

The MBJS furnished and installed at Pier 1B and the MBJS installed at Pier 4 will be measured by length in linear feet based on the out-to-out installed length of the device.

K. Basis of Payment

Payment for Item No. 2402.603 "MODULAR BRIDGE JOINT SYSTEM, TYPE 12" will be made at the Contract price per linear foot and shall be compensation in full for all costs of furnishing and installing the MBJS complete inplace as described above, including all incidentals thereto. Concrete required in the blockout area shall be paid for separately.

Payment for Item No. 2402.603 "INSTALL EXPANSION JOINT DEVICES" will be made at the Contract price per linear foot and shall be compensation in full for all costs of installing the MBJS furnished under the Phase I Contract, including installing rebar, and furnishing and placing concrete in the Span 5 blockout per the requirements of the Phase I Plans, and all incidentals thereto.

SB-4.3 Metal Railing

This work shall consist of furnishing, coating, and installing metal railing and ornamental fence, including all anchorages and fittings, in accordance with the applicable provisions of 2402, 2433, 2471, 2478, 2557, the Plans and the following. The Contractor is responsible for communicating all applicable specifications, special provisions and requirements to all subcontractors.

A. Materials

All materials shall be in accordance with the Plan details. If not specified, all steel shall comply with 3306, except that pipe and pipe sleeves shall comply with 3362. Threaded rods, bolts, nuts, and washers shall meet 3391 and shall be galvanized in accordance with 3392 or electroplated in accordance with ASTM B 633, Type III, SC 4.

B. Anchorages

Except when part of a proprietary anchorage assembly, threaded rods and bolts shall meet the requirements of 3385 and 3391, respectively.

Adhesive anchors may only be used on Item No. 2557.603 "ORNAMENTAL FENCE DESIGN SPECIAL A". All other anchors shall cast-in-place type anchorages unless otherwise noted in the plans.

If the Contractor chooses adhesive anchors for Item No. 2557.603 "ORNAMENTAL FENCE DESIGN SPECIAL A", the Contractor shall submit, for approval by the Engineer, the following chemical adhesive supplier's product literature or calculations to establish embedment depth. This information will demonstrate compliance with the specification:

Name of supplier
Full product name (as given in supplier's literature)
Embedment depth as determined from supplier's literature

Anchorages for fastening rail posts shall have an ultimate pull out strength, as specified in the Plan, and shall be installed in sound concrete to a depth equal to at least six times the rod or bolt diameter. Bolt heads and/or nuts shall be in contact with the adjacent surface and shall be torqued to approximately 80 foot pounds unless a different torque is recommended by the manufacturer. Adhesive anchorages shall consist of a continuously threaded rod secured by an adhesive or mortar.

Laboratory tests, that include static load tests for ultimate pullout strengths, shall be performed on anchorage systems that are subject to tensile loads. The tests, in accordance with ASTM E 488, shall be performed and certified by an independent testing laboratory. The Contractor shall furnish the Engineer with the test reports and the specification sheets that are prescribed by ASTM E 488.

The Contractor shall demonstrate the anchorage system for drilled-in anchorage systems at the first site of field installation prior to actual use in the Project. The demonstration shall include installation and a static tension test in the presence of the Engineer, in accordance with test procedures prescribed in ASTM E 488. No portion of the testing device shall bear on the concrete surface within a distance equal to the anchorage embedment depth. Three anchorages shall be tested to not less than 1/2 the required minimum ultimate pull out strength or the value given in Table 1, whichever is less. Failure of an anchorage test will require a modification of installation procedures or use of a different anchorage system.

In addition to the three tests stated above, the Engineer will require that each bridge have an additional 2% (not less than 1 test) of the remaining anchorages tested at a later date. The Engineer will determine the locations of the additional anchors. If a failure occurs while testing the

additional 2%, more testing will be required at the rate of an additional 1% per each failure at the Contractor's expense. Compensation for costs of testing is included in the payment for anchorage type reinforcement bars.

Location	Bolt or Rod Diameter inches	Minimum Embedment Depth inches	Ultimate Pull-out Strength pounds
Ornamental fence Design Special A	5/8”	5”	17,000

TABLE 1

ANCHOR ROD PROOF LOADS, KN (**kips**)
TYPE OF ROD, FROM SPEC. 3385

DIA., mm (inches)	**TYPE A**	**TYPE B**	**TYPE C**	**TYPE D**
13 (**1/2"**)	21.0 (**4.75**)	25.0 (**5.7**)	45.0 (**10.1**)	22.0 (**4.9**)
16 (**5/8"**)	33.0 (**7.4**)	39.5 (**8.9**)	70.0 (**15.8**)	34.0 (**7.6**)
19 (**3/4"**)	47.0 (**10.6**)	56.0 (**12.6**)	101.0 (**22.8**)	49.0 (**11.0**)
22 (**7/8"**)	65.0 (**14.5**)	77.0 (**17.4**)	138.0 (**31.0**)	67.0 (**15.0**)
25 (**1"**)	85.0 (**19.0**)	100.0 (**22.6**)	180.0 (**40.5**)	86.0 (**19.5**)

Installation of anchorages shall be in accordance with the manufacturer's recommendations and as specified in the Plan.

Any voids occurring between the top of the anchorages and the concrete in which it is embedded shall be filled with caulk approved by the Engineer.

C. Fabrication and Inspection Requirements

All metal railing shall be fabricated in accordance with 2471 and the Plan. The welding code shall be AWS D1.1-Structural Welding Code-Steel. Welding Procedure Specifications (WPSs) shall be submitted to the Engineer, for approval, prior to the start of fabrication.

Prior to fabrication the Contractor shall submit a Quality Control Plan (QCP) and fabrication drawings that are acceptable to the Engineer. Any work started prior to receiving approved drawings WPSs, and a QCP, shall

be subject to 1512. The Contractor shall also give the Engineer at least five (5) working days notice prior to beginning work so that Quality Assurance (QA) inspection may be provided.

All metal railing will be inspected by the Engineer. The purpose of the inspection(s) is to establish compliance with the Contract Documents. The shop inspection(s) is not intended to supplement or replace the Contractor's own Quality Control (QC). The Contractor is ultimately responsible for the correction of errors and faulty workmanship or for the replacement of nonconforming materials.

All parts of the fabrication are to be visually inspected and the inspections are to be documented by the Contractor's QC personnel. Any Nondestructive Testing required by the Contract Documents shall be performed and documented by an ASNT-TC-1A Level II qualified inspector.

Parts found to be in nonconformance shall be documented by using a Nonconformance Report form (NCR). The NCR shall describe in detail the fabrication error and the proposed repair procedure(s) in accordance with the QCP. Repair(s) performed shall be subject to the written approval of the Engineer.

D. Coating Requirements

All railing material shall be galvanized in accordance with 3394 after fabrication and painted (Duplex Coated) using the applicable provisions of 2478. The primer coat shall not be used on galvanized surfaces. For Item No. 2402.584 “STRUCTURAL TUBE RAILING DESIGN WYOMING” the color of the finish coat shall match Federal Standard 595 B No. FS 26300, Aircraft Exterior Gray and have a semi-gloss finish. For Item No. 2402.583 “ORNAMENTAL METAL RAILING TYPE SPECIAL 1”, Item No. 2557.603 “ORNAMENTAL FENCE DESIGN SPECIAL A” and Item No. 2557.603 “ORNAMENTAL FENCE DESIGN SPECIAL B” the color of the finish coat shall match Federal Standard 595 B No. FS 26081, Dark Gunship Gray and have a semi-gloss finish.

Pre-Galvanized Procedure(s):

1. Calibrate dry film thickness gages in accordance with SSPC-PA 2-Measurement of Dry Coating Thickness with Magnetic Gauges.

2. Prepare all fabricated material surfaces by abrasive blast cleaning to a minimum of SSPC-SP 6/NACE No. 3-Commercial Blast Cleaning, prior to galvanizing.

3. Purchase Order(s) shall inform the galvanizer as to which specific items are going to be duplex coated so that they may comply with any additional cleaning required to meet the "Post Galvanizing Procedures", and, as necessary, meet the visual requirements of aesthetic, ornamental products. The galvanizer shall also be informed which materials, to be galvanized, are reactive (e.g. 3309, etc.).

Galvanizing Procedure(s):

1. All metal railing to be galvanized will be processed utilizing a "dry" kettle. The metal railing shall be prefluxed prior to the galvanizing bath using an aqueous tank of zinc chloride/ammonium chloride.
The use of a "top flux" blanket on the molten zinc bath will not be permitted.

2. Air cool the metal railing to ambient temperature before handling for shipment and/or storage. Do not quench the metal railing or apply any post-galvanizing treatments.

3. Lumps, projections, globules, or heavy deposits of zinc, which will interfere with the "intended use of the product", will not be permitted. Damage to the galvanized zinc coating resulting in uncoated "black" and/or bare areas, blisters, flux deposits, and dross inclusions will also be considered unacceptable. Galvanized material that does
not meet the requirements of 3394, shall be repaired in accordance with the methods described in ASTM A780. Required repair(s) may be subject to written approval of the Engineer. "Intended use of the product" shall be defined as surface conditions that, when painted, will produce acceptable aesthetic and/or visual qualities.

4. Galvanized metal railing shall be stored in a manner that will prevent the formation of "white-rust" or wet storage painting. "White rust" or staining of the galvanizing is not acceptable. A written repair procedure shall be subject to the approval of the Engineer. All repairs shall be performed at no expense to the owner.

5. The galvanizer shall provide the Engineer with all galvanizing process-related Quality Control documents prior to shipment of the galvanized product. These documents shall include the following: coating material certifications, visual examinations, and coating thickness examinations.

6. The galvanized metal railing shall have a straightness tolerance of 1/8 inch in 10 ft, prior to any subsequent paint applications. Any galvanized metal railing not meeting this tolerance shall be straightened.

7. It is the galvanizer's responsibility to provide the Engineer with advanced notification of at least 5 working days of intent to ship so that the Engineer can perform a Quality Assurance audit.

Post Galvanizing Surface Preparation:

1. Preparation of galvanized surfaces for painting shall be in accordance with ASTM D6386.

Paint Application:

1. Surface cleaning shall be by the solvent cleaning method and surface preparation shall be performed by sweep blasting.

2. All sweep blasted galvanized railing shall be coated with the subsequent coat(s) within the time frame defined in ASTM D 6386, Sect. 5.4.1, or within the same 8-hour shift, maintaining manufacturer defined control and environmental conditions. The Contractors QC personnel shall document that all parameters were followed.

3. All coating material shall be applied in accordance with the contract documents and the manufacturer's Product Data Sheet (PDS) and application guides for the material and system specified.

4. Coating material(s) shall meet the requirements of 3520. The color of the intermediate coat shall present a distinct contrast from other applied coatings.

5. QC Inspections of all coated products shall be accomplished by an observer with normal color vision, in a "well lighted" area, during each coating phase and prior to final acceptance.

   "Well-lighted" shall be defined as a minimum of 50 foot candles of artificial light or natural daylight. A light meter with readings in foot candles shall be used to verify the adequacy of the lighting.

Handling and Shipping of Coated Metal Railing:

All completed, fabricated, and coated metal railing shall be protected during handling, and shipping, to prevent any damage to the coating(s).

Coated metal railing shall not be moved or handled until the coating has cured, but in no case sooner than recommended by the coating manufacturer.

Metal railing may be padded to protect it from direct contact with wood, steel, or other packaging materials that could scratch, mar or otherwise damage the final coated railing finish. Softeners may be used in conjunction with high-density foam or other acceptable packaging materials at all points of contact.

Storage of Coated Metal Railings:

All completed coated metal railing shall be stored in accordance with 1606 and the following:

1. All railing shall be clearly tagged/piece marked by the fabricator prior to final storage. Identification markings shall include, as a minimum: individual piece marks, bridge and/or project number(s), fabricator and applicator job numbers. All marking(s) shall not be visible to the public when the railing is in its installed position. The method of identification shall be included in the fabricators QCP.

2. It is the Contractor's responsibility to provide the Engineer with advance notification of at least 5 working days of intent to ship, so that the Engineer can perform a QA audit prior to shipping.

E. Construction Requirements

The steel posts shall be adjusted to obtain the grade and alignment as shown in the Plans by one of the following methods:

1. The steel posts shall be shimmed with steel shims or washers to the proper grade and alignment, not to exceed ¼- inch of shim height. Before attaching the nuts, coat the surface between the base plate and concrete rail with an approved silicone caulk. Tighten the anchor rod nuts (as per section "B"-Anchorages) and neatly smooth the caulk around the perimeter of the rail post base plate.

2. The anchor rods shall have leveling nuts threaded on them and turned down to the base of the anchor rods. The rails shall be installed and the steel posts set to the proper grade and alignment by adjusting the leveling nuts. Install the top nuts and tighten them firmly to the base plate. The space between the base plate and the concrete shall be filled and neatly finished with grout that is approved by the Engineer.

Ground all metal railings. Install all electrical grounding in accordance with the applicable provisions of Mn/DOT specification 2557 and the National Electrical Code. Clamp or braze the ground wires to the grounding device, then practicably route and attach to the nearest rail by clamping, brazing, or any other approved means that will provide a permanent positive connection. If rail has non-continuous sections, use a #6 AWG solid copper wire to connect adjacent railing panels.

Ground the rails at points directly below or adjacent to the railing at locations specified in the Plans. The grounding system will consist of a #6 AWG solid copper wire connected to the railing which in turn is connected to a copper coated steel rod having a nominal diameter of 5/8 inch or more and a minimum length of 8 feet installed to an elevation approximately flush with the ground surface.

If the bridge includes exposed electrical equipment, such as roadway lighting, traffic signals, variable message signs, surveillance cameras, or ramp metering, then bond the railing grounding system to the exposed electrical equipment grounding system. Refer to the electrical plans and electrical special provisions for details regarding bonding multiple electrical grounding systems.

Splice railings at the Pier 4 expansion joint with railings constructed under the Phase I Contract in accordance with the details shown in the Plans. The Contractor is responsible for verifying the fit-up between railings and railing splices provided under the Phase II contract and railings installed under the Phase I Contract. Any modifications to the plan details required for the fit-up between Phase I and Phase II railings shall be approved by the Engineer and at the Contractor's expense.

F. Repairs of Coated Steel Railings:

Any damaged coated surfaces, identified through either Quality Control or Quality Assurance inspections as being unacceptable, either after the application of the paint or after shipping and handling, shall be subject to the provisions of 1512.

G. Method of Measurement

Measurement will be by length in feet based on Plan dimensions according to the following:

(1) For Item No. 2402.583 "ORNAMENTAL METAL RAILING TYPE SPECIAL 1": Payment length will be measured between the centerline of Pier 4 and the east side of the Pier 1A & 1B concrete bridge head.

(2) For Item No. 2402.584 "STRUCTURAL TUBE RAILING TYPE WYOMING". Payment length will be measured between the centerline of Pier 4 and the end of tubing on the concrete parapet.

(3) For Item No. 2557.603 "ORNAMENTAL FENCE DESIGN SPECIAL A". Payment length will be measured between the centerline of the end post and the end of railing cantilever at the West Abutment.

(4) For Item No. 2557.603 "ORNAMENTAL FENCE DESIGN SPECIAL B". Payment length will be measured between the centerline of the West Abutment Expansion Joint and the west side of the concrete bridge head.

H. Basis of Payment

Payment for Item No. 2402.583 "ORNAMENTAL METAL RAILING TYPE SPECIAL 1", Item No. 2402.584 "STRUCTURAL TUBE RAILING DESIGN WYOMING", Item No. 2557.603 "ORNAMENTAL FENCE DESIGN SPECIAL A" and Item No. 2557.603 "ORNAMENTAL FENCE DESIGN SPECIAL B" will be made at the contract price per foot and shall be compensation in full for all costs of fabrication, galvanizing, surface preparation, painting, delivery, and installation, as described above. Failure to comply with any of these requirements will result in rejection of the material and/or reduction in payment.

SB-4.4 POT BEARING ASSEMBLIES

Description of Work

This work consists of furnishing pot bearing assemblies at Pier 1A, Pier 2, Pier 3, and Pier 4. At the Contractor's option, PTFE/Elastomeric or Disc bearings may be used as an alternate style. PTFE/Elastomeric or Disc bearings shall provide the same capabilities as specified for the three types of pot bearings. All bearing assemblies on Piers 1A, Pier 2, and Pier 3 shall be of one style, alternate styles will be permitted at Pier 4. All bearings located on Pier 4 shall be of one style. The requirements for PTFE/Elastomeric and disc bearings are specified in the 'PTFE/Elastomeric Bearings' and the 'Disc Bearings' sections below.

The work shall be performed in accordance with the applicable requirements of Mn/DOT 1703, 2402, the Plans, and the following:

General

A. Bearing Types

Three types of bearings are specified in the Plans; fixed, guided and non-guided bearings, all of varying load capacities. The bearings are defined as follows:

1. Fixed bearings shall allow rotation in the vertical plane, but no longitudinal or transverse movement in the horizontal plane.

2. Guided bearings shall allow rotation in the vertical plane and movement in a horizontal plane in the (longitudinal) (transverse) direction of the bridge. Horizontal movement in a direction (transverse) (longitudinal) to the bridge shall be restricted.

3. Non-guided bearings shall allow rotation in the vertical plane and horizontal movements in all directions.

B. Shop Drawings

Shop drawings for the bearing assemblies shall include, but not be limited to, the following:

1. Complete details of all components and sections showing all materials used in the bearing assemblies.

2. A listing of all applicable Mn/DOT, ASTM and AASHTO specifications.

3. Load capacity for each bearing assembly.

4. Name and address of the manufacturer, and location of the fabrication plant.

5. Name and telephone number of the manufacturer's representative who will be responsible for coordination of production, inspection, sampling and testing.

6. Welding procedures used in the bearing assembly manufacture shall be clearly described and detailed.

7. Longitudinal offsets for installation shall be shown based on the permanent and thermal movements shown in the plans.

8. Removal sequence for the elements described in the “Design and Fabrication Requirements” Section below.

Supplemental to the shop drawings, design calculations shall be furnished which indicate that the bearings furnished by the manufacturer are adequate for the requirements of the Contract. Calculations shall include rotation and horizontal movement capacity; and compression stresses on all elastomeric and sliding surfaces.

An erection plan showing the location, orientation, and longitudinal offset of each of the bearings shall be furnished to the Engineer at or before the time of delivery.

C. Bearing Dimension Options

Overall heights of the bearing assemblies, including the sole plates, are given in the Plans. The bearing manufacturer shall determine the thickness of the masonry and sole plates through design of the bearing assemblies and set the final height – Dimension 'H'--of each of the assemblies.

Dimensions given for the masonry plates may be changed by the manufacturer in accordance with design. Anchor blockouts shall be coordinated to avoid causing interference between the anchor rods and the pier reinforcement.

Anchor blockouts for the bearings at Pier 4 have been provided under the Phase I Contract. Masonry plates supplied under this Contract shall accommodate the anchor locations provided in Pier 4. The Contractor shall verify the location of the anchor blockouts prior to fabrication of the bearings at Pier 4.

If the final height of the bearing assemblies is different from that given in the Plans, the manufacturer shall clearly indicate the revised Dimension "H" and provide new bearing seat elevations to the Engineer.

D. Design and Fabrication Requirements

Design of the bearings shall be such that the pot cylinder and piston assembly of pot bearings, and the disc and both mating surfaces of disc bearings, can be removed for replacement or repair. Shop Drawings shall clearly show the bearing removal sequence.

Provide for all vertical and lateral loads, movements from temperature changes, rotation, camber changes, and the effects of creep/shrinkage of post-tensioned concrete box girders. Service limit state design loads and movement values are given in the Plans.

All materials used in the manufacture of pot and disc bearings shall be new and unused, with no reclaimed material incorporated into the finished product.

Stainless steel sliding surfaces shall be sized to completely cover the PTFE surfaces in all operating positions plus one additional inch in all directions of movement—as given in the Plans—except transversely in guided bearings.

Do not start fabrication of the bearing assemblies until the shop drawings have been approved by the Engineer.

Pot Bearings

Pot bearings shall consist of a confined elastomeric element encased in steel, the function of which is to transfer loads and accommodate relative movement, including rotation, between the bridge superstructure and the piers and abutments.

All material shown in the Plans for a single pot bearing unit shall make up an assembly.

Pot bearings shall be produced by a firm specializing in the design and manufacture of pot bearings, with a minimum of eight years of successful bearing installations.

Design, fabrication and testing shall be in accordance with the requirements of **AASHTO LRFD Bridge Design Specifications, Article 14.7.4 Pot Bearings** and the **AASHTO LRFD Bridge Construction Specifications, Article 18.3, Pot and Disc Bearings,** as modified herein.

Brass sealing rings shall be rectangular cross-section conforming to Article 14.7.4.5.2., with no less than *three* (3) rings per bearing assembly.

The Engineer shall be provided with written notification of bearing testing at least 30 calendar days prior to the start of testing operations.

PTFE/Elastomeric Bearings

PTFE/Elastomeric Bearings shall consist of a PTFE sliding surface to accommodate the required horizontal movements and an unconfined elastomeric element to accommodate the required vertical loads and rotational movements.

PTFE/Elastomeric bearings shall be produced by a firm specializing in the design and manufacture of PTFE/Elastomeric Bearings, with a minimum of eight years of successful bearing installations.

Fabrication and testing shall be in accordance with the requirements of these Specifications, the Plans, and the AASHTO LRFD Bridge Construction Specifications, Section 18, Bearing Devices as modified herein.

The Engineer shall be provided with written notification of bearing testing at least 30 calendar days prior to the start of testing operations.

Disc Bearings

Disc bearings shall consist of an elastomeric structural rotational element (disc) confined by upper and lower steel bearing plates plus masonry and sole plates. The function of the bearings is to transfer loads and accommodate relative movement, including rotation, between the bridge superstructure and the piers.

Disc bearings shall be produced by a firm specializing in the design and manufacture of disc bearings, with a minimum of eight years of successful bearing installations.

Design, fabrication and testing shall be in accordance with the requirements of the **AASHTO LRFD Bridge Design Specifications, Article 14.7.8, Disc Bearings** and the **AASHTO LRFD Bridge Construction Specifications, Article 18.3, Pot and Disc Bearings,** as modified herein.

The Engineer shall be provided with written notification of bearing testing at least 30 calendar days prior to the start of testing operations.

Fabrication of the disc bearings shall conform to the applicable requirements of Article 18.3.3.

Method of Measurement

Bearings will be measured by each individual unit which shall consist of all components shown in the Plans or on the approved shop drawings for a single bearing assembly, whether it is a Pot, PTFE Elastomeric, or Disc bearing.

Basis of Payment

Payment for Item No. 2402.602 "POT-TYPE BEARING ASSEMBLY" will be made at the Contract price per each and shall be compensation in full for all costs of furnishing and installing bearing assemblies--whether it be a Pot, PTFE Elastomeric, or Disc bearing--as described above.

SB-5 ACCESS DOOR

Description of Work

This work shall consist of furnishing and installing a lockable, steel, double access door in Pier 1A per the Plans and these specifications.

SB-5.1 Hollow Metal Door and Frame

Reference Standards:

The Metal Door and Frame will conform to the following:

A. ANSI A250.3 - Test Procedure and Acceptance Criteria for Factory-Applied Finish Painted Steel Surfaces for Steel Doors and Frames; 2007.

B. ANSI A250.8 - SDI-100 Recommended Specifications for Standard Steel Doors and Frames; 2003.

C. ANSI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 1998 (R2004).

D. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2007.

E. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames; 2006.

F. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.

Shop Drawings

Submit shop drawings for the Access door to the Engineer for approval in accordance with the requirements of 2471.3B.

Steel Doors and Frames

The Contractor shall provide an exterior type, steel, double door and frame to fit the opening size in Pier 1A as shown in the plans. The door and frame will meet the following:

A. Swing: The door will open into the enclosed Pier 1A & 1B structure.

B. Core: Polystyrene foam

C. Galvanizing: All components will be hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A 653/A 653M, with manufacturer's standard coating thickness.

D. Texture: Smooth faces.

E. Finish: Factory primed and painted to match the color of the Special Surface Finish applied to the concrete surfaces of Pier 1A.

F. ANSI A250.8 Level 3 Doors: 14 gage frames.

Accessory Materials

Grout for Frames: Portland cement grout of maximum 4-inch slump for hand troweling; thinner pumpable grout is prohibited.

Finish Materials

A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.

B. Factory Finish: Complying with ANSI A 250.3, manufacturer's standard coating of color as selected.

C. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

Installation

A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

B. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.

C. Coordinate frame anchor placement with Pier 1A construction.

D. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

E. Coordinate installation of hardware.

F. Touch up damaged factory finishes.

G. Adjust for smooth and balanced door movement.

SB-5.2 Door Hardware

Reference Standards

Door Hardware will conform to the following:

A. BHMA Directory of Certified Products: Builders Hardware Manufacturers Association.

B. ANSI/BHMA A156: BHMA Standards

C. Door and Hardware Institute (DHI) Publication "Installation Guide for Doors and Hardware"- 1994 Edition.

D. DHI Publication "Sequence and Format for the Hardware Schedule"

E. ANSI A117.1- Accessible and Usable Buildings and Facilities- 1998 Edition.

Shop Drawings

Shop drawings for door hardware will be submitted with shop drawings for the Steel Door and Frame to the Engineer for approval in accordance with the requirements of 2471.3B. The shop drawings will include a detailed, vertical type hardware schedule conforming to DHI publication, "Sequence and Format of the Hardware Schedule". Prepare schedule under the direct supervision of an Architectural Hardware Consultant (AHC). On existing openings, field-verify swings and functions prior to submitting schedule. Hardware schedules submitted without the AHC's signature will be rejected without review.

A. List and describe the opening; include degree of swing, and hand.

B. List all hardware items; include manufacturer's name, quantity, product name, catalog number, size, base metal, finish, fasteners and related details where applicable.

C. List related details; include dimensions, door and frame material and other conditions affecting hardware.

Quality Assurance

Where items of hardware are not definitely or correctly specified and is required for the intended service, such omission, error or other discrepancy should be directed to the Owner prior to the bid date for clarification. Otherwise, furnish such items in the type, quality and quantity established by this specification for the appropriate service intended.

Supplier Qualifications:

A. Commercial hardware supplier who maintains and operates an office and stocking warehouse in the project area for at least two years and can document experience with projects of similar type and scale.

B. Supplier to employ Architectural Hardware Consultant (AHC) as recognized by DHI for the purpose of overseeing the scheduling, coordinating hardware, establishing keying schedule, and be available during the course of construction to consult with Contractor and Owner about the mechanical door hardware specified. Persons not in the direct employ of the supplier shall not be considered as meeting this requirement.

C. Hardware Schedule shall be prepared under the direct supervision of and signed by an AHC.

Installer's Qualifications:

Firm with 3 years experience in installation of similar hardware to that required for this Project and the successful completion of not less than 5 comparable scale projects.

Post-Installation Walk Through:

After installation of hardware, coordinate with hardware supplier and Manufacturer's representative of continuous hinges, locks, closers and exit devices. Inspect hardware for proper installation and function. Document compliance. Hardware supplier and Manufacturers representative shall then meet with the Owner to explain functions, use and maintenance of all types of hardware installed.

Delivery, Storage, and Handling

A. Deliver products in original unopened packaging with legible manufacturer's identification.

B. Package hardware to prevent damage during transit and storage.

C. Mark hardware to correspond with approved Hardware Schedule.

D. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

E. Compare delivered hardware to Approved Hardware Schedule. Report any shortages or damaged materials to Architect and Supplier within 24 hours
of delivery. Shortages not reported will be the Contractor's responsibility.

F. Store hardware in a secured and dry environment to protect against loss, theft and damage.

Warranty

The Manufacturer's publicly published warranty must be greater than or equal to five (5) years.

Maintenance Service

Maintenance Tools and Instructions:

Furnish complete set of specialized tools and maintenance instructions as needed for the Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

Maintenance Service:

Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of door hardware installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door hardware operation. Provide parts and supplies same as those used in manufacture and installation of original products.

PRODUCTS

Fasteners:

A. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.

B. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors. Finish screw heads to match surface of hinges.

Hinges:

A. Butts and Hinges: BHMA A156.1. Listed under Category A in BHMA's "Certified Product Directory."

B. Hinge Sizes: Provide the following hinges in widths sufficient to minimally clear trim.

Thickness	Size
1-3/4 inch Doors	4-1/2 inch by 4-1/2 inch

C. Furnish butt hinges for each door leaf as follows:

1. 1 pair per leaf for openings through 60 inches high.

2. 1 additional hinge per leaf for each additional 30 inches in height or fractions thereof.

3. 1 additional hinge for doors 3'-6" wide to 4'-0" wide.

4. 1 additional hinge for exterior and vestibule doors.

D. Applications:

1. Exterior in swinging doors and vestibule doors: Type 4.

2. Exterior and reversed beveled interior lockable doors: Non-removable loose pin (NRP) hinges.

E. Acceptable Manufacturers and Products or Approved Equal:

Type	Bommer	Hager	McKinney	Stanley
Type 4	BB5004	BB1168	T4A3786	FBB168

Continuous Hinges:

Acceptable Manufacturers and Products or Approved Equal:

	Hager	McKinney	Pemko
Aluminum Geared	780-224HD	MCK-25HD	CFSM-HD

Flush Bolts and Dust Proof Strikes:

A. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1; designed for mortising into door edge.

B. Manual Flush Bolts: BHMA A156.16, Grade 1; designed for mortising into door edge.

C. Acceptable Manufacturers and Products or Approved Equal:

	DCI	Hager	Ives	McKinney	Trimco
Manual-Metal Door	780F	282D	FB458	FB01M	3917
Dust Proof Strike	82	280X	DP2	DPS1	3911

Lock sets/Latch sets:

A. Provide wrought boxes and curved lip strikes with lip length sufficient to minimally clear trim.

B. Heavy Duty Mortise Type:

1. Comply with ANSI/BHMA A156.13 requirements Series 1000

Operational Grade 1 mortise locks.

2. Provide locks and latch sets in the function as specified in function.

3. As specified in hardware sets.

4. Provide locks with corrosion-resistant stamped steel case.

5. Comply with ICC/ANSI A117.1 accessibility requirements.

6. Provide locks with reversible handing of lock without disassembly of lock.

7. Acceptable Manufacturers and Products or Approved Equal:

	Corbin-Russwin	Sargent	Schlage	Yale
Lock	ML2000	8200	L-9000	8800FL
Trim-Sect.	PSA	LNP	17A	PBR

Thresholds, Weatherstripping, and Gasketing:

A. Thresholds: Provide full-saddle type threshold unless floor conditions dictate or detailed otherwise.

1. Provide flat saddles at fire rated doors where combustible material is indicated on both sides.

2. Provide rain drip only at un-covered exterior doors.

3. Acceptable Manufacturers and Products or Approved Equal:

	McKinney	National Guard	Pemko	Reese
5 inch X 1/2 inch Saddle	MCK171	425	171	S205
Sweeps	MCK3452	C627	3452	354
Weatherstrip	MCK303 APK	135 NA	303 APK	815
Rain Drip	MCK346	16	346	R201
Gasket	MCKS88	2525	S88	797

B. Head and Jamb Gasketing:

1. Coordinate with door manufacturer. Comply with UL10C for intumescent fire and smoke material.

2. Provide smoke gasket at each labeled opening similar to

McKinney MCKS88

Fabrication

A. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

B. Fasteners: Provide screws per commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

Finishes

A. Standard: BHMA A156.18, as indicated in door hardware sets.

B. Exposed Metal Finishes: US26D = Satin Chrome,
US32D = Satin Stainless Steel

1. Hinges-Exterior US32D

2. Locksets US26D

3. Pushes, Pulls, Kick Plates US32D

Keying

A. Establish new, factory- generated master key system. Provide Utility-patented I/C core cylinders factory keyed as directed by Owner. The Owner will supply system expansion requirements.

Acceptable Manufacturers and Products or Approved Equal:

Utility Patented	Corbin-Ruswin	Sargent	Schlage	Yale
Keyway	Pyramid	Signature	Primus	Keymark

B. Cylinders: Interchangeable core, with cylinder collars solid and recessed to allow cylinder face to be flush and be free spinning. Provide temporary keyed construction cores for doors.

C. Keys: Provide factory-cut keys that are nickel silver and furnished with a large bow. Provide industry standard visual key control stamping for each

permanent cut key. Furnish 6 Master Keys and 10 extra key blanks. Ship permanent cylinders, keys, and system support material to hardware supplier. Forward Owner's Key System Registration Certificates, which are to accompany each procurement during construction period, to hardware supplier.

Installation

A. Steel Doors and Frames Preparation: Comply with DHI A115 Series.

B. Surface-Applied Door Hardware Preparation: Drill and tap doors and frames per ANSI A250.6.

C. Mounting Heights: Mount door hardware units at heights indicated and comply with DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames"

D. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3. Thresholds: Set thresholds in full bed of sealant complying with Manufacturer's recommendations.

E. Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

Basis of Payment

Payment for Item No. 2402.602 "ACCESS DOOR" will be made at the contract price per each and shall include all costs associated with furnishing and installing the access door in Pier 1A.

SB-6 (2404) CONCRETE WEARING COURSE FOR BRIDGES

The provisions of Mn/DOT 2404 are modified and/or supplemented with the following:

SB-6.1 Concrete Wearing Course 3U17A

The provisions of 2404 shall apply except as modified herein.

Add the following to 2404.3A:

Special precautions shall be taken to control and abate the dust generated by the blasting operation in accordance with MPCA Rule 7011.0150 https://www.revisor.leg.state.mn.us/rules/?id=7011.0150. The Contractor shall submit his/her proposed plan for dust abatement at least 14 days before the start of this work. This abatement plan shall include, but not necessarily be limited to, the following operations and procedures:

A. The bridge and approach slab shall be thoroughly swept prior to blasting. A power sweeper shall use the least amount of water necessary to minimize the dust from the sweeping operation.

B. The blast wheel or blasting nozzle or nozzles shall be enclosed in a housing, or directed into a housing. The housing shall have a negative air emission control system that draws the confined air and dust into an adequate filter collection system. The capacity of the exhaust system shall be sufficient to readily relieve the pressure generated within the housing by the blasting equipment. The filter collection system shall be cleaned, as necessary, to assure proper filtration. The sides and corners of the housing shall be
flexible at the bottom to the extent that the bottom of the housing shall be in contact with the deck surface during all blasting operations.

C. The housing and/or filter collection system shall be constructed, maintained, and operated so that avoidable dust emissions are eliminated.

D. After blasting, the prepared surface shall be thoroughly hand swept or swept with a "Pickup" type power sweeper equipped with adequate dust storage capacity. All minor debris remaining after the sweeping operation shall be completely removed by air blasting. The air supply system shall be so constructed that a suitable oil trap is placed in the air supply line between the storage tank and the nozzle.

Measurement will be made by the area, in square feet, based on the bridge roadway dimensions between gutter lines and from the centerline of Pier 4 to end of the approach panel.

Payment for performing this work, as described above, will be made under Item No. 2404.618 "BLASTING (SPECIAL)", at the Contract price per square foot.

SB-6.2 Texture Planing of Bridge Slabs

Delete the 16th paragraph of 2404.3A and substitute the following:

After completion of work required to meet surface tolerance, texture the roadway surface in a longitudinal direction by planing the hardened concrete using a diamond saw-blade grinder. The entire surface area of the roadway except the area within 20 inches of the curb and median shall be planed to a uniform texture. The surface shall have a finished texture with the width of the grooves between 1/10 inch and 1/8 inch at a distance of between 5/64 inch and 1/8 inch apart. The grooves shall not be less than 1/32 inch or more than 1/8 inch in depth. The actual textured surface in any selected 1.5 foot by 100 foot longitudinal strip shall not be less than 98% of the surface area.

During planing operations, joints must be adequately protected against damage and special care shall be taken to avoid damage to expansion devices. Planing shall be done in a manner that will provide a smooth riding surface at expansion joints and at the ends of the concrete wearing course. After completion of the planing, the permissible surface deviation will be 1/8 inch in 10 feet measured with a straightedge laid longitudinally and 1/8 inch in 3 feet measured transversely at right angles to the centerline of roadway.

All slurry material shall become property of the Contractor and must be disposed of as per Mn/DOT 2104.3C3, as approved by the Engineer, and as described in this special provision.

All concrete residue and water (slurry) resulting from concrete bridge deck texture planning operations must be continuously vacuumed from the surface, captured, and containerized for further handling or processing. The slurry must not be permitted to flow across lanes occupied by traffic, flow into drainage facilities or discharge anywhere within the highway Right of Way. The Contractor must submit a slurry disposal or reuse plan at the preconstruction conference for approval by the Engineer.

The method to manage the slurry may require separation of the solids from the liquids. This separation may be achieved mechanically by centrifuging or passively by allowing settlement of the fines to occur in a temporary impermeable lined containment area. If a temporary containment area is used within the highway Right of Way, a Site Plan as per 1717 will be required for the Engineer's approval. The minimum Site Plan shall include methods for storm water protection at the temporary containment area, a description of the proposed separation method, and the process for final removal and restoration of the

disturbed containment area. For any method used to separate the liquid from the solids, the Contractor shall identify the name and location of the POTW (publicly owned treatment works facility) that the liquids will be deposited in, or how the processed water will be reused by the Contractor.

As part of the slurry disposal or reuse plan, the Contractor must be able to provide, upon request, documentation that identifies the name and location of the MPCA permitted lined mixed municipal solid waste (MMSW) or industrial landfill that the solids will be deposited in, or identifies any alternative methods of disposal or reuse that meet environmental requirements of regulated industrial waste.

The Contractor shall hold the Owner harmless for any fines or sanctions caused by the Contractor's actions or inactions regarding compliance with concrete slurry management and disposal. All materials and labor for installation of storm water protection practices, maintenance, control, removal and disposal for the management of concrete slurry is incidental to the bridge deck texture planning operation.

Planed areas not meeting requirements may, at the Engineer's option, be replaced, re-planed or left as is and accepted for payment subject to a price reduction of 25 cents per square foot but, in all cases, positive surface drainage shall be provided.

Measurement will be made to the nearest square foot of concrete area planed and textured based on surface area. Payment will be made under Item 2401.618 "BRIDGE DECK PLANING", at the Contract bid price per square foot, which shall be compensation in full for all costs relative to the specified texture planing.

SB-7 **(2405) PRESTRESSED CONCRETE BEAMS**

The provisions of Mn/DOT 2405 are modified and/or supplemented with the following:

Delete the first paragraph of 2405.3M and substitute the following:

Prestressed concrete beams shall be erected in a manner that will provide safety to the workers, inspectors, and the public, at all times, as well as reasonable assurance against damage to the prestressed members. Prior to the placement of diaphragms, the prestressed beams shall be temporarily anchored, braced, and stabilized as they are erected so as to preclude sliding, tipping, buckling, or other movement that may otherwise occur. If active vehicular or railroad traffic will be permitted to travel beneath beams prior to complete erection of all the beams and diaphragms in a span, the Contractor shall submit an erection plan prepared by an engineer, thoroughly checked by a second engineer for completeness and accuracy, and certified by one of the aforementioned professional engineers

licensed in the State of Minnesota which details all temporary works necessary to brace and stabilize beams. Struts, bracing, tie cables, and other devices used for temporary restraint shall be of a size and strength that will ensure their adequacy. The Contractor shall arrange the work schedule so that each beam will be connected to an adjacent beam and at least two adjacent girders will be erected (including diaphragms and bolts fully tightened) and braced and stabilized in any one span before operations are suspended for the day.

Add the following immediately before the last paragraph of 2405.3M:

Threaded rods used to attach prestressed concrete beams to cast-in-place concrete diaphragms shall either be galvanized per Mn/DOT specification 3392 or electroplated in accordance with ASTM B633, service condition SC4.

SB-7.1 Prestressed Concrete Fabricator Certification

The Fabricator's quality control office shall maintain documentation containing the data required by the specifications and the State Materials Engineer. This documentation shall contain test data and measurements taken at times and locations approved by the Engineer, assuring that monitoring, by personnel not directly involved in production, is sufficient to ensure compliance with approved procedures.

If the Engineer's review of fabrication work discloses that approved procedures are not being followed, the Fabricator shall immediately correct the procedure.

The Engineer will determine what additional testing work must be done by the Fabricator or, if necessary, what part of the work must be repaired or replaced if fabrication work is not properly monitored and documented by the Fabricator.

Any and all costs of required additional monitoring and testing shall be at the expense of the Contractor with no additional compensation.

SB-7.2 Steel Intermediate Diaphragms

In lieu of providing the steel intermediate diaphragm shown in detail B403 of the plans, the Contractor may substitute a bent plate diaphragm. The bent plate diaphragm shall be made of 5/16" thickness plate bent as shown in detail B402 of Mn/DOT Bridge Details Manual. The minimum depth for diaphragm shall be dimension "C" shown in B403; minimum flange width shall be 5".

SB-7.3 Prestress Transfer

The Fabricator of prestressed concrete beams shall closely monitor the ends of the beams during the strand release process. The following sequence of releasing the

individual prestressing strands will be required if cracks occur in the ends of the beams during the fabricator's releasing sequence.

Delete the first sentence of the second paragraph of 2405.3H.

Add the following to 2405.3H:

Prestress transfer shall be conducted in a sequential and alternating manner symmetrical to the vertical axis of the beam in order to minimize the lateral eccentricity of the prestress forces and diminish cracking of the concrete. The sequence of individual prestressing strand release shall be in accordance with the following criteria unless different criteria are approved by the Engineer.

1. Beginning with the *straight* strands closest to the vertical axis of the beam and in the second row from the bottom of the beam, release the strands each side of center. Move two columns away from this column in the same row and release the strand on each side of the center. Then proceed to the outermost strands in this row and release the strand on each side of the center. Repeat the sequence for the third and subsequent rows from the bottom upward until approximately one-fourth of the straight strands have been released.

2. Release approximately one-half (+/- one strand) of the *draped* strands alternating about the vertical axis, starting from the bottom.

3. Release the hold-down anchors for the draped strands.

4. Release the remainder of the draped strands alternating about the vertical axis.

5. Release the remainder of the straight strands beginning with the strand in the bottom row nearest the vertical axis. The strands are released alternating each side of the center. Release all the strands in that column moving upward. Proceed two columns away from this column and release the strands bottom to top alternating each side of the center. Next, move to the outer most column and release strands bottom to top continuing to alternate each side of the center. The remainder of the strands shall be released bottom to top starting with the inner most column alternating each side of the center.

Once release has started, all strands of that beam shall be released in the sequence described above even if cracking is noticed near the end of the beam. The Engineer shall be notified immediately of any cracking and no other beams with the same strand pattern may be fabricated until the Engineer has approved a revised release sequence.

SB-8 (2451) STRUCTURE EXCAVATIONS AND BACKFILLS

The provisions of Mn/DOT 2451 are modified and/or supplemented with the following:

SB-8.1 Structure Excavation

The item Structure Excavation shall include all excavation, dewatering, sheeting and shoring and/or other protection, preparation of foundation, and placing of backfill necessary for construction of Bridge No. 27B60 (Phase II) and the associated retaining walls which is not specifically included in the grading portion of the Contract. It shall also include the disposal of surplus material.

The Contractor is hereby advised that Petroleum-contaminated soil and groundwater are present at the former Rocket Crane property, GAF Materials property, existing Lowry Avenue embankment area, and the Pacific Building property located on the north and south sides of Lowry Avenue. Additional information regarding this contamination is provided in the "Phase I Environmental Site Assessment" and the "Environmental Site Assessment and Response Action Plan Addendum; Phase Two of Lowry Avenue Bridge Replacement" which are available for viewing at the Hennepin County Transportation Department Office, 1600 Prairie Drive, Medina, MN, 55340 and via the Internet at https://egram.co.hennepin.us/.

The item Structure Excavation shall consist of excavating and handling of contaminated soils and all necessary dewatering in accordance with the applicable provisions of Mn/DOT 2105, as directed by the Engineer, MPCA requirements, and the applicable provisions of Section 2105 "EXCAVATION SPECIAL" and Section 2105 "DEWATERING" in Division S of these Special Provisions.

SB-8.2 Pier 2 and Retaining Wall B Foundation Excavation

The Contractor is hereby advised that temporary excavation support **WILL** be required, adjacent to the existing GAF Manufacturing Building, to construct the Pier 2 Foundation. The Contractor is hereby advised that Temporary Excavation Support **MAY** be required adjacent to the existing Trio Manufacturing Building, to construct a portion of the Retaining Wall B Foundation. The Contractor shall be solely responsible for evaluating the need for, design of, and installation of all items to provide excavation support and to prevent damage to the existing building. These measures shall include, but are not limited to, selecting construction methods and procedures that will prevent damage and monitoring and controlling the vibrations from construction activities. Driven or vibrated piling, or any other shoring method which would cause damage to the existing GAF Manufacturing Building, or the Trio Manufacturing building, will not be allowed.

The Contractor shall submit an excavation support plan, including computations and schedule, to the Engineer for approval in accordance with the requirements of 2471.3B.

All activities related to the construction at Pier 2 and at Retaining Wall B shall be monitored in accordance with the requirements of section (2011) "VIBRATION MONITORING" and section (1712) "PROTECTION AND RESTORATION OF PROPERTY" in Division S of these special provisions.

SB-8.3 Method of Measurement

No measurement will be made of the excavated or backfill material. All work performed as specified above will be considered to be included in a single lump sum for which payment is made under Item No. 2401.601, "STRUCTURE EXCAVATION".

SB-8.4 Basis of Payment

For purposes of partial payments, the portion of the lump sum Structure Excavation at each substructure unit will be defined as follows:

Bridge No. 27B60 (Phase II):

Retaining Wall A 30%
Retaining Wall B 30%
West Abutment 8%
Pier 1A & 1B 16%
Pier 2 ..... 8%
Pier 3 ..... 8%

SB-9 (2452) PILING

The provisions of Mn/DOT 2452 are modified and/or supplemented with the following:

Delete the second paragraph of 2452.3H and substitute the following:

Pile welders shall be qualified using AWS D1.1 standards or current Mn/DOT welding certification.

Delete the first sentence of the second paragraph of 2452.3D7 and substitute the following:

Piles designated by the Engineer to be redriven shall have a required minimum time delay of 72 hours between the initial driving and redriving.

SB-9.1 Equipment for Driving

Delete the first and second paragraph of 2452.3C1 and substitute the following:

All pile driving equipment to be furnished by the Contractor shall be subject to approval by the Engineer. Approval is based on the satisfactory results of a wave equation analysis.

At least 30 calendar days prior to the start of pile driving operations, the Contractor shall submit the following:

1. A completed pile and driving equipment data form for each hammer proposed for the project. The form may be downloaded from the following website: http://www.pile.com/pdi/users/grlweap/equipdatafrm-en.pdf

2. A wave equation analysis in accordance with GRL WEAP or similar program for each pile type and hammer. A hard copy of the results of the analysis, including a WEAP bearing graph, shall be submitted to the Engineer.

For the pile driving equipment to be acceptable, the required number of hammer blows indicated by the wave equation at 155% of the pile factored design load as shown in the Plans shall be between 30 and 180 blows per foot.

The pile stresses indicated by the wave equation shall be reviewed to determine that the piles can be driven as described in 2452.3D without failure. If stress levels are such that damage to the piling is considered to be likely, adjustments shall be made to the pile driving system or to the strength of the pile until satisfactory results are obtained. Substantial refusal is defined in subsequent paragraphs.

All costs associated with providing the wave equation analysis and submittals as described above shall be an incidental expense to the test piles and no additional compensation will be made for this work.

SB-9.2 Penetration and Bearing

Delete 2452.3E and substitute the following:

A. General

The nominal pile bearing resistances shown in the Plans were calculated using design loadings and indicate the factored loads that the piles are required to support. The nominal resistance determined using the dynamic methods, defined under Determination of Nominal Bearing Resistances, is

the basis for establishing the minimum criteria for pile acceptance in which the driving resistance is not less than the resistance specified in the Plans. It may be necessary to drive the foundation piles beyond the specified resistance until the required penetration as shown in the Plan is reached, or until the piles have been driven to a penetration as determined by the engineer based on the test pile results.

Since the purpose of a test pile is to provide information for authorizing the length of the foundation piles, it shall be driven full length unless substantial refusal (as defined below) is encountered at a lesser penetration. If the test pile has been driven full length and 115% of the nominal resistance required for the foundation piles has not been attained the Engineer may order the test pile be driven further as per 2452.3D2 and 2452.4A. If pile redriving is specified in the Plan, the penetrations and time delays shall be in accordance with 2452.3D7 and/or these special provisions.

Substantial refusal, as referenced in 2452.3D, shall be considered to have been attained when the penetration rate is equal to 0.05 inches per blow.

B. Determination of Nominal Bearing Resistance

The required nominal resistance shown in the Plans is based on a field control method as noted. The driven pile nominal resistance shall be determined in accordance with the following provisions using the Pile Driving Analyzer (PDA) field control method indicated in the Plans.

B1. Pile Driving Analyzer (PDA) Used as Field Control Method

The nominal pile bearing resistance shall be determined using the pile driving analyzer and the Case Pile Wave Analysis Program (CAPWAP) in accordance with the following section, Dynamic Monitoring of Pile Driving. The WEAP bearing graph listed below under deliverables shall be used to determine the bearing resistances that are recorded on the pile driving report (attach a copy of the bearing graph to the report). For informational and comparison purposes, the bearing resistances shall also be computed using the Mn/DOT formula and recorded on the report.

SB-9.3 Dynamic Monitoring of Pile Driving

A. Description of Work

The Contractor shall provide all equipment and personnel necessary to perform dynamic pile testing of driven piles using a Pile Driving Analyzer (PDA). The work shall be performed in accordance with the requirements of ASTM 4945. The dynamic pile testing shall be performed on the initial

driving and redriving of the test piles as directed by the Engineer. Testing may also be required on additional piles as designated by the Engineer.

B. Pile Preparation and Wave Matching

The Contractor shall prepare each pile to be tested by attaching instrumentation to the piles except that for testing on initial driving of steel shell piles, the Contractor shall attach the instrumentation after the pile has been placed in the leads. In addition, the Contractor shall perform wave matching of the PDA data using the Case Pile Wave Analysis Program (CAPWAP). This work shall be performed by an engineer experienced in dynamic testing and CAPWAP analysis. The program shall be run on all piles dynamically tested, or as directed by the Engineer.

C. Wave Equation Analysis

Following the wave matching, the Contractor shall use the GRLWEAP program and CAPWAP data to produce a refined Wave Equation Analysis Program (WEAP) bearing graph and inspector's chart to be used as the basis for pile acceptance. The bearing graph shall be used to determine the foundation pile's nominal bearing resistance that is to be recorded on the pile driving report. The wave matching analysis and wave equation analysis shall be performed in a timely manner.

D. Deliverables

The Contractor shall provide the following items to the Engineer within the specified time intervals described herein:

1. Results from each dynamic test performed with the PDA and checked with the CAPWAP program. The results shall be in the form of a hard copy of columnar data produced with the PDAPLOT program. The data shall consist of blow counts, stresses in the pile, pile capacities, hammer energies and hammer strokes for each one foot (0.25 meter) depth increment. The results shall be provided in a timely manner. In addition, the Contractor shall provide expert advice regarding the analysis of the PDA and CAPWAP data.

2. A WEAP bearing graph and inspection chart showing blow count-versus-pile resistance and stroke-versus-blow count that will be used for determining the nominal bearing resistance of the foundation piles. The graph/charts shall be developed based on the results of the PDA and CAPWAP data. Both the maximum force and maximum transferred energy calculated by WEAP shall match within 10% of those calculated by the CAPWAP. The bearing

graphs shall be delivered to the Engineer within two days after completion of driving the test piles at any single substructure unit. These graphs/charts shall also be documented in the appropriate reports listed below.

3. A brief report for the piles at each substructure tested including a summary of the PDA and CAPWAP results. In addition, the Contractor shall supply one or more 3.5 inch diskettes or CD containing all data for the piles tested for that substructure. The data shall be in the form of X01 (PDA file) and Q00 (PDAPLOT file) files and shall be properly labeled. These reports shall be sent to the Engineer no later than three working days after dynamic pile tests have been completed at any given substructure unit.

4. A PDA summary report which summarizes the findings from the PDA and the associated CAPWAP computer program and the developed GRLWEAP bearing graphs. This report shall be sent to the Engineer no later than one week following the completion of the dynamic pile tests, addressed separately.

E. Method of Measurement

When the Pile Driving Analyzer field control method is required by the contract, measurement will be by the number of piles on which the pile driving analysis is performed. Initial analysis and redrive analysis on an individual pile shall be counted as one pile analysis. The Owner reserves the right to increase or decrease the number of piles which are required to be dynamically monitored.

F. Basis of Payment

Payment for Item No. 2452.602 "PILE ANALYSIS" will be made at the Contract price per each and shall be compensation in full for all of the Contractor's expenses associated with the dynamic testing of a pile during initial driving and redriving. This includes, but is not limited to, additional time needed in driving operations, labor, consultants and equipment necessary for performing all of the work described above, including all incidentals thereto. This includes the payment for the dynamic testing of the redrive but all other work associated with the redrive itself will be paid for under the "Pile Redriving" pay item per each.

No unit price adjustment will be made in the event of increased or decreased Contract quantities for Pile Analysis.

SB-9.4 Extensions and Splices

Delete the fourth paragraph of 2452.3H and substitute the following:

Commercial drive fit splices may be permitted on a performance basis, subject to approval of the Engineer. However, such splices shall not be used in pile bent-type piers or abutments, or where foundation soils are soft or unstable, or in foundations where uplift is anticipated or where down drag is indicated in the pile load table, or within 10 feet of the pile cut-off.

SB-10 (2453) DRILLED SHAFT CONSTRUCTION

SB-10.1 Scope of Work

This work consists of furnishing all labor, equipment, material and other services necessary for construction of 24-inch and 48-inch diameter reinforced concrete drilled shafts in earth, to serve as foundation supports, as shown in the Plans, for Pier 2 of Bridge No. 27B60 (Phase II) and Retaining Wall 'B'. The work shall be performed in accordance with the applicable provisions of Mn/DOT 2401, 2451, the Plans, and these special provisions.

The work shall include, but not be limited to:

- Obtaining all required Federal, State and local permits
- Exploratory borings as required
- Conformance with environmental regulations
- Protection of adjacent structures
- Dewatering of site as necessary for drilled shaft construction
- Earth excavation for shafts
- Removal of obstructions
- Furnishing and placing temporary or permanent casing
- Disposal of drilling fluids, excavated material, waste concrete and reinforcement
- Furnishing and placing reinforcement and concrete
- Correction to acceptable tolerances
- Cross-hole Sonic Logging (CSL) testing of selected shafts

SB-10.2 Geotechnical Information

A. Geotechnical Data

Geotechnical borings were taken at this site for design purposes. A copy of the Foundation Report (and associated addendums) is included in this document. It is the responsibility of the drilled shaft contractor to review this geotechnical data and to visit the job site prior to submitting a proposal for this work.

B. Site Geology

The general geologic profile at the boring locations consisted of a variable layer of previously placed fill over alluvial and glacial deposits. Several of the borings encountered apparent bedrock below the glacial soils.

Below the pavement section of the existing embankment, the fill generally consisted of silty sand, with lesser amounts of poorly graded sand with silt, clayey sand, lean clay with sand, and lean clay. The fill contained variable amounts of organic material, peat, gravel, cobbles, concrete, bricks, glass, wood and cinders, and it is likely additional debris is present within the fill that could not be sampled or was not encountered by the borings. At the borings performed through the embankment, it appears a buried cobblestone or bituminous road surface is present near the base of the embankment. Also of note, at one boring, a 5-foot (approximate) layer of crushed concrete was encountered approximately 27 to 32 feet below grade.

Within the embankment, the fill deposits ranged in depth from approximately 31 to 35 feet below the road surface. In the paved or gravel areas to the south of the approach embankment, fill depths ranged from about 2 to 15 feet below grade.
The penetration resistances in the fill soils ranged from 2 blows-per-foot to 50 blows for 0 inches of penetration.

Alluvial soils were encountered at all of the borings below the existing embankment soils. The alluvial soils primarily consisted of poorly graded sand and poorly graded sand with silt. Lesser amounts of silty sand were also encountered.

The penetration resistances in the alluvial sands ranged from 3 to 41 blows-per-foot, indicating very loose to dense relative densities.

The underlying glacial soils consisted of poorly graded gravel, poorly graded sand, poorly graded sand with silt, silty sand, sandy silt, sandy lean clay, lean clay and fat clay. The glacial deposits increased in thickness

towards the river channel and also contained more frequent clayey (and fine grained) soil layers. The glacial soils contained variable amounts of gravel, cobbles and possibly boulders.

The penetration resistances in the non-cohesive glacial soils ranged from 11 blows-per-foot to 100 blows for 6 inches of penetration, indicating medium dense to very dense relative densities. The penetration resistances in the cohesive glacial soils ranged from 17 blows-per-foot to 50 blows for 10 inches of penetration, indicating very stiff to hard consistencies.

SB-10.3 Obstructions

An obstruction will be classified by the Engineer as material and/or objects that cannot be efficiently removed from a shaft during normal excavation operations with the drilling equipment adequate to excavate earth and rock materials found on the Project, and which necessitate the use of other methods and/or equipment to remove. Such obstructions may be rock fragments, boulders, waterlogged timbers, or any material, natural or man-made which requires use of special tools or procedures not otherwise required for excavation of rock or earth materials on the Project.

For this Project the following will *not* be classified as obstructions and, if present, shall be removed by the Contractor with no additional compensation.

- Material present above rock elevation which is (1) required to be removed by the Contract; or (2) known to the Contractor or readily visible upon site investigation and which can be removed by conventional surface excavation methods.
- Boulders which are one-fourth, or less, of the shaft diameter.

SB-10.4 Qualifications of Drilled Shaft Contractor

The drilled shaft contractor shall have a minimum of five years experience in drilled shaft installations and shall have successfully completed construction of shafts with similar site and subsurface conditions, shaft diameter and shaft depths. The supervisor in charge of this work shall have a minimum of three years of experience in the construction of similar types of drilled shafts.

The firm that will conduct the structural integrity tests, as described in the 'Non-destructive Structural Integrity Testing of Completed Shafts' section of these specifications shall have a minimum of two years experience in the required testing procedures.

SB-10.5 Submittals

The following information and data shall be submitted to the Engineer at the preconstruction conference:

A. Proof that the above-noted drilled shaft contractor qualifications have been met including a list of similar projects completed within the last three years with names and phone numbers of owner's representatives who can verify the contractor's participation in those projects.

B. Name and experience record of the supervisor in charge of the drilled shaft construction.

C. A preliminary installation plan that contains, but is not limited to, the following data:

- A description of the proposed drilling machine and down-hole tools to be used for the drilled shaft construction.
- Procedures for exploratory borings, if required.
- Means of access to the drilling site.
- Proposed construction methods. This shall include procedures for exploration, excavation, cleaning, inspection, placement of temporary and permanent casings, removal of temporary casings, placement of reinforcement, placement of concrete, filing of voids between permanent casing and earth or rock, and containment and disposal of excavated materials and drilling fluids.
- A description of spacers and supports to be used for the reinforcement.
- Proposed schedule and sequence of construction operations.
- A written contingency plan for containment and clean-up of any spill or discharge of material which might contaminate public waters.

D. Status of permits obtained or necessary for the work.

The Engineer will review the plan within 14 calendar days of submittal and provide written instructions if changes are necessary to meet Contract requirements. A final drilling plan shall then be submitted which meets all Contract requirements. If revisions in the plan are required to accommodate site conditions, or for other reasons, the Engineer's approval shall be obtained prior to implementation.

The Engineer's approval of the installation plan shall not relieve the Contractor of full responsibility for the safe and successful completion of construction of the drilled shafts.

SB-10.6 Non-destructive Structural Integrity Testing of Completed Shafts

A. General Requirements

The Contractor shall test a minimum of six completed shafts for Retaining Wall 'B' and six completed shafts for Pier 2. Shafts to be tested will be randomly selected by the Engineer for structural integrity using the Cross-hole Sonic Logging (CSL) testing method. The CSL tests shall be conducted by a firm experienced in CSL testing. These tests shall be performed after the construction of the shaft has been completed. Testing shall not be conducted until at least 24 hours after placement of concrete in the shaft is completed and the concrete has reached a strength of 1500 psi.

The Contractor shall provide suitable working space, additional equipment and access to every tested drilled shaft as required by the testing firm.

B. Preparation for Testing

To accommodate the CSL test requirements, the Contractor shall install four inspection tubes in each drilled shaft. The tubes shall be 1½-inch inside diameter Schedule 40 steel pipe per 3362. All pipe shall be new. The tubes shall have a round, regular internal diameter free of defects or obstructions including defects or obstructions at pipe joints in order to permit the free, unobstructed passage of 1 3/8-inch diameter source receiver probes. The tubes shall be watertight with clean internal faces to ensure passage of the probes. Each tube shall be fitted with a watertight cap on the bottom and a removable cap on the top. The tubes shall be installed in each shaft in a regular, symmetric pattern adjacent to the longitudinal rebars. The tubes shall be securely attached to the interior of the reinforcing steel cage by wire tying at every 3 feet, or otherwise secured so that the tubes stay in position during placement of the cage and during placement of concrete.

The tubes shall be as near to parallel as possible and extend from 6 inches above the shaft bottom to at least 36 inches above the shaft top. No tube shall be allowed to rest on the bottom of a drilled shaft excavation. Any joints required to achieve full length tubes shall be made watertight. Care shall be taken during lifting and placement of the reinforcing steel cage to avoid damage to the tubes.

After the cage is in place within the shaft and prior to placement of concrete, the Contractor shall investigate at least two tubes per shaft to make sure that there are no bends, crimps, obstructions, or other impediments to the free passage of the testing probes. If any tube is damaged to the extent that the test probes cannot be dropped to the bottom of the tube, the Contractor shall remove the cage and repair or replace the defective tube(s) to the satisfaction of the Engineer. If a tube is found to be defective after placement of concrete, the Contractor shall remove the tube, by drilling it out from the inside using a bit designed especially for this purpose. All costs of any remedial work to render the tubes satisfactory for the CSL tests shall be at the Contractor's expense.

After Placement of the cage and before placement of concrete, the tubes shall be filled with clean water and the tube tops shall be capped or sealed to keep debris or other foreign matter out of the tubes. In a case where conditions make rapid concrete placement imperative, the Engineer may permit the filling of the tubes to be delayed until after the concrete placement is completed. Care shall be exercised in the removal of caps so as not to apply excess torque, hammering or other stresses that could break the bond between the tubes and the concrete.

C. Cross-hole Sonic Logging Procedures

The CSL tests shall be conducted between various pairs of tubes. A record of the tube lengths, including a note of the projection of the tubes above the top of the shaft shall be made. The Contractor shall provide information on the shaft bottom and top elevations, length and construction dates to the Engineer prior to the CSL tests.

D. Evaluation of CSL Test Results

Results of the tests shall be submitted to the Engineer immediately following completion of the testing of any shaft. The Engineer will review the results of the drilled shaft integrity testing and other information on the shaft placement. Defects are indicated by longer pulse arrival times and significantly lower amplitude/energy signals. Any such potential defects will be evaluated by the Engineer and further tests may be ordered by the Engineer in regard to the extent of such defects.

If the results of the CSL tests indicate defects, and the Engineer determines that defects may be present, the shaft shall be cored by the Contractor using double-tube core barrels. A core sample shall be taken from each suspected defect location as specified by the Engineer. An accurate log of the core shall be kept and the core shall be crated and properly marked showing the drilled shaft depth at each interval of core

recovery. The core, along with five copies of the coring log, shall be provided to the Engineer.

E. Remedial Action

If the quality of the drilled shaft, as represented by the core samples, is determined to be unacceptable, the Contractor shall proceed as follows:

The Contractor shall submit a plan prepared by a professional engineer registered in the State of Minnesota for correction of defects to the Engineer for approval. All labor and materials required to perform remedial work shall be provided at no cost to the Owner and with no extension of the Contract time.

If an anomaly/defect is confirmed by coring, the Contractor shall pay for all coring and grouting costs, plus all costs of other remedial action ordered by the Engineer to render the shaft serviceable for use. If no anomaly/defect is encountered, compensation for all coring and grouting will be in accordance with 1403, Extra Work.

F. Continuation of Work

If an anomaly/defect is detected in a drilled shaft, the Contractor may proceed to continue to construct other drilled shafts at his/her own risk provided that all such drilled shafts constructed subsequent to detecting said anomaly/defect, be repaired by the Contractor if the Engineer determines that the anomaly/defect is caused by consistent errors in construction.

SB-10.7 Methods and Equipment

A. Drilling and Excavation Equipment

Drilling equipment used to perform the drilled shaft work on this Project shall have the capability of providing sufficient torque and down-thrust for drilling and excavating shafts in the geologic strata described herein which are 20% greater in diameter than the largest shaft diameter and at least 6.5 feet below the deepest shaft required for this Project.

Excavation equipment shall be capable of excavating the drilled shaft to the dimensions required in the Plan with a level bottom. The cutting edges of the excavation tools shall be normal to the vertical axis of the equipment within a tolerance of ±0.42 inches per foot of shaft diameter.

B. Concrete Placement Equipment

Tremie - Rigid tremie pipe used to place concrete underwater shall be watertight and of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. The tremie shall not contain aluminum parts that will have contact with the concrete. The tremie inside diameter shall not be less than 10 inches unless a smaller inside diameter is approved by the Engineer. The inside and outside surfaces of the tremie shall be clean and smooth to permit both flow of concrete and unimpeded withdrawal during concrete placement. The discharge end of the tremie shall be constructed to permit the free radial flow of concrete. Wall thickness of the tremie shall be adequate to prevent crimping or sharp bends that may restrict concrete placement. A plug, valve, or bottom plate shall be used to separate the concrete from the water until the concrete is flowing through the orifice. Plugs, if left in the shaft concrete, shall be of a material approved by the Engineer.

SB-10.8 Data Reports

The Contractor shall complete the initial data report supplied in this special provision for *each* drilled shaft constructed. The report shall be furnished to the Engineer within 24 hours after concreting has been completed for that shaft. Upon completion and acceptance of all shafts by the Engineer, a final report for each shaft--in the same standard format--containing any additional data shall be furnished to the Engineer. The following data shall be included in the final report:

- Date and time excavation started.
- Shaft location and identification.
- Shaft diameter per Plans and as constructed.
- River pool elevation, if appropriate.
- Description of soil and rock types encountered while drilling.
- Variation of shaft as constructed from plumb and from its Plan location.
- Location and extent of rock cavities.
- Comments on water condition within a shaft, if applicable, i.e., flow volume, hydrostatic head, elevation encountered.
- Date and time excavation completed and method of cleaning bottom, if applicable.
- Date concrete is placed, placement method(s) and Mix No(s).
- Diameter and depth of permanent casings used.
- Other comments as deemed necessary for the work including any non-

standard methods of construction which may have been required and which affected the shaft configuration and/or construction.

- Details of any obstructions encountered and removed including removal methods.
- Results of structural adequacy (CSL) test(s), if performed, and description of remedial action, if necessary.
- Date of acceptance of the completed shaft.

SB-10.9 Materials

A. Permanent casings shall conform to the requirements of ASTM A 252 or A 36, welded and seamless, and may be of unit or sectional construction with welded seams. The casings shall be of ample strength to withstand handling stresses, internal pressure of fluid concrete, external pressure of surrounding earth and water, and shall be watertight. Minimum wall thickness of permanent casing shall be 3/8 inch. The outside diameter of the casings shall not be less than the diameter of the drilled shaft. Casings shall be non-corrugated and the surface shall be smooth, clean and free from hardened concrete.

Used material in like-new condition with no section loss may be used for the permanent casings with approval of the Engineer.

B. Temporary casings shall conform to the requirements of permanent casings, except that the diameters shall be as required for the particular usage.

C. Inspection pipes shall conform to the requirements described under the 'Non-destructive Structural Integrity Testing of Completed Shafts' section of these Specifications.

D. Concrete shall conform to the requirements of Mix No. 1X46 unless otherwise specified in the Plans. Slump shall be increased to 7-8 inches by the use of Mn/DOT approved super-plasticizers.

E. Mineral slurries may be made with sodium bentonite or attapulgite mixed with fresh water, and shall meet the requirements given in the following table:

MINERAL SLURRY			
Acceptable Range of Values			
Property (Units)	**At Time of Slurry Introduction**	**In Hole at Time of Concreting**	**Test Method**
Density k/m^3 (**lb/ft^3**)	1030-1107 (**64.3-69.1**)	1030-1201 (**64.3-75.0**)	Density Balance
Viscosity seconds/liter (**seconds/quart**)	30-48 (**28-45**)	30-48 (**28-45**)	Marsh Cone
pH	8-11	8-11	pH Paper or Meter

SB-10.10 Acceptable Construction Methods

A. Casing or Wet Construction Method - The casing method may be used in earth and rock strata to prevent hole caving and/or excessive deformation of the hole.

The casing shall be advanced through the earth by twisting, driving, or vibrating before being cleaned out. For rock strata the casing shall be placed in a predrilled hole. No extra compensation will be allowed for concrete required to fill an oversized casing, or an oversized excavation required to place the casing.

1. Temporary Casing - All casing shall be considered temporary (unless the drilled shaft contractor chooses to provide a permanent casing at the top of the shafts as a form). The Contractor shall remove any temporary casing within the excavated shaft during concrete placement operations while the concrete is in a fluid state. If the Contractor elects to remove a casing and substitute a longer and/or larger diameter casing through caving soils, the excavation shall be stabilized, as approved by the Engineer, before the new casing is installed.

Temporary casings which become bound or fouled during shaft construction and cannot be practically removed, shall constitute a defect in the drilled shaft. The Contractor shall be responsible for improving such defective shafts to the satisfaction of the Engineer. Such improvement may consist of, but is not limited to, removing the shaft concrete and extending the shaft deeper to compensate for loss of frictional capacity in the cased zone. All corrective measures shall be performed by the Contractor to the satisfaction of the Engineer. No additional compensation and extension of Contract time will be made for corrective measures, or for casing left in place.

2. Permanent Casing - Permanent steel casing may be used at the Contractor's option to form the top of the shaft within the earth strata only. The casing may be set in place prior to start of shaft drilling or a temporary casing may be used for drilling and excavation, with the permanent casing placed prior to placement of reinforcement and concrete. Permanent casing may be larger than minimum shaft diameter to allow withdrawal of the temporary casing. The permanent casing shall be cut off at the top of finished shaft elevation, as given in the Plans before or after concrete and reinforcement placement, at the Contractor's option.

   When temporary casings are deemed necessary in conjunction with permanent casings, the drilled shaft contractor shall maintain alignment of both casings on the axis of the shaft.

B. Slurry Displacement Construction Method

The slurry displacement method may only be used in earth strata. All slurry must be removed from the excavation prior to beginning rock excavation unless written approval has been obtained from the Engineer. Mineral slurries shall be employed in the drilling process unless other drilling fluids are approved by the Engineer.

During construction, the level of the slurry shall be maintained at a height sufficient to prevent caving of the hole at a level not less than 4 feet above the highest expected piezometric pressure head along the depth of the shaft. In the event of a sudden significant loss of slurry such that the slurry level cannot practically be maintained by adding slurry to the hole, or the slurry construction method fails for any other reason, construction shall be delayed until an alternate construction procedure has been approved by the Engineer.

The Contractor shall ensure that heavily contaminated slurry suspension, which could impair the free flow of concrete, has not accumulated in the bottom of the shaft.

SB-10.11 Construction Requirements

A. General

Construction of drilled shafts shall not begin until the installation plan has been approved by the Engineer.

No reinforcement or concrete shall be placed in the drilled shafts without approval of the Engineer.

B. Protection of Existing Structures

Drilled shaft excavation is required within close proximity to inplace structures/buildings. The Contractor shall take all reasonable precautions to prevent damage to these, and any other, structures. Adverse effects of shaft drilling operations may include loss of ground support, lowering of water table, or vibrations detrimental to utilities and structures. The Contractor shall be solely responsible for evaluating the need for, design of, and installation of all reasonable precautionary features to prevent damage. These measures shall include, but are not limited to, selecting construction methods and procedures that will prevent damage and monitoring and controlling the vibrations from construction activities. All activities related to the construction of the drilled shafts shall be monitored in accordance with the requirements of section (2011) "VIBRATION MONITORING" and section (1712) "PROTECTION AND RESTORATION OF PROPERTY" in Division S of these Special Provisions.

C. Excavation of Shafts

Shaft diameters given are the minimum required for this Project. The drilled shaft contractor may increase diameters to conform to his equipment or to expedite drilling operations, but no additional compensation will be paid unless the increased diameter is ordered by the Engineer.

If drilling and excavation operations are performed with permanent casing inplace, care shall be taken to prevent damage, such as dents, to the casing.

Excavation of shafts occurring in strata subject to caving shall occur only after adjacent shafts are filled with concrete, and the concrete has reached a minimum strength of 1450 psi.

D. Cleaning and Inspection

Loose material shall be removed from drilled shafts prior to placement of reinforcement. After the shafts have been cleaned, the Engineer will inspect the shafts for conformance to Plan dimensions and construction tolerances. If permanent casing is damaged and unacceptable for inclusion in the finished shaft, the casing shall be replaced at the Contractor's expense. If a portion of a shaft is underwater, the Contractor shall demonstrate that the shaft is clean to the satisfaction of the Engineer. This shall include inspection by a diver, at no cost to the Owner, if considered necessary by the Engineer. Dewatering of the drilled shafts for

cleaning, inspection and placement of reinforcement and concrete will not be required. If the drilled shaft contractor chooses to dewater the shafts for convenience of construction, this work shall be done at the Contractor's expense.

E. Construction Tolerances

Tops of the finished shafts shall be at the elevations given in the Plans with a tolerance of plus ½ inch or minus 2". The base elevations given in the Plans are estimated only and may be revised by the Engineer.

No rock projections shall extend inside the plan diameter of the shaft by more than 2 inches.

The maximum permissible variation of the center axis at the top of any finished shaft is 3 inches from its Plan location. No finished shaft may be out of plumb by more than 2.0% of its depth. In the event that the above-noted tolerances are exceeded, additional reinforcing steel shall be added at the direction of the Engineer. All remedial work and materials required to restore or reconstruct a shaft for final acceptance by the Engineer shall be provided at the Contractor's expense.

F. Reinforcement

The shaft reinforcement cage shall be completely assembled and placed as a unit in accordance with the installation plan. Welding of reinforcement is not permitted.

When lifting the cage for placement in the shaft, the Contractor shall provide sufficient pick points to prevent bending of the cage that will cause deformation of the reinforcement bars. Damaged bars shall be replaced at the Contractor's expense.

The reinforcement cage shall be laterally supported at the top during placement of the concrete. The support system shall be concentric to prevent racking and displacement of the cage. Approved spacers shall be provided at intervals not to exceed 10 feet along the cage to ensure concentric positioning for the entire depth of the cage. A minimum of three perimeter spacers shall be provided at each spacing interval. Additional reinforcement may be added to stiffen the cage at the Contractor's option and expense. Extension of the top of the cage above the elevation of the top of each finished shaft shall not be less than that given in the Plans.

If after placement of the reinforcement the Engineer determines that the condition of the shaft is unsuitable or if concrete placement does not

immediately follow the reinforcing steel placement, the Engineer may order the cage removed from the shaft so that the integrity of the excavation, including accumulation of loose material in the bottom of the shaft and the condition of the sides of the shaft, can be determined by inspection. If the reinforcement cage moves up or down from its original position by more than 6 inches, the Engineer may consider the work to be defective and require both reinforcement and concrete to be removed.

G. Concrete

Within 24 hours after placement of the reinforcement, concrete shall be placed in the shaft in accordance with the applicable requirements of these special provisions. The minimum placing rate for concrete in the shafts shall be 40 cubic yards per hour.

Concrete in water or slurry-filled shafts shall be placed with a tremie or by pumping. Concrete placement shall not begin until the tremie or pump line is placed to within one tremie or line diameter of the shaft base. Plugs shall be removed if not specifically approved to remain in the shaft. The discharge end shall not be raised until it becomes immersed at least 5 feet in the concrete. Immersion shall remain at a minimum of 5 feet at all times after starting the flow of concrete until the shaft has been filled. If, at any time during concrete placement in water, the discharge end is raised to the top of the fluid concrete and concrete is discharged above the rising concrete level, the Engineer may consider the shaft defective and require removal of both reinforcement and concrete. A positive pressure differential shall be maintained in the tremie or pump line to prevent water intrusion into the concrete.

Concrete shall be placed continuously to the top of the shaft once placement has begun. Concrete placement shall continue until good quality concrete is evident at the top of the shaft. The top 5 feet of concrete shall be vibrated to assure compaction at the top of the shaft.

Concrete within 6 inches of the top of the shaft and water diluted concrete remaining shall be removed to the depth ordered by the Engineer and wasted. Only concrete that meets specification requirements shall remain as part of the finished shaft.

Concrete in a dry shaft shall be placed either by free-fall, by a tremie, or by a concrete pump. Free-fall placement will only be permitted for dry construction where the depth of water does not exceed 3 inches immediately prior to commencement of the concrete pour. Concrete shall fall directly to the base without contacting the rebar cage or the shaft sidewall. A hopper and/or drop chute shall be used to direct the concrete.

If concrete placement causes the shaft sidewall to cave or slough, or if the concrete strikes the reinforcement cage or sidewall, the drilled shaft contractor shall reduce the height of free-fall or reduce the rate of concrete flow into the excavation. If placement cannot be satisfactorily accomplished by free-fall the Contractor shall place the remaining concrete with a tremie or pump.

Before temporary casing is withdrawn, the level of fresh concrete in the casing shall be at least 3 feet above the bottom of the casing. As the casing is withdrawn, care shall be exercised to maintain an adequate level of concrete within the casing so that water behind the casing is displaced upward without contaminating or displacing the shaft concrete.

Following concrete placement the projecting reinforcing steel shall be thoroughly cleaned to remove accumulations of splashed mortar. This work shall be completed before the concrete takes its initial set. Care shall be taken when cleaning the reinforcing steel to prevent damage to the epoxy coating or breakage of the concrete-steel bond.

H. Disposal of Excavated Material

The Contractor is hereby advised that Petroleum-contaminated soil and groundwater are present at the location of the Pier 2 foundation. Additional information regarding this contamination is provided in the "Phase I Environmental Site Assessment" and the "Environmental Site Assessment and Response Action Plan Addendum; Phase Two of Lowry Avenue Bridge Replacement" which are available for viewing at the Hennepin County Transportation Department Office, 1600 Prairie Drive, Medina, MN, 55340 and via the Internet at https://egram.co.hennepin.us/.

All soils and groundwater removed from the shaft holes due to the contractors construction operations shall become the property of the Contractor and shall be disposed of by the Contractor outside of the Project limits in accordance with a satisfactory Disposal Plan. This Disposal Plan shall constitute the Contractor's proposal for acceptable disposition of surplus materials and/or groundwater outside of the Project limits in accordance with the applicable provisions of Mn/DOT 2105, as directed by the Engineer, MPCA requirements, and the applicable provisions of Section 2105 "EXCAVATION SPECIAL" and Section 2105 "DEWATERING" in Division S of these Special Provisions. A satisfactory Disposal Plan shall be submitted to the Engineer prior to starting the drilling operations.

SB-10.12 Method of Measurement

A. Excavation for Drilled Shafts (Earth) will be measured by length in feet along the axis of each shaft from the bottom of footing to the elevation of the top of the rock or tip of the shaft. Portions in water above the ground surface will not be included as excavation is not required.

B. Shaft reinforcement, including spirals, will be measured by mass in pounds for the amount of reinforcement bars required for constructing the drilled shafts excluding reinforcement placed to facilitate construction. Additional splices due to shaft lengths exceeding plan lengths will be measured at 40 bar diameters for each splice required.

C. Shaft concrete will be measured by volume in cubic yards for the amount of concrete required for constructing the drilled shafts based on nominal diameters and approved lengths. Concrete placed to facilitate construction or because of over excavation will not be measured for payment.

D. Structural Integrity Tests will be measured by the number of shafts on which the Cross Sonic Logging Test is performed. The Owner reserves the right to increase or decrease the number of shafts which are required to be tested.

SB-10.13 Basis of Payment

Payment for constructing drilled shafts will be made under separate pay items for 1) shaft excavation in earth and disposal of waste materials, 2) furnishing and placing reinforcement bars, and 3) furnishing and placing concrete, and 4) Non-destructive Structural Integrity Testing of Completed Shafts as follows:

A. Payment for Item No. 2453.603 "24 INCH DIAMETER DRILLED SHAFTS (EARTH)" and for Item No. 2453.603 “48 INCH DIAMETER DRILLED SHAFTS (EARTH)”, will be made at the Contract price per foot and shall be compensation in full for all costs of drilling, excavating, cleaning, and inspecting the shafts in earth as described herein including temporary casings.

B. Payment for Item No. 2401.608 "SHAFT REINFORCEMENT", will be made at the Contract price per pound and shall be compensation in full for all costs of furnishing and placing vertical reinforcement bars for the drilled shafts.

C. Payment for Item No. 2401.501 "STRUCTURAL CONCRETE 1X46", will be made at the Contract price per cubic yard and shall be compensation in full for all costs of furnishing and placing concrete for the drilled shafts.

D. Payment for Item No. 2453.602 "STRUCTURAL INTEGRITY TEST" will be made at the Contract price per each and shall be compensation in full for all costs of completing the Cross Sonic Logging Tests as defined in these Special Provisions.

No additional compensation will be paid for increased dimensions of shafts due to Contractor's method of construction, oversized casing, caving of earth or rock, or corrective action necessitated to meet Contract requirements.

MINNESOTA DEPARTMENT OF TRANSPORTATION

DRILLED SHAFT REPORT

Bridge No. _____ S.P. No. _____ Pier No. _____ Shaft No. _____

Prime Contractor _____

Drilled Shaft Contractor _____ Mn/DOT Inspector _____

GENERAL INFORMATION

Date Shaft Construction Started _____

Date Shaft Construction Completed _____

River Pool Elev. _____ Water Temp. _____

Construction Method: Wet _____ Dry _____

SHAFT INFORMATION

Permanent Casing Dia.: Plan _____ mm

As-built _____ mm

Date Permanent Casing Set _____

Bottom Elev. of Permanent Casing _____

Top Elev. of Finished Shaft: Plan _____

As-built _____

Elev. of Initial Contact of Rock _____

Bottom Elev. of Drilled Shaft _____

Rock Shaft Dia. Plan _____ mm, As-built _____ mm

DRILLING INFORMATION

Drill Rig Make and Mdl. _____

_____

Drilling Tools Used: _____

_____

_____

Excavation Tools Used: _____

_____

_____

Earth Drilling Start Date _____ , Finish Date _____

Rock Drilling Start Date _____ , Finish Date _____

Excavation Finished Date _____

Location and Extent of Rock Cavities or Shaft Caving:

_____

_____

_____

OBSTRUCTIONS

Description of Obstructions Encountered in Earth Shaft

_____

_____

Removal Methods and Tools Used _____

_____

_____

ROCK SHAFT CLEANOUT PROCEDURE

Method _____

_____

Estimated Thickness of Sediment at Bottom of Shaft at Time of Concreting _____

CONCRETE PLACEMENT OBSERVATIONS

Concrete Mix No. _____

Placement Date _____

Ambient Temperature _____

Placement Method _____

Total Placement Time _____

Water Elev. in Shaft at Time of Conc. Placement _____

VARIATION OF SHAFT FROM PLUMB AND PLAN LOCATIONS

Plumb _____

Lateral _____

REMARKS/COMMENTS/NOTES

_____

_____

_____

_____

SB-11 (2461) STRUCTURAL CONCRETE

The provisions of 2461 shall apply except as modified herein.

Add the following to Item (c) in the fourth paragraph of 2461.3B2:

The minimum cementitious content for bridge deck concrete shall be 611 pounds per yd^3.

SB-12 (2471) STRUCTURAL METALS

The provisions of Mn/DOT 2471 are modified and/or supplemented with the following:

Delete the fourth paragraph of 2471.3A2 and substitute the following:

The Contractor/Fabricator performing coating application must demonstrate qualification by obtaining the AISC Sophisticated Paint Endorsement (SPE), the SSPS QP Certification, or a Quality Control Plan (QCP) that is acceptable to the Engineer.

Add the following to the end of the second paragraph of 2471.3C:

The Engineer will audit suppliers with approved QCP's on a biannual or annual basis or as deemed necessary by the Engineer to determine if the QCP is being implemented. The Owner will invoke its Corrective Action Process if the audit indicates non-conformance. Corrective action, up to and including the supplier hiring a third party Quality Control Inspector, may be required as a disciplinary step, at no cost to the Owner. A copy of the Owner's Corrective Action Process is available from the Engineer.

Add the following to 2471.3E1 as the first paragraph:

Steel plates and splice plates for major structural components shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile or compressive stresses.

Add the following to 2471.3F:

F1b Web-to-Flange Welds

For the purpose of this specification, a repair is defined as any area of the welded product not in compliance with the current edition of AASHTO AWS D1.5 Bridge Welding Code. Limit each individual web-to-flange weld repairs to 2 percent of the weld length and grinding web-to-flange weld repairs to 5 percent of the weld length. Exceeding these limits will result in revocation of the Welding Procedure Specification (WPS) used to perform the initial production welding.

Add the following as 2471.3G1:

G1 Fracture Critical Welder Qualifications

Fracture Critical Welder Qualifications shall be in accordance with AASHTO/AWS D1.5-Bridge Welding Code. Annual requalification shall be based upon acceptable radiographic test results of either a production groove weld or test plate. If a welder is requalified by test, a WPS written in accordance with the requirements of D1.5, shall be used and the test plate shall be as shown in Figure 5.24. The WPS shall be included in the Fabricators QCP.

Add the following to 2471.3N1:

Work that is not performed in accordance with the suppliers approved QCP shall be subject to rejection in accordance with 1512.

SB-13 DRAINAGE SYSTEM BRIDGE DECK

SB-13.1 Description of Work

This work consists of furnishing and installing a deck drainage system on Bridge No. 27B60 (Phase II). The work shall be performed in accordance with the applicable requirements of 2402, the Plans, and the following:

SB-13.2 MATERIALS

A. Fiberglass Materials

1. Pipe

All pipes and special shapes shall be filament-wound “E” type fiberglass reinforced thermosetting epoxy resin products of the diameter, lengths and shapes shown in the Plans. Manufacture shall be in accordance with ASTM D2996.

The pipes, fittings and shapes shall have a reinforced wall made up of not less than 45 percent by weight glass roving. The roving length shall be, at least, the circumference of the pipe outside diameter. Reinforced wall thickness shall be determined per ASTM D 3567.

All pipe and fittings shall be colored to approximate the color of the special surface finish on the concrete. The color shall be obtained by pigmenting the resin to match Mn/DOT standard color “Pearl Grey” on file in the Mn/DOT Chemical Laboratory (Ph. 651-779-5548).

2. Fittings and Adhesive Kits

Pipe, fittings and adhesive kits shall be produced by the same manufacturer. The piping, including joining method, shall have been commercially available from the manufacturer for a minimum of three years.

Minimum Performance Standard for Fittings: The ultimate 90º Elbow Bending Moment shall meet or exceed 11,200 foot-pounds.

3. Quality Assurance

All pipe, reducers and fittings shall be visually inspected at the factory per ASTM D2563. Pipe or fitting failing visual acceptance level II shall not be used. Inspection for shipping damage shall be performed at the job site prior to installation.

A random selection of 10% of the pipe joints shall be tested for proper resin cure. Proper resin cure shall be a minimum of 97% of theoretical cure as determined by a differential scanning calorimeter.

The pipe manufacturer shall submit to the Engineer a one-foot sample of the pipe to be used on the Project for comparison of color with the specified Mn/DOT standard color.

4. Certification

The manufacturer shall certify in writing that all materials supplied have
been tested in accordance with the ASTM test methods under D2996.
The certification shall also state that the materials are in conformance with these special provisions.

B. Steel Plates, Shapes and Hardware

Structural steel shall be fabricated and inspected in accordance with the applicable requirements of 2471. Steel plates and shapes for scuppers pipe clamps, hangers and brackets shall conform to 3306 or 3309 at the Contractor's option. Structural tubing shall conform to ASTM A500. Plates and shapes shall be galvanized after fabrication per 3394.

Cast iron per 3321, Class 35B may be substituted for the steel grates at the Contractor's option.

Hardware shall conform to 3391 and galvanized per 3392.

C. Concrete Anchorages

Anchorages for attaching downspout clamps to the piers and superstructure may be either mechanical and/or adhesive anchorages at the Contractor's option. All anchorages shall be 3/4-inch diameter with ultimate pullout strength of 30,000 pounds. Refer to the Metal Railing section of the (2402) STEEL BRIDGE CONSTRUCTION Special Provisions for anchorage requirements. Pullout tests are *not* required.

SB-13.3 Shop Drawings

Submit shop drawings to the Engineer for approval in accordance with the requirements of 2471.3B.

SB-13.4 Construction Requirements

Scuppers shall be set in place at the locations shown in the Plans and adjusted for elevation and correct slope be means of the attached adjusting bolts. Field-drill holes for attaching brackets to the beam webs.

Installation of the fiberglass piping materials shall be in accordance with the Plans and any special recommendations of the manufacturer/supplier. A manufacturer's representative shall provide on-site training for the installers. Training shall include a demonstration of recommended field fabrication procedures.

Downspout pipes shall be installed plumb. Horizontal pipes shall be installed with to the grades (slopes) shown in the Plans. Pipes shall be parallel to the face of the adjacent concrete surface.

Ends of downspout pipes that terminate underground shall be temporarily capped if the catch basins are to be installed later.

SB-13.5 Method of Measurement

The entire drainage system for the bridge deck will be measured as a single lump sum for all components of the system.

SB-13.6 Basis of Payment

Payment for Item No. 2402.601 "DRAINAGE SYSTEM BRIDGE DECK" will be made at the Contract price per lump sum and shall be compensation in full for furnishing and installing the entire drainage system for the bridge deck complete in place, as described above and shown on the plans, including all incidentals thereto.

SB-14 CONDUIT SYSTEMS

Each Conduit System shall be furnished and installed in accordance with the Plans, approved erection drawing, the applicable requirements of 2545, 2550, 2565 and the following:

The Contractor will be required to splice conduit systems constructed under this contract with conduit systems constructed under the Phase 1 Contract at the locations given in the plans (within the box girders constructed under the Phase 1 Contract). All splices, fittings, hardware, and labor required to splice the conduits shall be included in this contract and considered incidental to each Conduit System.

All conduit runs shall be straight and true and all offsets and bends shall be uniform and symmetrical. The Contractor shall adjust the elevations of the conduit assembly, for its full length, to approximately the same gradient as the finished roadway, and s/he shall furnish and install in the approaches such suitable spacers and framing as may be necessary to maintain the correct grade and alignment.

Ferrous components of fittings shall be hot dip galvanized. All fittings shall be carefully installed according to the manufacturer's recommendations and at the locations shown in the Plans. At time of installation, adjacent conduit sections to be coupled by fittings shall be in true alignment.

Fabrication and inspection of structural metals used for each Conduit System shall be in accordance with the applicable requirements of 2471.

The ends of conduits shall be identified as lighting, signals, telephone, telegraph, power, etc. by the use of embossed metallic tags or other equally durable identification.

Non-metallic conduit and fittings shall conform to the requirements of the NEMA Standards Publication No. TC 14, entitled "Filament-Wound Reinforced Thermosetting Resin Conduit and Fittings."

Three sets of erection drawings of each Conduit System shall be furnished to the Engineer for approval in accordance with the requirements of 2471.3B.

The drawings shall be to a scale of not less than 1/4" = 1'-0" and shall show the locations of the diaphragms and inserts, a conduit placement scheme, and detailed views of the placement of the sleeves through walls, the soffit slab, and diaphragms. The locations of the sleeves shall be defined from established reference points or lines and elevations, such as working points or centerlines and bridge seat elevations. The locations and manufacturer of expansion fittings shall be shown in the drawings.

Concrete inserts for hanger assemblies shall be spaced in such a manner that the assemblies will not interfere with conduit couplings. Hanger spacing shall not exceed 10 feet. Conduit shall be installed in 10 foot lengths where practicable.

Each expansion fitting shall be in accordance with 3839, except that the fitting shall provide for at least 12 inch linear movement at the Pier 1B and Pier 4 expansion joint.

A combination expansion/deflection fitting shall consist of an expansion fitting and an expansion/deflection fitting connected by a nipple. The expansion fitting shall be in accordance with 3839, except that the fitting shall provide for at least 12 inch linear movement at the Pier 1B and Pier 4. Each expansion/deflection fitting shall be an approved watertight unit which can accommodate 3/4 inch of linear expansion or contraction of conduit, 3/4 inch of parallel misalignment of adjacent conduit sections, and up to 30 degrees of angular misalignment of the axis of adjacent conduit sections. To prevent damage to internal bonding jumper, fittings should not be twisted during installation.

The Contractor shall seal any remaining conduit opening at the back face of each abutment with an approved sealant after the conduit is in place.

All exposed conduit, fittings, and junction boxes mounted to the surface of Pier 3 shall be painted to match the color of the Special Surface Finish applied to the Concrete Surfaces of Pier 3.

SB-14.1 BASIS OF PAYMENT

Payment for Conduit Systems shall be made at the contract price of lump sum for each system will be compensation in full for all costs of furnishing and installing the complete system as specified. Payment shall include all conduit, fittings, sleeves, hardware, hanger assemblies, and expansion fittings based on the following limits:

Payment for CONDUIT SYSTEM (ROADWAY LIGHTING) shall include all items required to install the system routed from the handhole in the west approach sidewalk to the junction box within Pier 1A (as shown on the electrical plans) and routed to the first light poles west of Pier 4.

Payment for CONDUIT SYSTEM (PIER LIGHTING) and Payment for CONDUIT SYSTEM (CCTV) shall include all items required to install the system routed from the handhole in the proposed grade south of Pier 3 to 2 feet beyond the concrete diaphragm at Pier 4 (constructed under the Phase I Contract).

Payment for CONDUIT SYSTEM (VENTILATION) shall include all items required to install the system routed from the handhole in the proposed grade south of Pier 3 routed to 2 feet beyond the concrete diaphragm at Pier 4

(constructed under the Phase I Contract) and routed to the Junction Box inside the Superstructure at Pier 3.

Payment for CONDUIT SYSTEM (ANTI-ICING) shall include all items required to install the system routed from the handhole in the proposed grade south of Pier 3 routed to 2 feet beyond the concrete diaphragm at Pier 4 (constructed under the Phase I Contract) and routed through the West Abutment to the end of the Approach Panel.

Payment for CONDUIT SYSTEM (SIGNALS) shall include all items required to install the system routed from the handhole in the median west of the Approach Panel to the west face of the Span 5 Superstructure (constructed under the Phase I Contract).

Payment for CONDUIT SYSTEM (XCEL) and CONDUIT SYSTEM (FUTURE) shall include all items required to install the system routed from the back face of the West Abutment to 2 feet beyond the concrete diaphragm at Pier 4 (constructed under the Phase I Contract).

SB-15 POST-TENSIONING GROUT

SB-15.1 General Requirements

This Section covers grouts to be used to protect post-tensioning steel. Grout applications are differentiated into two applications: horizontal and repair.

Grouts shall be prepackaged in moisture proof containers. Grout bags shall indicate application, date of manufacture, LOT number and mixing instructions. Any change of materials or material sources requires new testing and certification of the conformance of the grout with this Specification. 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 six 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.

SB-15.2 Qualified Products List

Manufacturers of post-tensioning grout shall provide certified test reports from an independent laboratory, audited by the Cement Concrete Reference Laboratory (CCRL) which shows the material meets all the requirements specified herein.

A written certification from the manufacturer that the product meets the requirements of this Section must be provided. Grout products will be qualified by application (horizontal or repair).

SB-15.3 MIXING

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

SB-15.4 Grout Physical Properties

A. Gas Generation

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

B. 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 conducted at normal laboratory temperature (65-78°F) and conditions. 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 C 1152
Fine Aggregate (if utilized)	99% passing the No. 50 Sieve (300 micron)	ASTM C 136*
Hardened Height Change @ 24 hours and 28 days	0.0% to + 0.2%	ASTM C 1090**
Expansion	$\leq$ 2.0% for up to 3 hours	ASTM C 940
Wet Density – Laboratory	Report maximum and minimum obtained test value lb/ft^3 (kg/l)	ASTM C 185
Wet Density – Field	Report maximum and minimum obtained test value lb/ft^3 (kg/l)	ASTM C 138
Compressive Strength 28 day (Average of 3 cubes)	$\geq$ 7,000 psi [48.3 MPa]	ASTM C 942
Initial Set of Grout	Min. 3 hours Max. 12 hours	ASTM C 953
Time of Efflux***		
(a) Immediately after mixing	Min. 20 Sec. Max. 30 Sec.	ASTM C 939
	Or Min. 9 Sec. Max. 20 Sec.	ASTM C 939***
(b) 30 minutes after mixing	Max. 30 Sec.	ASTM C 939

with remixing for 30 sec	Or Max. 30 Sec.	ASTM C 939****
Bleeding @ 3 hours	Max. 0.0 percent	ASTM C 940*****
Permeability @ 28 days	Max. 2500 coulombs At 30 V for 6 hours	ASTM C 1202

* Use ASTM C117 procedure modified to use a #50 sieve. Determine the percent passing the #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 one liter container placed directly under the flow cone.

**** Modify the ASTM C939 test by filling the cone to the top instead of to the standard level.

***** Modify ASTM C940 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 to 75°F.

(c) Mix the conditioned dry ingredients with the conditioned mixing water and place 800 ml of the resulting grout into the 1,000 ml graduate 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 three 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.

SB-15.5 Accelerated Corrosion Test Method (ACTM)

Perform the ACTM as outlined in Appendix B of the "Specification for Grouting of Post-Tensioning 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 exceed 1,000 hours is considered satisfactory.

SB-15.6 Variation in Testing for Specific Applications

A. Horizontal Applications

Horizontal grout applications are defined as grouting of all superstructure tendons. All physical requirements defined in the "Grout Physical Properties" and "Accelerated Corrosion Test Method (ACTM)" sections of this Specification are applicable for grouts used in horizontal applications.

B. Repair Applications

Repair applications are used to augment grouting operations which did not completely fill the duct or anchorage. For new construction, repairs may be made with the same grout approved for use in the tendon as long as the volume of the void is less 0.5 gal. In all other cases, use a non-sanded grout meeting the requirements of the "Grout Physical Properties" and "Accelerated Corrosion Test Method (ACTM)" sections of this Specification with a modified maximum permeability of 2,800 coulombs (ASTM C 1202 at 30 volts). Non-sanded grouts shall have 95% passing on the #100 sieve and 90% passing the #170 sieve as determined by ASTM C33. Each sieve may be washed and dried before weighing in accordance with the procedure in ASTM C117 modified for sieve size.

SB-16 (3371) STEEL SHELLS FOR CONCRETE PILING

The provisions of Mn/DOT 3371.2 are modified and/or supplemented with the following:

Add the following to 3371.3:

The use of small quantities of piling from the Contractor's surplus of cut-offs and overruns may be submitted for use and approved by the Engineer. These materials shall be certified by the Contractor to be remaining quantities of materials previously submitted with accompanying Mill Test Reports and subsequently approved for use on other projects. Pile splices used to make up authorized pile lengths shall be considered to have been made at the Contractor's convenience and shall not be considered eligible for extra compensation under 2452.4B.

SB-17 **(3385) ANCHOR RODS**

The provisions of 3385 shall apply except as modified below:

Add the following to 3385.2:

Anchorages supplied under this specification must be pre approved by the Mn/DOT Laboratory and the certification from the Mn/DOT Laboratory must not be more than one year old. The Contractor must furnish the Engineer a copy of the Mn/DOT approval letter for the source, size and grade of anchorages specified in the plans and also a certification stating that anchor bolts of the size and grade specified were manufactured and tested in accordance with ASTM F 1554 (e.g., heat analysis and heat number, tensile tests, zinc coating weight and thickness, etc.).

SB-18 **(3391) FASTENERS**

Delete the contents of 3391.2B and substitute the following:

Field and shop bolts for steel bridges shall meet ASTM A325, Type 3 bolts. The bolts shall project through the nut not less than 1/8" nor more than 3/8". Field and shop nuts for steel bridges shall meet ASTM A563/A563M, Grade C3 or DH3 nuts and field and shop washers for steel bridges shall meet ASTM F436/F436M, Type 3 washers.

For all other bridges and structures the bolts shall meet ASTM A325, Type 1 (for painted and/or galvanized applications) or Type 3 (for unpainted weathering steel applications). The bolts shall project through the nut not less than 1/8" nor more than 3/8". The nuts shall meet ASTM A563/A563M and the washers shall meet ASTM F436/F436M.

ASTM A325 bolts may only be retightened once after having been previously fully tightened.

At the time of installation of fasteners, all nuts, regardless of their specified finish, shall be lubricated with a lubricant of contrasting color as per ASTM A 563 Supplementary requirements S1, S2, and S3.

Delete the first two sentences of 3391.2E and add the following:

Stainless steel bolts are to meet the requirements of ASTM F 593, Condition CW1, Type 304, 316, or 316L, with a minimum yield strength of 60,000 psi, an ultimate tensile strength of 95,000 psi, and a minimum elongation of 20 percent in 2 inches. The nuts are to meet the requirements of ASTM F 594, Condition CW1, Type 304, 316, or 316L.

SB-19 (3741) ELASTOMERIC BEARING PADS

The provisions of 3741 shall apply except as modified below:

Replace the first sentence in 3741.2A with the following:

The elastomeric portion of the bearing pads shall be in accordance with AASHTO M251-04 with a specified Shore A scale hardness of 60 ±5 durometers. The elastomer compounds shall be classified as of low-temperature Grade 4 as specified by the grade requirements of Table 14.7.5.2-2, "Low temperature Zones and Minimum Grade of Elastomer", of the *AASHTO LRFD Bridge Design Specifications*.

Delete all of 3741.2B1 except for the last paragraph.

SB-20 ANTI-GRAFFITI COATING

A. Description of Work

This work consists of applying an anti-graffiti coating to all exposed bridge substructure and retaining wall concrete surfaces (excluding the top of pier caps and top of abutments) extending from 1 foot below finished grade. Additionally, the roadway face of the concrete bridgehead at Pier 1A & 1B shall receive an anti-graffiti coating. Limits of anti-graffiti coating at the retaining walls are given on the plans.

B. Materials

Anti-Graffiti Coatings

Anti-graffiti coatings shall be a clear, multi-component, multi-coat system designed as a permanent, non-destructive coating system for exterior architectural aesthetics. Product shall be compatible with any surface sealer and/or special surface finish that may have been previously applied to the concrete surfaces. It shall be non-yellowing, non-chalking and UV-resistant, available in a flat, matte or semi-gloss finish and shall not require re-application after graffiti removal. Coating shall not contain paraffin (wax) or elastomeric silicones. Acceptable products shall demonstrate protection from graffiti defacement, chemical staining,

ghosting, shadowing and normal environmental effects without yellowing, color change, increased dirt pick-up or damage to the coating or substrate for a minimum ten-year period.

Acceptable anti-graffiti coating products are as follows:

1 Invisi Shield as manufactured by Sherwin Williams

2 Permaclean as manufactured by TK Products

3 Graffiti Guard as manufactured by Tex-Cote

4 Other products submitted for approval by the Mn/DOT Office of Materials – Analytical Lab

Graffiti removal agents shall be non-toxic, non-flammable, biodegradable and have a pH of 7 - 8.5. After graffiti removal, no evidence of graffiti shall be present. The product(s) shall not cause a change in the appearance to the treated surface, including shadowing, ghosting or staining of the coating or substrate.

C. Submittals

Submittals may be made at any time prior to being incorporated in the work. Allow sufficient time so that construction will not be delayed as a result of the time required to approve the submittals, including time for re-submittal as necessary. An extension of time will not be authorized because of failure to transmit submittals sufficiently in advance of the work.

The Contractor shall submit the following items to the Engineer:

(a) Manufacturer's product data sheets indicating technical information, label analysis and application instructions for each material proposed.

(b) For the purpose of future maintenance, a list of manufacturer-approved products for cleaning of the surface of the anti-graffiti coating product(s) used on the Project

(c) Certified test reports indicating compliance with requirements.

(d) A one-quart sample of each anti-graffiti coating product and a compatible graffiti removal agent for verification purposes.

(e) Test panel in accordance with the requirements of the 'Special Surface Finish' portion of the (2401) "CONCRETE BRIDGE CONSTRUCTION" section of these Specifications.

(f) Applicator qualifications demonstrating experience in coating applications. Include a list of recently completed graffiti-resistant coating projects. Supply name and location of project, name and telephone number of owner, and a description of products used, substrates, applicable local environmental regulations and application procedures.

D. Quality Assurance

All products applied under this Project shall be supplied by the same manufacturer. Coating and removal products shall demonstrate a history of successful use on transportation, commercial or industrial projects.

The approved coating manufacturer shall conduct a training seminar for the purpose of training applicators on anti-graffiti product technology, substrates and application methods. Applicator trainers shall be approved by and shall be in good standing with the manufacturer.

E. Application

Anti-graffiti coating shall be applied after all components of the Architectural Surface Finish have been applied to the areas of architectural concrete texture.

The substrate shall be prepared and the anti-graffiti coating product(s) shall be applied in accordance with the manufacturer(s) directions.

Prior to full application of the anti-graffiti coating to the designated surfaces, the applicator shall apply the anti-graffiti coating to the test panel containing SSF as described in the 'Special Surface Finish' portion of the (2401) "CONCRETE BRIDGE CONSTRUCTION" section of these Specifications to confirm compatibility, coverage and possible color change. Any problems or damage to the color system as a direct result of the anti-graffiti products or surface preparation methods, shall be corrected to the satisfaction of the Engineer and at the Contractor's expense.

F. Method of Measurement

Measurement for the Anti-graffiti Coating will be based on the surface area in square feet.

G. Basis of Payment

Anti-graffiti Coating

Payment for Item No. 2411.618, "ANTI-GRAFFITI COATING", shall be at the Contract price per square foot and shall be compensation in full for

all costs of furnishing and applying finishing materials to the areas shown on the Plans.

Application of the anti-graffiti coating to the test panels for quality assurance purposes shall be considered incidental and no direct compensation will be made therefore.