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DIVISION SB

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BRIDGE PLANS

The plans for this Project, consisting of the sheets tabulated below, were approved by the State Bridge Engineer.

<u>BRIDGE</u> <u>NO.</u>	<u>TOTAL</u> <u>SHEETS</u>	<u>SHEET</u> <u>NO.</u>	<u>DATE OF</u> <u>APPROVAL</u>
69071	35	1-35	10-7-10

S.P. 6917-69071 (T.H. 53 = 011)
October 7, 2010

New or revised sheets were approved as listed below:

<u>BRIDGE</u> <u>NO.</u>	<u>SHEET</u> <u>NO.</u>	<u>DATE OF</u> <u>APPROVAL</u>
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I hereby certify that the Special Provisions for bridge construction (Division SB) contained in this Proposal were prepared by me or under my direct supervision, and that I am a duly licensed Professional Engineer under the laws of the State of Minnesota.

(Francis M. Jordan)

Date: _____ Lic. No. 15048

SB-1 BRIDGE PLANS

Plans of existing structures are available at the Minnesota Dept. of Transportation, Bridge Office, 3485 Hadley Avenue N., Oakdale, MN, 55128, for review and inspection by Bidders; or electronic copies are available for viewing, printing, and downloading on the Mn/DOT Consumer Access EDMS (Electronic Document Management System). Go to: http://dotapp3.dot.state.mn.us/cyberdocs_guest/ however, the State neither warrants nor represents that existing structures conform exactly to the details shown in those Plans.

SB-2 SCOPE OF PROJECT

SB-2.1 Description of Work

Bridge No. 69071 utilizes full depth precast concrete deck panels to facilitate the development of Accelerated Bridge Construction (ABC) in the State of Minnesota.

The full depth precast concrete panels are placed on prestressed beams, post-tensioned longitudinally with grout-filled haunches and shear pockets to achieve composite beam/deck behavior. The bridge deck is finished with a chip seal overlay. The integral abutments are founded on steel HP piles.

SB-2.2 Coordination

Bidders are advised that significant coordination and cooperation will be required between the Contractor, Subcontractors, Mn/DOT and other associated parties during the execution of this Project. In addition to typical project coordination, the Contractor will be required to coordinate his/her activities closely with the work of the prestressed concrete beam manufacturer, the precast concrete deck panel manufacturer, the post-tensioning operators, Mn/DOT and other situations that may arise during the course of the Project.

SB-2.3 Special Provisions

Detailed special provisions for the construction of components of Bridge No. 69071 are contained in the remainder of Division SB of this Proposal.

SB-2.4 Submittals

As part of the contract, the Contractor is required to provide several submittals. It is the Contractor's responsibility to provide all submittals required in the contract documents (plans, specifications, special provisions). The following list of bridge related submittals is not all inclusive:

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|----|---|----------------------------|
| A. | Plan to provide OSHA required safety equipment | (SB-3) |
| B. | Plan & specifications for sheeting & shoring if required | (SB-4) |
| C. | Precast concrete deck panel shop drawings | (SB-10.2A.1) |
| D. | Precast concrete deck panel erection plan | (SB-10.2.A.2) |
| E. | Test data and certified test results | (SB-10.2.B) |
| F. | Repair procedures | (SB-10.4.C) |
| G. | Product data sheets, specifications, certified test reports, installation procedures and drip seal wearing course | (SB-11.1.E,
(SB-11.2.A) |
| H. | Post tensioning system drawing and calculations | (SB-12.1.A) |
| I. | Post tensioning system product data sheets, specifications, stressing records, duct pressure field tests, certified test reports, and installation procedures | (SB-12.2 and
SB-12.3) |
| J. | Slurry disposal | (SB-8.4) |
| K. | Mock-up Panel Shop Drawings & Cores | (SB-9) |

Submittals identified in items C through K shall be submitted as a combined "Fabrication, Assembly and Installation Plan".

SB-3 (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 1.8 meters (**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 in place 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.

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-4 CONSTRUCTION OPERATIONS ADJACENT TO ROADWAYS

This work shall be performed in accordance with the provisions of Mn/DOT 1404, 1502, and 1707 except as modified below:

The Contractor shall, when necessary to adequately prevent undermining of the existing roadbed and protect traffic, sheet and shore the roadway side and end of each footing excavation having a traveled roadway adjacent thereto. The sheeting and shoring shall remain in place until the excavated area has been properly backfilled.

At least six weeks before starting construction of Br. No. 69071, supply the Engineer with five copies of the detailed Plans and Specifications and two copies of the associated calculations of the proposed system for constructing an installation adjacent to traveled roadways. Design the protective installations 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. Include in the documents sufficient details so that construction of the proposed system, be it staged or not staged, can be completed solely by reference to the Plans and Specifications. No work will be permitted adjacent to traveled roadways until these plans have been approved by the Engineer.

SB-5 (1717) AIR, LAND AND WATER POLLUTION

The provisions of 1717 are supplemented as follows:

The Contractor's attention is hereby directed to MPCA Rule 7011.0150 as it relates to sandblasting and/or concrete removal operations (<http://www.pca.state.mn.us/index.cfm>).

Unless otherwise provided in these special provisions, construction, demolition and/or removal operations conducted over or in the vicinity of public waters shall be so controlled as to prevent materials from falling into the water. Any materials which do fall into the water, or onto areas where there is a likelihood that they will be picked up by rising water levels, shall be retrieved and stored in areas where such likelihood does not exist.

SB-6 (2104) REMOVAL OF ASBESTOS AND REGULATED WASTE (BRIDGE)

This work shall consist of the removal and disposal of any regulated waste found on existing bridges or from the utilities located on the bridge, in accordance with the applicable Mn/DOT Standard Specifications and the following:

SB-6.1 If during the course of removal or renovation of utility or bridge, additional asbestos materials or regulated wastes, other than that noted in the Assessment Summary are encountered, the Contractor shall notify the Mn/DOT Project Engineer who shall suspend work and the Contractor shall furnish a documented inspection and evaluation by a Mn/DOT approved certified MDH contractor prior to the resumption of work. The work, as outlined in this paragraph, will be paid for as Extra Work.

SB-6.2 All asbestos and/or regulated waste shall be disposed of in accordance with Mn/DOT's manual. Only those listed in this manual as pre-approved for asbestos and/or regulated waste will be allowed to work on this Project. The Contractor's shall use Mn/DOT approved companies for testing, waste transport and disposal as provided and described in Mn/DOT's manual "*Asbestos and Regulated Waste Manual For Structure Demolition Or Relocations for Construction Projects*" available on the following website: <http://www.dot.state.mn.us/environment/regulated-materials/index.html>. Contact Mark Vogel, Mn/DOT Office of Environmental Services, 651-366-3630 with any questions regarding the manual.

SB-6.3 All material shall be removed, identified, and disposed of in accordance with Section S-1701 (LAWS TO BE OBSERVED (BRIDGE)) of these Special Provisions. The Contractor will not receive permission to begin the regulated waste removals, with the exception of material needed for hazardous and regulated waste assessment or testing, until the Engineer has copies of all required notices.

SB-6.4 The Contractor will not be allowed to proceed with the demolition or renovation of bridges until the Engineer has received copies of all required notifications as indicated in Section S-1701 (LAWS TO BE OBSERVED (BRIDGE)) of these Special Provisions.

The Contractor shall be responsible to notify any utility owners at least three (3) days prior to the removal of any regulated waste which may affect the utility allowing the utility owner time to have a representative on site.

SB-6.5 See the attached "Asbestos and Regulated Waste Assessment Summary" for information on whether or not asbestos or regulated waste was detected in the bridge to be removed or renovated.

The assessment summary included with the Plan or Special Provisions are intended for informational purposes. Quantity, type and analysis of any asbestos or regulated waste containing material are estimates intended as a general guide.

SB-7 BRIDGE ABUTMENT CONSTRUCTION

Construction of each abutment shall not be started until after the approach fill at that abutment has been constructed to the full height and cross section. The approach fill construction shall extend a distance of at least 15 m (**50 feet**) behind the abutment as measured along the centerline of the roadway.

SB-8 (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 .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

SB-8.1 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-8.2 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 be not more than 8274 kPa (**1200 psi**).
2. Cork shall comply with Mn/DOT 3702 and AASHTO M153 Type II.
3. Polystyrene shall comply with the following:

Type	Minimum Compressive Strength (5 percent deflection)	Characteristics
A	207 kPa (30 psi)	Closed Cell Expanded Polystyrene
B	69 kPa (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.

The quantity of preformed cork joint filler material given in the Plans is for the Contractor's convenience only. Any additional joint filler required shall be furnished by the Contractor with no additional compensation.

SB-8.3 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 as designated below for Bridge No. 69071.

1. Outside surfaces of barrier railing
2. Wingwalls
3. Copings
4. Edges of slabs
5. Bottom of overhangs
6. Abutments

Provide a finish color for all SSF matching Mn/DOT standard color "Gray-Modified" on file in the Mn/DOT Chemical Laboratory (651-366-5548). Provide paint free of toxic metals and toxic pigments.

Provide a test area, 1 meter x 1 meter (**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 MnDOT 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 (and medians), 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 Mn/DOT standard color "Gray-Modified" on file in the Mn/DOT Chemical Laboratory (651-366-5548). Apply the paint at a rate of 7.4 m² per L (**300 ft² per gallon**). Commence or suspend the painting operation when the air and surface temperature meet or exceed the manufacturer's recommendations.

2. Finish slipformed roadway faces and tops of barrier railings (and median), in accordance with the following:

a) Lightly broom the railing surface immediately after passage of the slipformer.

b) Coat the roadway face and top of the barrier railing as described above for the conventionally formed railing.

C. Finishing Precast Concrete Girders

Apply 100% acrylic paint (Mn/DOT 3584) on the exposed concrete surfaces as designated below for Bridge No. 69071.

1. Outside face of fascia girder
2. Bottom of bottom flange of fascia girder

Provide a finish color for acrylic paint matching Mn/DOT standard color "Gray-Modified" on file in the Mn/DOT Chemical Laboratory (651-366-5548).

D. Beam Ends Penetrating Sealer

Furnish and apply a penetrating sealer to the vertical concrete surfaces located within 6 feet of the end diaphragms of all prestressed concrete beams of Bridge No. 69071. Perform this work in accordance with the applicable provisions of MnDOT 2433, the Plans, as directed by the Engineer, and the following:

1. Apply a MnDOT approved, penetrating, solvent based silane sealer. Provide the Engineer with the sealer Manufacturer's written instructions for application and use, at least 30 calendar days before the start of the work.
2. Furnish only one of the materials listed on the Department's "Approved/Qualified Product Lists of Bridge Penetrating Sealers" (<http://www.dot.state.mn.us/products/index.html>). For products not on the Department's prequalified list, provide information as required on the web site and as stated in the following table.

Qualification Requirements for Penetrating Sealer	
Active Ingredient	Solvent-based alkylalkoxysilane with 40 % solids minimum
Resistance to Chloride Ion Penetration AASHTO T259 and T260	Less than 0.55 Chloride Content Ratio of Sealed /Unsealed at 1/2 inch level-(Adjusted for baseline chloride)
NCHRP 244 Series II	
Water Absorption	80 % reduction minimum
Absorbed chloride	85 % reduction minimum
NCHRP Series IV - Southern climate	
Absorbed chloride	95 % reduction minimum
Waterproofing after Abrasion, %, Alberta DOT Type 1a Penetrating Sealer Test	82.5 %
Moisture Vapor Transmission	80 % minimum
Penetration Depth	0.15 inch

The manufacturer of the silane product must directly ship a one quart sample of the sealer to the MnDOT Materials Lab (1400 Gervais Avenue; Maplewood, MN 55109) for quality assurance testing and IR scanning.

3. Clean all areas to be sealed by removing dirt, dust, oil, grease, curing compounds, laitance, or other contaminants that would impede the penetration of the sealant. Collect all debris and other material removed from the surface and cracks, and dispose of it in accordance with applicable federal, state, and local regulations. Immediately before applying the sealer direct a 125 psi air blast, from a compressor unit with a minimum pressure of 365 ft³ / min., over the entire surface to remove all dust and debris paying special attention to carefully clean all deck cracks. Use a suitable oil trap between the air supply and nozzle. Provide shielding as necessary to prevent dust or debris from striking vehicular traffic. Have the Engineer approve the prepared surface prior to applying the sealer.

4. Do not apply sealer materials during wet weather conditions or if adverse weather conditions are anticipated within 12 hours of the completion of sealer application. Do not mix or apply any of these products at temperatures lower or higher than those specified in their product literature. Apply the sealant at the coolest time of the day within these limitations. Application by spray methods will not be permitted during windy conditions, if the Engineer predicts unsatisfactory results.

5. Do not thin or alter the sealer unless specifically required in the Manufacturer's instructions. Mix the sealer before and during its use as recommended by the Manufacturer. Distribute the sealant with a spray bar near the surface so the spray pattern and coverage rates are reasonably uniform to the satisfaction of the Engineer. Do not allow running or puddling of the sealer to occur. Apply the sealant at a minimum rate of 180 sq. ft. / gallon and apply in two coats if running or puddling can not be controlled.

Allow the sealant to dry according to the Manufacturer's instructions.

Apply the paint at a rate of 7.4 m² per L (**300 ft² per gallon**). Commence or suspend the painting operation when the air and surface temperature meet or exceed the manufacturer's recommendations.

E. Basis of Payment

Finishing of concrete surfaces, except as otherwise provided in these special provisions, special surface finish, application of topcoat, beam ends penetrating sealer, 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-8.4 Planing of Precast Deck Panels

Delete the 3rd paragraph of 2401.3F3b(3) and substitute the following:

Special care shall be taken in finishing roadway surfaces in the vicinity of joints to ensure a smooth riding surface.

Before the application of the chip seal overlay, a surface smoothness check will be made on the bridge surfaces and approach panel surfaces. The final surface shall meet the tolerance requirements of 2401.3F3b(3). Surface areas not meeting the specified tolerances shall be corrected by removal and replacement or by grinding the high spots to the extent directed by the Engineer prior to beginning surface planing operations. Nonconforming areas that are not satisfactorily corrected shall be subject to 1503 and 1512.

Planing shall be done in a manner that will provide a smooth riding surface at joints and at the ends of the approach panels. After completion of the planing, the permissible surface deviation will be 3 mm (**1/8 inch**) in 3 meters (**10 feet**) measured with a straightedge laid longitudinally and 3 mm (**1/8 inch**) in 1 meter (**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 texture planning 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 Mn/DOT 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 \$2.70 per square meter (**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 planing.

SB-8.5 Sealant For Control Joint In Concrete Barrier

Sealant shall be a one-component, high performance, gun grade, paintable, elastomeric polyurethane sealant meeting Federal Specification TT-S-00230C, Type II, Class A and ASTM Standard C-920, Type S, Grade NS, Class 25 or higher. The following are acceptable products: Sikaflex-15 LM, High-performance, low-modulus elastomeric sealant; Sonolastic NP 1, One-component, elastomeric, gun-grade polyurethane sealant; Vulkem 116, One-Part, High Performance Polyurethane Sealant; or an engineer approved equal.

SB-9 MOCK-UP PANEL

A. Description of Work

This work consists of constructing reinforced concrete mock-up deck panels, including all necessary materials, equipment and testing to complete the work, as shown in the Plans. Reinforcement shall consist of two mats with bar size and spacing similar to that of the precast concrete deck panels for Br. No. 69071. Contractor shall construct the mock-up panel to demonstrate the ability to handle, place, finish and cure the Precast Concrete Deck Panel concrete and the structural non-shrink grout all to the tolerances shown in the Plan.

Submit shop drawings of mock-up panel to the Engineer for review before any work is started. Submit 5 copies on 11 x 17 paper.

Contractor shall demonstrate the ability of placing the proposed haunch forming material and its ability to prevent leaking of the non-shrink grout.

Contractor shall demonstrate the ability of the proposed foam backer rod in the transverse deck panel joint to prevent leakage of the non-shrink grout.

Contractor shall demonstrate the ability of the vertical adjustment assemblies to distribute loads uniformly to the mock-up beams and the ability to adjust the panels to required grade and tolerances as required by the Plans and these Special Provisions.

Contractor shall demonstrate the ability of the structural non-shrink grout and placement method to fill the spaces in the haunches, transverse panel joint, shear pocket blockouts and post-tensioning duct splice blockouts without the formation of any voids.

The Contractor shall furnish, install, place, finish, cure, demonstrate and test the mock-up panel as specified in the Plans and these Special Provisions; using the same personnel, methods, equipment and material that the Contractor intends to use on Br. No. 69071.

Not less than one week after construction of the mock-up panel, the Contractor shall take twelve full-depth cores, at location agreed to by the Engineer. The full-depth cores shall be a minimum of 6" in diameter and extend from the top of the precast panel to the bottom of the haunch or bottom of the precast panel depending on the location. The cores shall be visually examined by the Engineer to determine uniformity, consolidation and the extent of voids in the concrete and non-shrink grout.

Acceptance of the mock-up panel is contingent upon demonstrating that the requirements of this specification are satisfied for placement, consolidation, finishing, curing, performance and testing. If unsatisfactory results are obtained, the Contractor shall submit a written procedure to the Engineer for review identifying corrective actions for non-conforming results.

The mock-up panel shall be removed and disposed of by the Contractor.

The mock-up panel construction, grouting, curing and testing shall be performed at the same location the Precast Concrete Deck Panels are fabricated.

The mock-up panel construction, grouting, curing and testing shall be performed before the Precast Concrete Deck Panels are fabricated.

SB-9.1 Basis of Payment

Payment for Item No. 2405.601, "MOCK-UP PANEL", will be made at the Contract price per Lump Sum and will be compensation in full for all costs of manufacturing, testing and disposal of this work.

SB-10 PRECAST CONCRETE DECK PANEL

A. Description of Work

This work consists of furnishing, erecting, grouting, and installing precast concrete deck panels including all necessary materials and equipment to complete the work as shown in the Plans.

SB-10.1 Materials

A. Precast concrete deck panels shall be installed and transported 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 panels. The precast panels shall be temporarily anchored, braced, and stabilized as they are transported and erected so as to preclude sliding, tipping, buckling, or other movement that may otherwise occur. Struts, bracing, tie cables, and other devices used for temporary restraint shall be of a size and strength that will ensure their adequacy.

The concrete for the precast panels shall be Mn/DOT mix 3Y36.

B. Use structural non-shrink grout for haunches, shear pocket blockouts, transverse keyway, and duct splice blockouts shown on the Plans. The Contractor shall submit test results of the grout mixture verifying compliance with the following requirements:

1. Product Composition

1.1 Neat Grouts: The product shall be composed of all fine particles and have a consistency of a powder.

1.2 Extended Grouts: A 3/8 inch pea gravel aggregate extension may be used in conjunction with a neat grout. The aggregate composite shall not exceed 50% by weight.

1.3 Neat and extended grouts must comply with the specifications set forth in Section 2 through Section 9 of SB-10.1.B.

2. Compressive Strength

2.1 The product shall meet the following time-based criteria for compressive strength based on ASTM C 109:

- 1 day: Minimum 4000 psi
- 7 day: Minimum 5000 psi

2.2 If a 7 day compressive strength is not available for a product, the following criteria shall be used:

- 28 day: Minimum 6000 psi

3. Splitting Tensile Strength

3.1 The product shall meet the following time-based criteria for splitting tensile strength based on ASTM C 496:

- 1 day: Minimum 200 psi
- 7 day: Minimum 400 psi

3.2 If a 7 day splitting tensile strength is not available for a product, the following criteria shall be used:

- 28 day: Minimum 600 psi

3.3 If no splitting tensile strength information is available for a product, the following criteria shall be used:

- 1 day compressive strength divided by 15 must be greater than 300 psi
- 7 day compressive strength divided by 15 must be greater than 400 psi
- 28 day compressive strength divided by 15 must be greater than 500 psi (in lieu of 7 day strength)

4. Shrinkage

4.1 The product shall meet the following criteria for shrinkage based on either ASTM C 157 or ASTM C 596. Neat grouts shall be evaluated with 1 in. square cross section prisms and extended grouts shall be evaluated with 3 in. square cross section prisms. The criteria shall remain the same regardless of test prism size.

- 28 day: Maximum 0.04% (400 microstrain)

5. Sulfate Resistance

5.1 The product shall meet the following criteria for sulfate resistance based on ASTM C 1012. Neat grouts shall be evaluated with 1 in. square cross section prisms and extended grouts shall be evaluated with 3 in. square cross section prisms. The criteria shall remain the same regardless of test prism size.

- 28 week: 0.10% (1000 microstrain)

6. Freeze-Thaw Resistance

6.1 The product shall meet the following criteria for freeze-thaw resistance based on ASTM C 666, Procedure A:

- 300 Cycles: Minimum 80% Durability Factor

7. Scaling Resistance

7.1 The product shall meet the following criteria for scaling resistance based on ASTM C 672:

- 25 Cycles: 0 Scaling Rating (no scaling)

8. Mixing Procedure

8.1 If an aggregate extension is used, the aggregate shall be added to the initial water content before any powder is added.

8.2 The powder shall be added to the specified minimum water content. An additional water amount shall be supplied after approximately 80% of the product has been added to the initial water. This additional water amount may be specified by the manufacturer or may be taken as the difference between the specified maximum water content and the specified minimum water content. The specified maximum water content for a specific product shall not be exceeded. No water shall be added to the product once placement has commenced.

9. Flow

9.1 The product shall be tested on site according to SB-10.1.B.9.2, after mixing and immediately before pouring the product.

9.2 The product shall be tested on a standard flow table specified by ASTM C 230. The testing procedure shall follow ASTM C 1437 with the following modifications:

- The average diameter of the product shall be measured after the mold is lifted to determine the product's flow under its own self weight.
- The table shall then be dropped 10 times in 15 seconds.
- The average diameter of the product shall be measured after the 10 drops.
- If either the self weight or 10 drops causes the product's diameter to exceed the diameter of the table, then that measurement shall be recorded as the diameter of the table.

9.3 The product shall meet the following criteria for flow based on the procedure in 9.2:

- Minimum average diameter from self weight flow: 7 in.
- Minimum average diameter after 10 drops: 9 in.

10. Recognized Grout Products

- Set 45® Hot Weather Grout
- Five Star® Highway Patch
- Set 45® Hot Weather Grout extended with pea gravel

11. Verification

- Supply written verification to the Engineer that the chosen grout product is compatible with the chip seal wearing course

SB-10.2 Submittals

A. Submit the following to the Engineer for review and in accordance with the requirements of 1502 and these special provisions:

1. Shop Drawings:
 - a. Submit five sets, 11 x 17 inch sheets with a 1½ inch blank margin on the left-hand edge.
 - b. Place the Project designation data in the lower right-hand corner of each sheet.
 - c. Prepare shop drawings and supporting calculations certified by a Professional Engineer licensed in Minnesota.
 - d. Design, show and locate all lifting inserts, hardware or devices, and vertical adjustment hardware on the shop drawings for the Engineer's review. Design lifting hardware according to the provisions of Chapter 5 of the PCI Design Handbook.
 - e. Show type and size of longitudinal post-tensioning anchorage assembly and ducts. Design local zone reinforcing for the anchorage assembly. See SB-12.2 and SB-12.3.
 - f. Submit a Test Result for non-shrink grout to the Engineer for review.
 - g. Do not order materials or begin work until review of the shop detail drawings is complete.
 - h. Do not deviate from the shop drawings unless authorized in writing. Contractor is responsible for costs incurred due to faulty detailing or fabrication.
 - i. The Engineer reserves the right to review these drawings for up to 14 calendar days without granting an increase in the number of working days on the Project. This right applies each time the drawings are submitted or re-submitted.

2. Erection Plans:
- a. Submit five sets, 11 x 17 inch sheets with a 1½ inch blank margin on the left-hand edge.
 - b. Place the Project designation data in the lower right-hand corner of each sheet.
 - c. Prepare drawings and supporting calculations certified by a Professional Engineer licensed in Minnesota.
 - d. Check that all handling and erection stresses, deflections and bracing conform to Chapter 5 of the PCI Design Handbook.
 - e. Include the following at a minimum on the installation plans:
 - 1) Minimum clearances of reinforcing to panel edges.
 - 2) Locations and details of lifting devices including supporting calculations. Design all lifting devices based on the no cracking criteria in Chapter 5 of the PCI Design Handbook. Use a device that will have a 3" top cover and a 1 inch bottom cover after installation. Galvanize the device after fabrication per Mn/DOT Spec. 3392 or 3394.
 - 3) Type and amount of any additional reinforcing required.
 - 4) Calculations showing that tensile stresses on both faces do not exceed the modulus of rupture during the handling, fabrication, shipping, and erection of the panel.
 - 5) Minimum compressive strength attained prior to handling the panels.
 - 6) Load distribution.
 - 7) Cables and lifting equipment.
 - 8) Details of vertical adjusting hardware. Galvanize per Mn/DOT 3392 or 3394.
 - f. Include details showing the erection and installation of the proposed deck panels in accordance with the design plans.
 - g. Submit Erection Plan drawings and calculations including the following minimum information:
 - 1) Crane and pick locations
 - 2) Crane charts
 - 3) Panel erection sequence
 - 4) Vertical adjustment method for distributing panel load to Prestressed Concrete Beams uniformly and achieving grade elevation tolerances.
 - h. Submit to the Engineer for review a proposed method for forming the haunches, forming the transverse panel joints and installing the structural non-shrink grout, sequence, and equipment for grouting operation. Submit a back-up procedure in the event leaks occur during grout installation. Obtain approval prior to placing structural non-shrink grout.

- i. Submit a method of forming joints between precast panels.
- j. The Engineer reserves the right to review these drawings for up to 14 calendar days without granting an increase in the number of working days on the Project. This right applies each time the drawings are submitted or re-submitted.

B. Submit for Materials.

- 1. Supply test data for concrete panels including slump, air content and unit weight after 7, 14, and 28 days for fresh concrete and compressive strengths for the hardened concrete.
- 2. Supply certified test results from an independent accredited test laboratory for the structural non-shrink grout.

SB-10.3 Precast Concrete Deck Panel Fabricator Certification

The Contractor shall fabricate the deck panels in a precast/prestressed concrete fabrication plant that has been granted certification by the Precast/Prestressed Concrete Institute, or by an organization approved by the Materials Engineer.

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-10.4 Quality Assurance

- A. Permanently mark each precast unit with date of casting and supplier identification. Stamp markings in fresh concrete.
- B. Prevent cracking or damage during handling and storage of precast units.

- C. Defects and Breakage of Prestressed and Nonstressed Elements:
1. Elements that sustain damage or surface defects during fabrication, handling, storage, hauling, or erection are subject to review and rejection.
 2. Write and submit proposed repair procedures and obtain approval from the Engineer before performing repairs.
 3. Repair work must reestablish the element's structural integrity, durability, and aesthetics to the satisfaction of the Engineer.
 4. Determine the cause of any damage and take corrective action.
 5. Failure to take corrective action leading to similar repetitive damage is cause for rejection of the damaged elements.
 6. Cracks that extend to the nearest reinforcement plane and fine surface cracks that do not extend to the nearest reinforcement plane but are numerous or extensive are subject to review and rejection.
 7. Full depth cracking and breakage greater than nine inches in length are cause for rejection.
 8. Cracks wider than 0.007 inches shall be repaired.
- D. Construct panels to tolerances shown in the Plans.

SB-10.5 Construction

- A. Do not place concrete in the forms until the Engineer has inspected the placement of all materials in the deck panels.
- B. Finish the precast concrete deck panels as shown in the Plans.
- C. Wet cure the deck panels for 14 consecutive days. This cure is to begin immediately after performing the final finish.
1. Wet cure panels by covering all exposed surfaces with wet burlap, cotton mats, or both, and plastic sheets.
- D. Do not strip the forms before the precast panels have obtained a minimum compressive strength of 4000 psi.
- E. Immediately after completion of wet cure, the Contractor shall apply a membrane curing compound meeting requirements of Mn/DOT Specification 3754 Section B. The curing compound shall be applied with approved power operated spray equipment. The Contractor shall place membrane cure material homogeneously to provide a uniform solid white opaque coverage on only the top surface.

SB-10.6 Shear Studs on Prestressed Concrete Beams (For Shear Stud Option)

A. Installation of the Shear Studs

1. Install shear studs at the locations shown on the plans.
2. Weld shear studs to plates embedded in prestressed concrete beams according to AWS specifications.
 - a. Use method and equipment recommended by the manufacturer of the studs and approved by the Engineer.
 - b. Contractor shall provide grounding method.
 - c. Embed plate material per Mn/DOT Spec. 3306.
 - d. Welded stud material per Mn/DOT Spec. 3391.D.

SB-10.7 Installing Precast Concrete Deck Panels

- A. Fully brace concrete beams before placing deck panels. Clean and remove all debris from the top of the concrete beams.
- B. Place the precast concrete deck panels as shown in the Plans or approved working drawings.
- C. Adjust leveling devices to bring panels to the tolerances shown in the Plans. Torque all leveling devices on each panel to within 15 percent of each other to ensure proper distribution of panel weight to the supporting beams.
- D. Prevent shifting of the precast concrete deck panels during the joining of all the deck panels.

SB-10.8 Longitudinal Post Tensioning (See SB-12 for additional information)

- A. Cure Precast panels for 28 days after fabrication before tensioning of any post-installed strands.
- B. Design and show all post-tensioning hardware and blockouts. Manufacturer designed proprietary hardware is acceptable with the Engineer's approval. Seal ducts at Duct Splice Block-outs. See SB-12.2.C for details.
- C. Clean and remove all debris from blockouts and panel shear keyways.
- D. Grout panel transverse shear keyway joint between panels.

- E. Do not begin stressing operations until the grout in the transverse joint reaches the strength and age designated on the Plans. Stress strands within 72 hours of transverse joint grouting, but not until the panel transverse shear key joint grout has attained a compressive strength of 1000 psi (based on manufacturer's data).
- F. Install strands as shown in the Plans.
- G. Fully tension strands and grout all ducts (see SB-12).
- H. Visually inspect the shear stud installation and connection details. Place structural non-shrink grout in the girder haunches and shear blockouts in a continuous operation complete without voids.

SB-10.9 Preparation and Installation of Structural Non-Shrink Grout

- A. Form the girder haunches as shown in the approved Erection Plan.
- B. Clean and remove all debris from the haunches, blockouts and panel shear keyways prior to placement of the structural non-shrink grout.
- C. Keep bonding surfaces free from laitance, dirt, dust, paint, grease, oil, rust, or any contaminant other than water.
- D. Pre-test grout material installation under field conditions with the mock-up panel prior to construction of the deck to determine grout flowability and whether subsequent cracking will occur.
- E. Mix and place product following manufacturer's recommendations for preparation and installation.
- F. Place structural non-shrink grout in the girder haunches and shear blockouts in a continuous operation within a panel after all panels are fully installed.
- G. Do not allow voids in the grout.
- H. Do not apply superimposed dead loads or live loads to the precast concrete deck panels until the structural non-shrink grout in the shear blockouts and the girder haunches has reached a strength of 2500 psi based on manufacturer's published data.

- I. Cure structural non-shrink grout per manufacturer's recommendation.
 - 1. Contact the manufacturer's representative for advice on how to reduce heat such as wet curing or adding retarding admixture if the heat of hydration is excessive.

- J. Finish grout flush or a maximum of 1/8 inch above adjacent panels.
 - 1. Correct blockout and void profiles in excess of 1/8 inch higher than the adjacent panel through surface texture planing
 - 2. Correct blockout and void profiles below the top of the adjacent panels through removal and replacement of the blockout or void.
 - 3. No additional compensation will be made for any corrections to the finish of the blockout or void.

SB-10.10 Basis of Payment

Payment for Item No. 2405.618, "PRECAST DECK PANEL", will be made at the Contract price per SQUARE FOOT and will be compensation in full for all costs of manufacturing, transporting, non-shrink grout installation, and erecting the concrete panels in their final position including any temporary bracing required.

SB-11 CHIP SEAL WEARING COURSE

A. Description of Work

This work consists of furnishing and applying two layers of a two-component polymer wearing course system to the bridge decks shown on the Plans. The total thickness of the overlay system shall be 3/8" minimum.

SB-11.1 Materials

A. General

Furnish materials specifically designed for use over concrete bridge decks. Pre-qualified polymer liquid binders are as follows:

<u>Product Trade Name</u>	<u>Manufacturer or Supplier</u>	<u>Telephone</u>
Mark-163 Flexogrid	PolyCarb, Inc.	(866) 765-9227
Mark-174 Polymer Road System	Poly Carb, Inc.	(866) 765-9227
Sikadur 22 Lo-mod	Sika Corporation	(651) 261-1996
E-Bond 526 Lo-Mod	E-Bond Epoxies, Inc.	(954) 566-6555
Propxy DOT Type III	Unitex	(816) 231-7700
Flexolith	Tammes	(815) 970-5660

B. Polymer Resin

The polymer resin base and hardener shall be composed of two-component, 100% solids, 100% reactive, thermosetting compound with the following properties:

Property	Requirements	Test Method
Gel Time ^A	15 - 45 minutes @ 75° F	ASTM C881
Viscosity ^A	7 - 25 poises	ASTM D2393, Brookfield RVT, Spindle No. 3, 20 rpm
Shore D Hardness ^B	> 65	ASTM D2240
Absorption ^B	1% maximum at 24 hr	ASTM D570
Tensile Elongation ^B	30% - 70% @ 7 days	ASTM D638
Tensile Strength ^B	>2000 psi @ 7 days	ASTM D638
Flexural Strength ^B	>4500 psi @ 7 days	ASTM D790

^A Uncured, mixed epoxy binder

^B Cured, mixed epoxy binder

C. Aggregates

Furnish natural or synthetic aggregates that have a proven record of performance in applications of this type. Furnish aggregates that are non-polishing, clean, free of surface moisture, fractured or angular in shape; free from silt, clay, asphalt, or other organic materials; and meet the following properties and gradation requirements:

Aggregate Properties:

Property	Requirement	Test Method
Moisture Content	≤0.2%	ASTM C566
Hardness	≥6.5	Mohs Scale

Gradation:

Sieve Size	% Passing by Weight
No. 4	100
No. 8	30 – 75
No. 16	0 – 5
No. 30	0 – 1

D. Required Properties of Wearing Course System

The required properties of the overlay system are listed in the table below:

Property	Requirement ^A	Test Method
Minimum Compressive Strength at 8 Hrs. (psi)	1,000 psi @ 8 hrs 5,000 psi @ 24 hrs	ASTM C 579 Method B, Modified ^B
Thermal Compatibility	No Delaminations	ASTM C 884
Minimum Pull-off Strength	250 psi @ 24 hrs	ACI 503R, Appendix A

^A Based on samples cured or aged and tested at 75°F

^B Plastic inserts that will provide 2-inch by 2-inch cubes shall be placed in the oversized brass molds.

E. Approval of Bridge Deck Polymer Wearing Course System

A minimum of 20 working days prior to application, submit product data sheets and specifications from the manufacturer, product history/reference projects, and a certified test report to the Engineer for approval of the wearing course system. The engineer may request samples of the polymer and/or aggregate, prior to application, for the purpose of acceptance testing by the Department.

The product history/reference projects consist of a minimum of 5 bridge/roadway locations where the proposed wearing course system has been applied in locations with a similar climate. Include contact names for the facility owner, current phone number or e-mail address, and a brief description of the project.

A certified test report consists of a certification by an independent testing laboratory showing compliance with the requirements of this specification. Include the test results with the certification.

Product data sheets and specifications from the manufacture consists of literature from the manufacturer showing general instructions, application recommendations/methods, product properties, general instructions, or any other applicable information.

SB-11.2 Construction

A. General

Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the Engineer a copy of the recommended procedures and apply the wearing course system according to the manufacturer's instructions. The manufacturer's representative familiar with the wearing course system installation procedures, shall be present at all times during surface preparation and wearing course placement to provide quality assurance that the work is being performed properly.

Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturers recommendations. Store all aggregates in a dry environment and protect aggregates from contaminants on the job site.

B. Deck Preparation

1. Surface Preparation

Determine an acceptable shotblasting machine operation (size of shot, flow of shot, forward speed, and/or number of passes) that will provide a surface capable of a tensile bond strength greater than or equal to 250 psi or the failure area at a depth of 0.25 inches or more is greater than 50% of the test area when tested according to ACI 503R, Appendix A of the *ACI Manual of Concrete Practice*. Continue adjustment of the shotblasting machine and testing adhesion until a passing test result is obtained from the bridge.

Prepare the entire deck using the final accepted adjustments to the shotblasting machine as determined above. Thoroughly blast clean with hand-held equipment any areas inaccessible by the shotblasting equipment. Do not perform surface preparation more than 24 hours prior to the application of the overlay system.

Just prior to overlay placement, clean all dust, debris, and concrete fines from the deck surface including vertical faces of curbs and barrier walls up to a height of 2 inches above the wearing course with compressed air. When using compressed air, the air stream must be free of oil. Any grease, oil, or other foreign matter that rests on or has absorbed into the concrete shall be removed completely. Brooms shall not be used.

The Engineer may consider alternate surface preparation methods per the overlay system manufacture's recommendations. The Engineer will approve the final surface profile and deck cleanliness prior to the contractor placing the epoxy.

All deck preparation equipment will be staged at least 50' from deck so as not to get any windblown dust on the bridge prior to placement.

C. Application of the Wearing Course

Perform the handling and mixing of the epoxy resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer's instructions. Do not apply the wearing course system if any of the following exists:

- a. Ambient air temperature is below 60°F;
- b. Deck temperature is below 60°F;
- c. Moisture content in the deck exceeds 4.5% measured in accordance with ASTM D4263. A plastic sheet left taped in place for a minimum of 2 hours (ASTM D4263) or other methods approved by the Engineer shall be used to identify moisture in the deck.
- d. Rain is forecasted within 8 hours after the estimated completion time;
- e. Materials component temperatures below 50°F.
- f. Epoxy wearing course shall not be placed until all deck concrete has 28 days of cure.

After the deck has been shotblasted or during the wearing course curing period, only necessary surface preparation and wearing course application equipment will be allowed on the deck.

Begin wearing course placement as soon as possible after surface preparation operations.

The polymer wearing course shall consist of a two-course application of epoxy and aggregate. Each of the two courses shall consist of a layer of epoxy covered with a layer of aggregate in sufficient quantity to completely cover the epoxy. Apply epoxy and aggregate a minimum 2" up from deck on vertical surface of rail. Apply the epoxy and aggregate according to the manufacturer's requirements. Apply the wearing course using equipment designed for this purpose. The application machine shall feature positive displacement volumetric metering and be capable of storing and mixing the polymer resins at the proper mix ratio. Disperse the aggregate using a standard chip spreader or equivalent machine that can provide a uniform, consistent coverage of aggregate. The dry aggregate shall be applied in such a manner as to cover the epoxy mixture completely within 5 minutes. First course applications that do not receive enough aggregate before the epoxy gels shall be removed and replaced. A second course applied with insufficient aggregate may be left in place, but will require additional applications before opening to traffic.

After completion of each course, cure the wearing course according to the manufacturer's instructions. Follow the minimum cure times as prescribed by the manufacturer. Remove the excess aggregate from the surface treatment by sweeping, blowing, or vacuuming without tearing or damaging the surface; the material may be re-used if approved by the Engineer and manufacturer. Do not allow traffic on the treated area until directed by the Engineer. Brooming the excess aggregate from any layer of the wearing course shall not begin until the overlay has cured sufficiently to ensure that the brooming operations will not damage the surface.

In the event Contractor operations damages or mars the wearing course, the Contractor shall remove the damaged areas by sawcutting in rectangular sections and replacing the wearing course in accordance with this specification at no additional cost.

After the first layer of coating has cured to the point where the aggregate cannot be pulled out, apply the second layer. Prior to applying the second layer, broom and blow off the first layer with compressed air to remove all loose excess aggregate.

No traffic is allowed on lanes between first and second application.

If there are small deck panel areas that cannot freely drain water after second chip seal application, isolated areas of a third layer may be required to achieve positive drainage.

D. Application Rates

Apply the epoxy wearing course in two separate courses in accordance with the manufacturer's instructions, but not less than the following rate of application.

Course	Minimum Epoxy Rate^A (GAL/100 SF)	Aggregate^B (LBS/SY)
1	2.5	10+
2	5.0	14+

^A The minimum total applications rate is 7.5 GAL/100 SF.

^B Application of aggregate shall be of sufficient quantity to completely cover the epoxy.

E. Minimum Curing Periods

As a minimum, cure the coating as follows:

Course	Average temperature of deck, epoxy and aggregate components in °F					
	60-64	65-69	70-74	75-79	80-84	85+
1	4 hrs.	3 hrs.	2.5 hrs	2 hrs	1.5 hrs.	1 hr.
2 *	6.5 hrs.	5 hrs.	4 hrs.	3 hrs.	3 hrs.	3 hrs.

* Cure course 2 for 8 hours if the air temperature drops below 60° F during the curing period.

F. Acceptance

Acceptance of the materials will be based on the certified test report received during the approval process, a certification of compliance from the manufacturer, and results of any acceptance tests ordered or performed by the Engineer during construction.

G. Measurement

The Department will measure Chip Seal Wearing Course in area by square feet of completed and accepted work.

H. Payment

Payment will be made under Item 2404.618, "CHIP SEAL WEARING COURSE" for measured quantities at the contract bid price per square foot.

Payment is full compensation for preparing the surface; for providing the overlay; for cleanup; and for sweeping/vacuuming and disposing of excess materials.

SB-12 POST TENSIONING SYSTEM

A. Description of Work

This work shall consist of longitudinal post-tensioning of the precast deck panels. The work shall be performed in accordance with the plans, the applicable provisions of Mn/DOT 2401 and 2405, and the following:

This work includes:

1. Design calculations and working drawings.
2. Furnishing and installing the prestressing strands, including strand positioning devices for the tendons and appurtenant items necessary for the particular system to be used. Installation of the post-tensioning ducts shall be coordinated with the manufacturer of the Precast Concrete Deck Panels.
3. Furnishing and installing the anchorage system.
4. Post-tensioning the concrete deck panels.
5. Grouting the ducts and anchorage blockouts upon completion of the stressing operations. Furnishing & Installing Post-Tensioning Ducts is included in price bid for "Precast Concrete Deck Panel".
6. Protection of anchorages, clean-up, and other work necessary for installation of the system.

SB-12.1 Working Drawings

A. General:

Working drawings of the proposed Post-Tensioning System shall be submitted in accordance with the requirements of 1502 and these special provisions. Supplement the submittal requirements of SB-10.2 with the following:

The Contractor shall prepare composite drawings in plan, elevation and section which show to scale the relative positions of all items that are to be embedded in the Precast Concrete Deck Panel, the concrete cover, and the embedment depth. Such embedded items include the prestressing ducts, vents, anchorage reinforcement and hardware, and reinforcing steel strand. Such drawings shall be adequate to ensure that there will be no conflict between the planned positions of any embedded items, and that concrete cover will be adequate. If, during the preparation of such drawings, conflicts are discovered, the Contractor shall revise the working drawings for one or more of the embedded items, or proposed changes in the dimensions of the work as necessary to eliminate the conflicts or provide proper cover. Any such revisions shall be approved by the Engineer before work on an affected item is started.

The drawings shall show the method and procedure including the sequence of jacking and the type, size, and properties of the strands and the anchorage assemblies. The number of strands per tendon shall be shown. Details in addition to those shown on the contract plans shall be included for any additional reinforcing steel required to resist the concrete bursting stresses in the vicinity of the anchorage assemblies. The force or stress diagram shall be shown on the drawings. The sizes, shapes, and dimensions shall be shown for the ducts. Vent locations and details of the vents shall also be included on the drawings.

The drawings shall include complete details of the method, materials, and equipment proposed for use in the post-tensioning operations. Such details shall outline the method and sequence of jacking, show complete details of the prestressing steel, anchoring devices, type of enclosures, block-outs, and show all other data pertaining to the post-tensioning system or operations.

Calculations shall be submitted showing, at each stage of erection, the elongation of the strands at the time of jacking, the initial forces in the strands, prestress losses, parameters, and the final working forces. Calculations shall show the stresses in the anchorages and distribution plates.

Complete details shall be submitted for grouting post-tensioning tendons including the materials and proportions for grout, details of equipment for mixing and placing grout and methods of mixing and placing grout.

B. Contractor Proposed Options:

The Contractor may propose for consideration by the Engineer certain variations from the post-tensioning systems shown in the contract document.

C. Restrictions to Contractor Proposed Options:

1. Materials and devices used in the prestress system shall conform to the requirements in the following Materials Section of this Special Provision.
2. The net compressive stress in the concrete after all losses shall be at least as large as that provided by the system shown on the Plans.
3. The Contractor shall submit 5 sets of complete shop drawings including the prestressing scheme and system, reinforcing steel, and concrete cover; and design calculations (including short and long term prestress losses) for the Engineer's approval.

SB-12.2 Materials

A. Post-Tensioning Anchorages

All post-tensioning steel shall be secured at the ends by means of permanent type anchoring device. Prestress anchorages shall develop at least 95 percent of the guaranteed ultimate tensile strength of the prestressing steel.

Testing of anchorage devices shall be performed by an independent testing agency in accordance with the procedures described in Division II Article 10.3.2 of AASHTO. The anchorage device shall meet the acceptance criteria specified in Division II Article 10.3.2.3.10 for a moderately aggressive environment using samples representing the type of post-tensioning steel and concrete strength to be used on the project. The test specimen shall be assembled in an unbonded state and, in testing, the anticipated anchor set shall not be exceeded. Certified copies of test results for the anchorage system shall be supplied to the Engineer. The anchorage system shall be so arranged that the prestressing force in the tendon may be verified prior to the removal of the stressing equipment.

For tendon anchorages, the design and furnishing of local zone reinforcement in accordance with AASHTO Division I, Section 9.21 (in addition to the reinforcement shown on the plans) shall be the responsibility of the Contractor.

Post-tensioning anchorage devices shall effectively distribute prestressing loads to the concrete and shall conform to the following requirements.

- a. The bearing stress in the concrete created by the anchorage plates shall not exceed the values per AASHTO Division I, Section 9.21.

b. Bending stresses in the plates or assemblies induced by the pull of the post-tensioning steel shall not exceed the yield point of the material in the anchorage plate when 95 percent of the ultimate strength of the tendon is applied. Nor shall it cause visual distortion of the anchor plate as determined by the Engineer.

B. Ducts

1. General

All duct material shall be sufficiently rigid to withstand loads imposed during placing of concrete and internal pressure during grouting while maintaining its shape, remaining in proper alignment and remaining watertight.

The duct system, including splices and joints shall effectively prevent entrance of cement paste or water into the system and shall effectively contain pressurized grout during grouting of the tendon. The duct system shall also be capable of withstanding water pressure during flushing of a duct in the event the grouting operation is aborted.

The interior diameter of ducts for single strand, bar or wire tendons shall be at least 6 mm ($\frac{1}{2}$ inch) greater than the nominal diameter of the tendon. The interior diameter of ducts for tendons consisting of more than one strand, bar or wire shall be such that the interior area is not less than 2.5 times the net area of the prestressing steel.

C. Specific Material Properties

1. Heat Shrink Sleeves

Ensure the heat shrink sleeves have an adhesive layer that will withstand 150° 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°F	216°F
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
Shrinkage		33%	23%

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

2. Type C - Corrugated Plastic Duct

Do not use ducts manufactured from recycled material. Use seamless fabrication methods to manufacture ducts.

Use corrugated duct manufactured from unfilled polypropylene or polyethylene. The polypropylene duct shall meet the requirements of ASTM D4101 “Standard Specification for Polypropylene Plastic Injection and Extrusion Materials” with a cell classification range of PP0340B14542 to PP0340B67884.

The polyethylene duct shall be corrugated high-density material conforming to the requirements of ASTM D 3350 “Standard Specification for Polyethylene Plastics Pipe and Fittings” Type III, Class C, Category 5, Grade P33.

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 in 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 % GUTS in a maximum length of 16 duct diameters.

D. Minimum Radius of Curvature

Tendon ducts shall be installed with a radius of curvature shown in the Plans.

E. Grout and Grout Storage

a. Use only pre-packaged grouts that meet the specifications of the table below. Select the post-tensioning grout for use by the proper application either repair or horizontal. Pre-packaged grout shall be mixed with potable water. Maintain grout fluidity in strict compliance with the grout manufacturer’s recommendations and test with a flow cone.

b. 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.

Grout Properties

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 18-25°C (**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*
Property	Test Value	Test Method
Hardened Height Change @ 24 hours and 28 days	0.0% to + 0.2%	ASTM C 1090**
Expansion	≤ 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)	≥ 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 with remixing for 30 sec	Max. 30 Sec.	ASTM C 939
	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 0.5 m (**20 inch**) length of ASTM A416 seven wire 12.7 mm (**0.5 inch**) diameter strand. Wrap the strand with 50 mm (**2 inch**) wide duct or electrical tape at each end prior to cuffing 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 18 to 24°C (**65 to 75°F**).

(c) Mix the conditioned dry ingredients with the conditioned mixing water and place 800 ml (**27 oz.**) of the resulting grout into the 1,000 ml (**1 quart**) 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.

Simulated Field High Temperature Fluidity Test.

Perform a conditioned laboratory high temperature grout fluidity test as described below using production grouting equipment utilizing both mixing and storage tanks. Grouts must conform to the requirements of SB-12.2.E including initial fluidity test. For the test to be successful, the grout must have an efflux time of not greater than 30 seconds at the end of the one hour test period. Efflux time may be determined by either ASTM C939 or the modified ASTM C939 described herein.

(a) Perform the test in a temperature conditioned laboratory. Condition the room, grout, water, duct, pump, mixer and all other equipment to be used to a temperature of 32.5°C (**90°F**) for a minimum of 12 hours prior to the test.

(b) Use 122 m ± 3 m (**400 feet ± 10 feet**) of duct (tube) for the test. Use a duct with a nominal inside diameter of 25 mm (**1 inch**).

(c) Mix the grout to the specified water content. Pump the grout through the duct until the grout discharges from the outlet end of the duct and is returned to the pump.

(d) Start the one hour test period after the duct is completely filled with grout. Record the time to circulate the grout through the duct. Constantly pump and recirculate the grout into the commercial grout mixer storage tank.

(e) Pump and recirculate the grout for a minimum of one hour.

(f) Record at 15 minute intervals throughout the test period, the pumping pressure at the inlet, grout temperature, and fluidity at the discharge outlet.

F. Prestressing Steel

1. Strand: Unless otherwise noted on the plans, use uncoated strand meeting requirements of AASHTO M203, ASTM A416, (Grade 270), low relaxation 7-wire strand meeting the requirements of ASTM A 416).

G. Inlets, Outlets, Valves and Plugs

1. Provide permanent grout inlets, outlets, and threaded plugs made of ASTM A 240 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 of 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. 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. 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 of 3/4 inch for strand and 3/8 inch for single bar tendons and four-strand duct.

3. Provide dual mechanical shutoff valves when performing vertical grouting.

4. Temporary items, not part of the permanent structure, shall be specifically designated on the PT System drawings and may be made of any suitable material.

H. Permanent Grout caps

1. Use permanent grout caps made from fiber reinforced polymer or ASTM A 240 Type 316L stainless steel. The resins used in the fiber reinforced polymer shall be either 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). For products made from nylon a cell class of S-PA0141 (weathering resistant) is required.

2. 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 A 240 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.

SB-12.3 Construction Requirements

A. Protection of Prestressing Steel

Prestressing steel shall be protected against physical damage at all times from manufacture to grouting or encasing in concrete. Prestressing steel that has sustained physical damage at any time will be rejected. Any reel that is found to contain broken wires will be rejected and the reel shall be replaced.

Prestressing steel shall be packaged in containers or shipping forms for protection of the steel against physical damage and corrosion during shipping and storage. A corrosion inhibitor, which prevents rust or other results or corrosion, shall be placed in the package or form, shall be incorporated in a corrosion inhibitor carrier type packaging material, or, when permitted by the engineer, a corrosion inhibitor may be applied directly to the steel. The corrosion inhibitor shall have no deleterious effect on the steel or concrete or bond strength of steel to concrete. Inhibitor carrier type packaging material shall conform to the provisions of Federal Specifications MIL-P-3420. Packaging or forms damaged from any cause shall be immediately replaced or restored to original condition.

The shipping package or form shall be clearly marked with the heat number and with a statement that the package contains high-strength prestressing steel, and care is to be used in handling. The type and amount of corrosion inhibitor used, the date when placed, safety orders and instructions for use shall also be marked on the package or form.

The prestressing steel shall be stored in a manner which will prevent the packing material from becoming saturated with water and will allow a free flow of air around the packages. If the useful life of the corrosion inhibitor in the package expires, it shall immediately be rejuvenated or replaced.

At the time the prestressing steel is installed in the tendons, it shall be free from loose rust, loose mill scale, dirt, paint, oil, grease or other deleterious material. Removal of tightly adhering rust or mill scale will not be required. Prestressing steel which has experienced rusting to the extent that it exhibits pits visible to the naked eye shall not be used in the work.

If the period of time between installation of prestressing steel and grouting of the tendon will exceed 10 calendar days, the prestressing steel shall be protected from corrosion during the entire period it is in place but ungrouted as provided below.

When the plans provide for prestressing steel to be installed in one unit with a length of prestressing steel left projecting to be threaded into another unit during erection, all of the prestressing shall be protected from corrosion from immediately after it is installed in the first unit until the tendon is grouted in the second unit as provided below.

When corrosion protection of in-place prestressing steel is required, a corrosion inhibitor which prevents rust or other results of corrosion shall be applied directly to the prestressing steel. The corrosion inhibitor shall have no deleterious effect on the prestressing steel or grout or bonding of the prestressing steel to the grout. The inhibitor shall be water soluble. The corrosion inhibitor, the amount and time of initial application, and the frequency of reapplication shall be subject to the Engineer's approval.

B. Installation of Ducts

Ducts shall be securely tied in position, carefully inspected and repaired before placing of the concrete is started. Care shall be exercised during placement of the concrete to avoid displacing or damaging the ducts. Internal ducts shall be supported at intervals of not more than 0.6 meters (**2 feet**). Any additional mild reinforcing required to support post-tensioning ducts shall be supplied by the contractor with no additional compensation. The tolerance on the location of the tendons shall be plus or minus 3 mm (**1/8 inch**) at any point. After installation in the forms, the ends of ducts shall at all times be sealed to prevent entry of water and debris.

All ducts or anchorage assemblies for permanent post-tensioning shall be provided with vent pipes or other suitable connections at each end and at each side of couplers for the injection of grout after post-tensioning. Ducts, except vertical ducts, shall be vented at the high points of the post-tensioning steel profile when there is more than a 150 mm (**6 inch**) variation in the vertical position of the duct. All low points shall be vented if freezing weather conditions are anticipated prior to grouting. Vents shall be 13 mm (**½ inch**) minimum diameter standard pipe or suitable plastic pipe. All connections to ducts shall be made with metallic or plastic structural fasteners. Waterproof tape shall be used at all connections including vent and grouting pipes. Plastic components, if selected and approved, shall not react with the concrete or enhance corrosion of the post-tensioning steel, and shall be free of water soluble chlorides. The vents shall be mortar tight, taped as necessary, and shall provide means for injection of grout through the vents and for sealing the vents. Ends of steel vents shall be removed at least 25 mm (**one inch**) below the concrete surface after the grout has set. Vents shall be properly grouted over with an epoxy grout. Ends of plastic vents shall be removed to the surface of the concrete after the grout has set.

All grout injection and vent pipes shall be fitted with positive mechanical shut-off valves. Vents and injection pipes shall be filled with valves, caps or other devices capable of withstanding the pumping pressures.

C. Testing of Prestressing Tendons by the Contractor

1. Test Data

The Contractor shall provide, in graph form, load extension test data for strand samples taken from each coil to be used in the work. This data shall be submitted to the Engineer at least one week prior to the use in the work of any of the strand from the coil.

All strand coils shipped to the Project shall be identified by the use of metallic tags, or other equally durable means, indicating the heat number and physical properties of the material. The marking system shall remain in place until the entire coil has been used up. All strand received at the Project that does not have the required identification, as described above, will be rejected.

D. Post-Tensioning Operations

1. Stress in Tendons

The post-tensioning forces shown are theoretical and do not include losses in the system or thermal effects.

All post-tensioning shall be tensioned by means of hydraulic jacks so that the force of the post-tensioning steel shall not be less than the value shown on the approved working drawings. The maximum temporary tensile stress (jacking stress) in prestressing steel shall not exceed 81 percent of the guaranteed ultimate tensile strength (GUTS) of the post-tensioning steel. The post-tensioning steel shall be anchored in a way that will result in the ultimate retention of forces not less than those shown on the approved working drawings, but in no case shall the stress, after anchor set, exceed 70 percent of the guaranteed ultimate tensile strength of the prestressing steel at the anchorage nor 75% at the end of the anchorage seating zone.

When friction must be reduced, water soluble oil or graphite with no corrosive agents may be used as a lubricant subject to the approval of the Engineer. Lubricants shall be flushed from the duct as soon as possible after stressing is completed by use of water pressure. These ducts shall be flushed again just prior to the grouting operations. Each time the ducts are flushed, they shall be immediately blown dry with oil-free air.

2. Stressing Jacks

Each jack used to stress tendons shall be equipped with a pressure gauge having an accurate reading dial at least 150 mm (**6 inch**) in diameter for determining the jack pressure. The display indicator on the gauge shall be readable by normal vision at a distance of 3.05 meters (**10 feet**). Prior to use for stressing on the project, each jack and its gauge shall be calibrated as a unit by a testing laboratory approved by the Engineer.

Calibration shall be done with the cylinder extension approximately in the position that it will be when applying the final jacking force and with the jacking assembly in an identical configuration to that which will be used at the job site (i.e. same length hydraulic lines). Certified calibration calculations and a calibration chart, both in Metric units of measure, shall be furnished to the Engineer for each jack.

Recalibration of each jack shall be done at six month intervals and at other times when requested by the Engineer. At the option of the Contractor, calibrations subsequent to the initial laboratory calibration may be accomplished by the use of a master gauge. The master gauge shall be calibrated at the same time as the initial calibration of the jacks, and shall be part of the unit for each jack. The data recorded during the initial calibrations shall be furnished to the Engineer for use in the field. The master gauge shall be supplied by the Contractor in a protective waterproof container capable of protecting the calibration of the master gauge during shipment. The contractor shall provide a quick-attach coupler next to the permanent gauge in the hydraulic lines which enables the quick and easy installation of the master gauge to verify the permanent gauge readings. The master gauge shall remain in the possession of the Engineer for the duration of the project. If a jack is repaired or modified, including replacing the seals or changing the length of the hydraulic lines, the jack shall be recalibrated by the approved testing laboratory. No extra compensation will be allowed for the initial or subsequent jack calibrations or for the use and required calibration of a master gauge.

3. Stressing of Tendons

Post-tensioning forces shall not be applied until the concrete has attained the specified compressive strength as evidenced by tests on representative samples of the concrete. These samples shall be stored under the same conditions as the concrete in order to accurately represent the curing condition of the concrete in place.

The tensioning process shall be so conducted that tension being applied and the elongation of the post-tensioning steel may be measured at all times. A permanent record shall be kept of gauge pressures and elongations at all times and shall be submitted to the Engineer. The post-tensioning force may be verified as deemed necessary by the Engineer.

For all tendons the elongation coinciding with the tendon force measured by gauge pressure shall agree within seven percent of the theoretical calculated elongation for the entire operation. When provisional (unused) ducts are installed to accommodate future additional post-tensioning, the tolerance will be 7%. Any deviation shall be checked and the source of error determined and remedied to the satisfaction of the Engineer before proceeding with the work. Elongations shall be measured to the nearest millimeter. In determining why the measured tendon force and the theoretical elongation do not agree within five percent, the Contractor may elect to establish that the apparent modulus of elasticity of the Post-tensioning steel varies from the value shown in the general notes to the plans by conducting a bench test on a full size tendon in accordance with a procedure furnished by the Engineer. This test may be performed at a site remote from the project provided that the Contractor pays the cost to the Engineer of sending a representative to witness the test. Equipment for tensioning the tendons must be furnished by the manufacturer of the system. Should agreement between pressure gauge readings and measured elongations fall outside the acceptable tolerances, the Engineer may require without additional compensation to the Contractor, additional in-place friction tests in accordance with these Special Provisions.

In the event that more than two percent of the individual strand wires in a tendon break during the tensioning operation, the tendon shall be removed and replaced. Previously tensioned strands shall not be allowed unless approved by the Engineer.

Post-tensioning steel shall be cut by an abrasive saw within 19 mm to 38 mm (**3/4" to 1½ inch**) away from the anchoring device. Flame cutting of post-tensioning steel is not allowed, except for pretensioned prestressing steel.

4. Record of Stressing Operations: Keep a record of the following post-tensioning operations for each tendon installed:

1. Project name, Financial Project ID;
2. Contractor and/or subcontractor;
3. Tendon location, size and type;
4. Date tendon was first installed in ducts;
5. Reel number for strands and heat number for bars;
6. Tendon cross-sectional area;
7. Modulus of elasticity;
8. Date Stressed;
9. Jack and Gauge numbers per end of tendon;
10. Required jacking force;
11. Gauge pressures;
12. Elongations (theoretical and actual);
13. Anchor sets (anticipated and actual);

14. Stressing sequence (i.e. tendons to be stressed before and after);
15. Stressing mode (one end/ two ends /simultaneous);
16. Witnesses to stressing operation (Contractor and inspector);
17. Date grouted

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

5. 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 five minutes. A pressure loss of 10 psi is acceptable. If the pressure loss exceeds 10 psi, repair leaking connections using methods approved by the Engineer.

E. 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:

1. Names and proof of training for the grouting crew and the crew supervisor in conformance with this specification;
2. Type, quantity, and brand of materials used in grouting including all certifications required;
3. Type of equipment furnished, including capacity in relation to demand and working condition, as well as back-up equipment and spare parts;
4. General grouting procedure;
5. Duct pressure test and repair procedures;
6. Method to be used to control the rate of flow within ducts;
7. Theoretical grout volume calculations;
8. Mixing and pumping procedures;
9. Direction of grouting;
10. Sequence of use of the inlets and outlet pipes;
11. Procedures for handling blockages;
12. Procedures for possible post grouting repair.

b. Before grouting operations begin, a pre-grouting conference 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.

c. 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.

d. 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.

e. Equipment:

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.

1. Provide an air compressor and hoses with sufficient output to perform the required functions.
2. Provide vacuum grouting equipment (volumetric measuring type) prior to the start of grouting operations and retain the equipment on the job during the duration of tendon grouting operations.

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.

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 ft) 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.

Vacuum Grouting Equipment: Provide vacuum grouting equipment at the job site, concurrently with all pressure grouting operations, consisting of the following:

Volumeter for the measurement of void volume.

Vacuum pump with a minimum capacity of 10 cfm and equipped with flow-meter capable of measuring amount of grout being injected.

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

Standard colloidal mixers, for voids 20 liters and greater in volume.

Stand-by Equipment: During grouting operations, provide a stand-by grout mixer and pump.

F. Grouting:

1. General: Perform test to confirm the accuracy of the volume-measuring component of the vacuum grouting equipment each day before performing any grouting operations. Use either water or grout for testing using standard testing devices with volumes of 0.5 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 device volume and must verify the accuracy of the grout volume component of the vacuum grouting equipment within 5% of the test device volume. Ensure the Engineer is present when any tests are performed. Grout tendons in accordance with the procedures set forth in the approved grouting operation plan. Grout all empty ducts.

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.
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. Perform fluidity test for every other 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, 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.

Perform a wick induced bleed test in accordance with manufacturer's recommendations at the beginning of each days grouting operation for the initial two cantilevers and spans being precast or erected. Frequency may be reduced to the first and every third day of consecutive grouting operations should zero bleed is consistently achieved.

If zero bleed is not achieved at the end of the required time period, 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.

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. 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.

6. Construction Traffic and Operations Causing Vibrations: During grouting and for a period of 4 hours upon completion of grouting, eliminate vibrations from sources such as moving vehicles on the partially completed superstructure as well as jackhammers, compressors, generators, pile driving operations and soil compaction operations 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 24 to 48 hours. Perform inspections within one hour after the removal of the inlet/outlet. After the grout has cured, remove all outlets located at anchorages and high points along the tendon to facilitate inspection. Drill and inspect the inlets or outlets located at the anchorages only if there are voids or problems that exist during grouting operations. 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 as. 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.

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-12.4 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.

When blockouts are used, the following shall apply: Epoxy coated mesh shall be placed across the anchor head block out and tied to the in-place reinforcement with plastic coated wire ties. An approved high strength and low shrinkage grout shall then be placed over the anchor heads. After the grout has cured, an approved epoxy paint (which does not delaminate) shall be placed over the concrete block out. The entire block out plus at least 300 mm (**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-12.5 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, stressing and grouting all temporary and permanent post-tensioning tendons. Payment includes submittals, anchorage assemblies, 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.

Furnishing and installing Post-Tensioning Ducts and duct splices are included in price bid for "Precast Concrete Deck Panel".

SB-13 (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.

SB-13.1 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-13.2 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-14 (2442) REMOVAL OF EXISTING BRIDGES

The provisions of Mn/DOT Specification 2442 shall apply except as supplemented herein.

Disposal of materials by the Contractor shall be in accordance with 1506, 2104.3C, 2442, Mn/DOT "Asbestos and Regulated Waste Manual for Structure Demolition or Relocations for Construction Projects" and the following: The Contractor shall furnish written information to the Engineer as to disposal of steel bridge beams and other steel bridge components coated with lead paint. This information shall include method of stabilization and disposal; name, address, and telephone number of disposal site; certification that Contractor has notified disposal site of presence of lead paint; acknowledgment by Contractor of OSHA requirements relating to lead; and certification that Contractor is familiar with proper handling and disposal of materials with lead-based paint systems. All lead paint that has been identified as peeling must be stabilized by coating with a paint or similar material that will prevent the peeling paint from flaking during demolition, or must be scraped. This must all be completed as per the Mn/DOT "Asbestos and Regulated Waste Manual for Structure Demolition or Relocations for Construction Projects". The form supplied in this special provision shall consist of the signature of the authorized Superintendent verifying that the information is correct.

SB-14.1 Salvaged Materials

No salvage of materials is required.

SB-15 (2451) STRUCTURE EXCAVATIONS AND BACKFILLS

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

SB-15.1 Structure Excavation

The item Structure Excavation shall include all excavation, sheeting and shoring and/or other protection, preparation of foundation, and placing of backfill necessary for construction of Bridge No. 69071, which is not specifically included in the grading portion of the Contract. It shall also include the disposal of surplus material.

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".

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

Each Abutment 50%

SB-16 (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.

SB-16.1 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-16.2 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 appropriate corresponding field control method indicated in the Plans. Unless otherwise specified, if more than one field control method is shown, the method used shall be determined in accordance with the following:

- When the "Pile Analysis" pay item is included for a bridge, the Pile Driving Analyzer (PDA) shall be required for the field control.
- When the "Pile Analysis" pay item is not included for a bridge, the field control method shall be at the Contractor's option. The cost of the PDA shall be incidental to the cost of Piling Driven.

B1. Mn/DOT Nominal Resistance Pile Driving Formula Used as Field Control Method

The nominal pile bearing resistance shall be determined by dynamic formula as follows:

All types of piling driven with power-driven hammers.

$$R_n (metric) = \frac{867E}{S+5} \times \frac{W + (CxM)}{W + M} \qquad R_n (english) = \frac{10.5E}{S+0.2} \times \frac{W + (CxM)}{W + M}$$

WHERE:

- R_n = Nominal Pile Bearing Resistance in Newtons (**pounds**).
- W = Mass of the striking part of the hammer in kilograms (**pounds**).
- H = Height of fall in millimeters (**feet**).
- S = Average penetration in millimeters (**inches**) per blow for the last 10 or 20 blows, except in cases where the pile may be damaged by this number of blows.
- M = Total mass of pile plus mass of the driving cap in kilograms (**pounds**).
- C = 0.1 for Timber, Concrete and shell type piles, 0.2 for Steel H piling

*The following definition is for Metric units. See English units below:

- E = $WH \times 0.00981$ for single acting power-driven hammers. It is equal to the joules or newton-meters (joule = newton-meter) of energy per blow for each full stroke of either single acting or double acting hammers as given by the manufacturer's rating for the speed at which the hammer operates.

*The following definition is for English units:

- E = WH for single acting power-driven hammers. It is equal to the foot pounds of energy per blow for each full stroke of either single acting or double acting hammers as given by the manufacturer's rating for the speed at which the hammer operates.

NOTES:

When provisions are not made available for field determination of the energy output on a power-driven hammer, such as measurement of the drop for single-acting hammers, or such as pressure gauges or determination of energy on the basis of the frequency of the blows (cycles per minute) for double-acting hammers, the manufacturer's rated energy shall be reduced by 25 percent. This reduction is not intended to apply when determining the required hammer size. Double-acting hammers, for the purpose of these requirements, will include all hammers for which a power source is utilized for acceleration of the down-stroke of the ram. The dynamic formula specified herein-before are applicable only when:

- (a) The hammer has a free fall.
- (b) The head of the pile is free from broomed or crushed fibre.
- (c) The penetration of the pile is at a reasonably uniform rate.
- (d) There is not noticeable bounce after the blow. When there is a noticeable bounce, twice the bounce height shall be deducted from H to determine the value of H in the formula.

B2. 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-16.3 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 re-driving 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 Department reserves the right to increase or decrease the number of piles which are required to be dynamically monitored.

When the Pile Driving Analyzer field control method is not required by the contract but is chosen at the Contractor's option, no measurement will be made of the analyses performed and all costs associated with the dynamic testing will be at the Contractor's expense.

SB-16.4 Pile Tip Protection

This work consists of furnishing pile tip protection for steel H-piles in accordance with the following:

A. The Contractor shall:

1. Provide an approved H-pile tip protector from the "Approved/Qualified Product List for Bridge Products, "H-pile Tip Protection" (<http://www.dot.state.mn.us/products>). For products not on the Department's prequalified list, provide information as required on the web site.

2. Attach cast steel points to the piles in accordance with the manufacturer's recommendations.

B. Payment for pile tip protection will be by the number of authorized piles, including test piles, with their tips protected.

C. Payment will be made under Item 2452.602 "PILE TIP PROTECTION 10 INCH", at the Contract price per each. Payment will be compensation in full for all costs of furnishing and attaching tips to the piles.

SB-17 (2401) STRUCTURAL CONCRETE (3Y33HP) SPECIAL: (Contractor Concrete Mix Design)

For Bridge No. 69071, the Contractor shall design a 3Y33HP concrete mixture for the end diaphragm closure pours and longitudinal closure pour that will minimize shrinkage and cracking. The work shall be performed in accordance with the requirements of Mn/DOT 2461 and the following:

The Contractor shall be responsible for determining the appropriate concrete mix design proportions based on a volume of 1.000 cubic yard and testing the mixes in accordance with the requirements.

Any Mn/DOT approved admixture including water reducers, super-plasticizers, retarders, accelerators, and any Viscosity Modifying Admixture (VMA) or a combination thereof may be used at the discretion of the Contractor. The approved list is on file in the Mn/DOT Concrete Unit or can be found at the following web site:

www.dot.state.mn.us/products

If any adjustments are made on site they shall be done with the addition of admixtures originally incorporated into the mix. No water will be allowed to be added on site, except that required to dilute the admixture for mixing (less than 1 gallon). The load shall be mixed a minimum of 50 revolutions after an addition of the admixture.

A. Specific requirements for 3Y33HP concrete:

1. Cement complying with ASTM C 150 Type I or I/II or ASTM C595 blended cement currently on the Mn/DOT approved list shall be used. Up to a total of 30 percent replacement by mass (weight) with fly ash conforming to ASTM C618, ground granulated blast furnace slag conforming to ASTM C 989, and/or Silica Fume conforming to ASTM C 1240 may be used. Replacement with Silica Fume shall not exceed 5 percent of the total cementitious material.
2. The Contractor shall designate a 3" slump range. The slump shall be kept consistent during the entire placement.

3. The coarse aggregate shall be class A, B, or C. Mn/DOT 3137.2D2(h) is hereby deleted and the following is inserted: The maximum absorption of class B aggregate shall be 1.10%.
4. The Contractor shall use any good standard practice to develop a job mix formula and gradation working range by using procedures such as but not limited to 8-18, 8-20 gradation control, Shilstone process, FHWA 0.45 power chart or any other performance related gradation control to produce a workable and pumpable concrete mixture meeting all the requirements of this Contract.
5. The mixture shall be designed and produced at a water/cementitious ratio of not greater than 0.45.
6. The air content shall be 6.5 percent plus 2.0 percent or minus 1.5 percent at the point of placement.
7. The shrinkage of the concrete when performed in accordance with ASTM C157 shall not be greater than .040 percent at 28 days.
8. The concrete will obtain an anticipated strength of 4300psi at 28 days when measured in accordance with ASTM C31.

B. Mix design submittals

The Contractor shall submit the following to the Engineer and Mn/DOT for review prior to the beginning of laboratory tests for the mix designs.

1. A completed Contractor mix design form using the Mn/DOT Contractor Mix Design Submittal package available from the Mn/DOT Concrete Engineering website. Any changes or adjustments to the material or mix design require a new Contractor mix design submittal. For mix design calculations, Mn/DOT Concrete Unit will provide specific gravity and absorption data.
2. A Job Mix Formula (JMF) containing proportions of materials and individual gradations of each material, plus a composite gradation.
3. The dosage and types of admixtures proposed for use and their purpose.

C. Laboratory testing requirements and submittals:

To determine the characteristics of the Contractor proposed mix design, the Contractor will be required to prepare test batches and do laboratory testing. The following tests shall be conducted at an AMRL certified laboratory using the exact materials proposed in the mix design:

Lab testing requirements:

1. Slump and air content.
2. Compressive strength at 28 days.
3. Concrete shrinkage (ASTM C 157) at 28 days.

All testing for plastic concrete shall be performed after admixtures have been added to the concrete mixture.

The mix design used in the permanent work shall be of the same materials, same supplier, and same supplier's manufacturing plant, and proportions as were used in the approved test mix. Strength requirements specified for each mix shall also be applicable to the cylinder tests taken during the production work.

D. Basis of Payment

Payment for Item No. 2401.607, "STRUCTURAL CONCRETE (3Y33HP) SPECIAL", will be made at the Contract price per cubic yard and will be compensation in full for all costs of designing the concrete mix, constructing the closure pours in place, mix design submittals, laboratory testing and test submittals.

SB-18 (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 Department 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 Department. A copy of the Departments 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-19 (2511) RIPRAP – GEOTEXTILE FILTER TYPE IV (MODIFIED)

The provisions of Mn/DOT 2511 are modified and/or supplemented with the following:

SB-19.1 Adhere to 2511.2 and 3733 material requirements except as modified below:

Modify 3733.2A as follows:

Delete the first sentence of the first paragraph and replace with the following:
 Use non-woven needle punched fabric for geotextile.

Modify 3733.2B as follows:

Delete the first sentence of section and replace with the following:

Geotextile property requirements are the same as shown in Table 3733-1 except as modified below:

Table 3733-1 (Modified):

Geotextile Property	Test Method (ASTM) Units	Type (A)
		IV
B1 Grab Tensile Strength minimum, each principal direction	D4632 kN (pounds)	1.45 (315)

SB-19.2 Delete the second paragraph of 2511.3A and replace with the following:

Place riprap on a filter material, to the thickness and extent specified in the plans.

Delete the last paragraph of 2511.3B2 and replace with the following:

Place Geotextile Filter as shown in the Plans.

SB-19.3 Measurement will be made to the nearest square yard of area on the basis of actual surface dimensions as staked, with no allowance for overlaps or seams.

SB-19.4 Payment will be made under Item 2511.515 "GEOTEXTILE FILTER, TYPE IV (MODIFIED)" at the Contract bid price per square yard, which shall be payment in full for all costs involved, including the geotextile filter, labor and equipment.

SB-20 (3372) STEEL PILING

The provisions of 3372.2 shall apply except as modified below:

The first paragraph of 3372.2 is hereby deleted and the following substituted therefore:

Steel H-piles shall be bearing sections of the size and mass per unit of length specified in the Plans and shall conform to ASTM A572M/**A572**, Grade 345 (**50**) for carbon steel shapes of structural quality.

SB-21 (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 3 mm (**1/8"**) nor more than 10 mm (**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 3 mm (**1/8"**) nor more than 10 mm (**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.

SB-21.1 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 415 MPa (**60,000 psi**), an ultimate tensile strength of 660 MPa (**95,000 psi**), and a minimum elongation of 20 percent in 50 mm (**2 inches**). The nuts are to meet the requirements of ASTM F 594, Condition CW1, Type 304, 316, or 316L.

SB-22 (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.