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JOB SPECIAL PROVISIONS TABLE OF CONTENTS (BRIDGE)

	**MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION** 105 W. CAPITOL AVE. JEFFERSON CITY, MO 65101 Phone (888) 275-6636
	Wiss, Janney, Elstner Assoc, Inc. **330 Pfingsten Road** **Northbrook, IL 60062** **Certificate of Authority: 001448** **Consultant Phone: 847-272-7400**
	JOB NO. J6I3413 St. Louis County, MO Date Prepared: 10/1/2021
Date: 9/28/2021	**Addendum No. #**
Only the following items of the Job Special Provisions (Bridge) are authenticated by this seal: All	

A. CONSTRUCTION REQUIREMENTS

1.0 Description. This provision contains general construction requirements for this project.

2.0 Construction Requirements. The plans and the asbestos and lead inspection report for the existing structures are included in the contract in the bridge electronic deliverables zip file for informational purposes only.

2.1 In order to assure the least traffic interference, the work shall be scheduled so that the bridge closure is for the absolute minimum amount of time required to complete the work. The bridge shall not be closed until material is available for continuous construction and the contractor is prepared to diligently pursue the work until the closed bridge is opened to traffic.

2.2 Qualified special mortar shall be a qualified rapid set concrete patching material in accordance with Sec 704. A qualified rapid set concrete patching material will not be permitted for half-sole repair, deck repair with void tube replacement, full depth repair, modified deck repair and substructure repair (formed) unless a note on the bridge plans specifies that a qualified special mortar may be used.

2.3 Provisions shall be made to prevent any debris and material from falling into the waterway. If determined necessary by the engineer, any debris and material that falls below the bridge outside the previously specified limits shall be removed as approved by the engineer at the contractor's expense.

2.4 Any damage sustained to the remaining structure as a result of the contractor's operations shall be repaired or the material replaced as approved by the engineer at the contractor's expense.

2.5 Provisions shall be made to prevent damage to any existing utilities. Any damage sustained to the utilities as a result of the contractor's operations shall be the responsibility of the contractor. All costs of repair and disruption of service shall be as determined by the utility owners and as approved by the engineer.

2.6 A washer shall be required under head and nut when any reaming is performed for bolt installation.

2.7 SSPC-SP2 and SSPC-SP3 surface preparation shall be in accordance with the environmental regulations in Sec 1081 and collection of residue shall be in accordance with Sec 1081 for collection of blast residue. SSPC-SP6, SSPC-SP10 and SSPC-SP11 surface preparation shall be in accordance with the approved blast media and environmental regulations in Sec 1081 and collection of blast residue shall be in accordance with Sec 1081.

3.0 Coating Information.

3.1 Slab Drains and Stay-In-Place Forms. The stay-in-place forms, slab drains and slab drain brackets shall not be recoated, overcoated or damaged during the painting operation. Any portion of the slab drain bracket that is blast cleaned shall be recoated with System G. Any damage sustained as a result of the contractor's operations shall be repaired or the material replaced as approved by the engineer at the contractor's expense.

3.2 Existing Bridge Information. The coating systems are as follows:

3.2.1 Bridge No. A1850. The coating systems on this structure include a System S over-coat on the original System B on the approach span fascia girders, arch span fascia stringers, tie girders, and the arch members, and System G installed on the girders and stringers below the deck expansion joints. The remainder of the structure is weathering steel.

3.2.2 Bridge No. A4936. The coating systems on this structure include the original System B on the arch members, System S over-coat on the original System B on the approach span fascia girders, approach span girders below expansion joints, arch span fascia stringers, and tie-girders, and System G installed on the stringers below the deck expansion joints in the arch span. The remainder of the structure is weathering steel.

3.3 Environmental Contact. Environmental Section may be contacted at the below address or phone number. The Missouri Department of Health may be contacted at (573) 751-6102.

MoDOT - Design Division - Environmental Section
P.O. Box 270
105 W. Capitol Ave., Jefferson City, MO 65102
Telephone: (573) 526-4778

3.4 Approved Smelter and Hazardous Waste Treatment, Storage and Disposal Facility. The following is the approved smelter and hazardous waste treatment, storage and disposal facility:

Doe Run Company - Resource Recycling Division - Buick Facility
Highway KK
Boss, MO 65440
Telephone: (573) 626-4813

3.5 Impermeable Surface Limits. For the duration of cleaning and recoating or overcoating the arch span, the arch span superstructure shall not be draped with an impermeable surface subject to wind loads for a length any longer than 1/4 the span length at any one time regardless of height of coverage.

4.0 Navigation Requirements.

4.1 All work shall be performed so that the free flow of navigation is not unreasonably interfered with, the navigable depths are not impaired and navigation lighting is visible at all times. Any floating equipment or vessels working in the channel shall display lights and signals as required by the current “Inland Navigation Rules”. If scaffolding or nets are suspended below low steel in the navigation span, the U.S. Coast Guard district office shall be advised so that the temporary reductions in clearance for river traffic can be checked for reasonableness and appropriate notices can be published. Positive precautions shall be taken to prevent the accidental dropping of spark producing, flame producing, lighted or damaging objects onto barges or vessels passing beneath the bridge. All flame cutting, welding or other similar spark producing operations shall be ceased over the channel when vessels are passing beneath the bridge.

4.2 The contractor shall be responsible for submitting a work plan to the engineer for review. When the engineer is in concurrence with the work plan, the engineer will forward the material to the U.S. Coast Guard district office for approval. The U.S. Coast Guard will require at least 30 days to review the work plan prior to any work beginning. The work plan shall be submitted to the District Commander, Western Rivers Operation, Eighth Coast Guard District, Bridge Branch.

5.0 Method of Measurement. No measurement will be made.

6.0 Basis of Payment. Payment for the above described work will be considered completely covered by the contract unit price for other items included in the contract.

B. DIAMOND GRINDING

1.0 Description. This work will only be performed at the discretion of the engineer and will be underrun if not required by the engineer. This work shall consist of grinding the new concrete surface to provide good riding characteristics, a surface texture and proper drainage. If the engineer determines it necessary to provide good riding characteristics, grinding shall be performed on all or part of the bridge approach slabs and sealed in accordance with Sec 703.3.8. The finished surface shall be in accordance with Sec 703.3.7 and as shown on the plans or as directed by the engineer except as modified below.

2.0 Equipment. The equipment shall be of a size that will grind a strip at least 3 feet wide using diamond blades and shall not cause spalls at cracks, joints or other locations.

3.0 Construction Requirements. The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Auxiliary or ramp lane grinding shall transition from the edge of the mainline as required to provide drainage and an acceptable riding surface.

3.1 Deck repair, if required, shall be completed prior to any grinding.

3.2 Grinding shall be accomplished in a manner that eliminates joint or crack faults and provides lateral drainage by maintaining a constant cross slope between grinding extremities in each lane. A maximum tolerance of 1/16 inch will be allowed for adjacent sides of joints and cracks, except that under no circumstances shall the grinding depth exceed 1/4 inch from the top of the original surface. When grinding across faulted joints, a minimum of a 20-foot transition onto the approach side slab shall be used.

3.3 The cross slope of the pavement shall be as shown on the plans and shall have no depressions or misalignment of slope greater than 1/4 inch in 12 feet when measured with a 12-foot straightedge placed perpendicular to the centerline. Areas of deviation shall be reground. Straightedge requirements will not apply across longitudinal joints or outside the ground area.

3.4 As soon as practical after grinding, the surface will be straight edged longitudinally, and all variations exceeding 1/8 inch in 10 feet will be plainly marked. Areas of deviation shall be reground.

3.5 Substantially all of the pavement surface shall be textured. Extra depth grinding to eliminate minor depressions in order to provide texturing on 100 percent of the pavement surface will not be required. No unground surface area between passes will be permitted, except as specified otherwise in the contract documents.

3.6 The grinding process shall produce a final pavement surface that is true to grade and uniform in appearance with a longitudinal line-type texture. The line-type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy-type appearance. The

peaks of the ridges shall be approximately 1/32 inch higher than the bottoms of the grooves. The grooves shall be evenly spaced. There shall be approximately 50-55 grooves per foot, measured perpendicular to the centerline.

3.7 The contractor shall remove and dispose of all residue from the grinding in a manner and at a location to satisfy environmental regulations. The contractor shall have the engineer's approval for the method of spreading and disposal of the residue prior to beginning any grinding operations.

3.8 Solid residue shall be removed from the pavement surface before any residue is blown by traffic action or wind.

3.9 Residue shall not be permitted to encroach on open lanes.

3.10 The residue shall not enter into gutters or closed drainage systems.

3.11 The contractor may disperse residue onto unpaved shoulders, adjacent roadside embankments, or median ditch areas of divided highways where the residue runoff can percolate into the soil, unless specified otherwise in the contract. The spread rate shall not generate surface runoff. If surface runoff occurs at a grinding location, the contractor shall haul the residue to an approved location at the contractor's expense.

3.12 Discharge of any residue runoff shall not flow into adjacent rivers, streams, lakes, ponds or other open bodies of water.

3.13 Residue shall not be spread within 100 feet of any streams, lakes or other open bodies of water, or within 15 feet of a water filled ditch.

3.14 The contractor shall use appropriate equipment and methods so the discharging of the residue does not cause erosion of soil or damage to established vegetation along the roadway. The contractor shall repair and reseed any areas where the discharge of grinding residue causes damage to roadway slopes or vegetated areas at the contractor's expense.

3.15 If the solids concentration of discharged residue at any particular area is determined to be excessive by the engineer, the contractor shall provide equipment and material to flush the areas with water as directed by the engineer, at the contractor's expense.

3.16 The pavement shall be cleaned prior to opening to traffic as directed by the engineer.

4.0 Smoothness Requirements.

4.1 No diamond grinding shall be performed until the pavement has attained a strength sufficient to be opened to all types of traffic. All diamond grinding shall be completed on any section prior to opening that section to other than construction traffic, unless approved by the engineer.

4.2 The engineer will be the sole authority for determining if the driving surface is sufficiently smooth.

4.3 The engineer will evaluate the smoothness of the concrete wearing surface after the concrete has cured and direct the contractor to diamond grind where deemed necessary.

4.4 After initial diamond grinding operations, if any, the engineer will again evaluate the smoothness of the concrete wearing surface and approach slab, repeating as many times as necessary to achieve the desired surface smoothness.

4.5 Any deficiencies in the final surface due to improper contractor operations or equipment shall be corrected by the contractor at the contractor's expense.

4.6 All areas shall be tested with a 10-foot straightedge in accordance with section 3.4 of this job special provision.

5.0 Method of Measurement. Measurement for diamond grinding will be made to the nearest square yard. Measurement will be based upon the area of initial diamond grinding completed as directed by the engineer. Subsequent passes of diamond grinding over a previously ground area will not be measured. No deduction will be made for gaps to avoid striping or raised pavement markers. No additional measurement will be made for diamond grinding bridge approach slabs.

6.0 Basis of Payment. Payment for diamond grinding will be paid for at the contract unit price per square yard. Payment for diamond grinding will be considered full compensation for all labor, equipment, material, and incidentals to complete this work, including hauling and disposal of grinding residue and cleaning the pavement prior to opening to traffic.

C. STRUCTURAL STEEL REQUIREMENTS

1.0 Description. This provision contains general structural steel requirements for this project.

2.0 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as shown below. The gray epoxy-mastic primer (non-aluminum) shall be compatible with concrete and produce a dry film thickness of no less than 3 mils (75 µm).

Item	Section
Structural Steel Construction	712
Gray Epoxy-Mastic Primer (non-aluminum)	1045
Structural Steel Fabrication	1080
Coating of Structural Steel	1081

3.0 Construction Requirements.

3.1 Before fabrication of new metalwork, the contractor shall make the necessary measurements in the field to verify dimensions of the existing structure where new members are affected. Any deviation of the dimensions shown on the plans shall be called to the engineer's attention. The contractor shall be responsible for developing all required dimensional adjustments and coordinating the implementation of the dimensional adjustments with all involved fabricators and subcontractors.

3.2 Prior to erection of the new structural steel, the steel that is to remain shall be carefully inspected for irregularities. If such irregularities are found, the irregularities shall be brought to the attention of the engineer.

3.3 Holes in the new diaphragm or cross frame connection plates and angles may be used as a template for drilling the holes in the existing material.

3.4 A minimum edge distance shall be maintained for all field drilled holes. The minimum edge distance for bolts shall be as shown in table below measured from the centerline of holes.

Bolt Diameter inch (mm)	**Minimum Edge Distance inch (mm)**
3/4 (19.0)	1-1/4 (32)
7/8 (22.2)	1-1/2 (38)
1 (25.4)	1-3/4 (45)

3.5 The surfaces of existing steel that will become faying surfaces for non-slip critical new connections, typically secondary members, shall be cleaned according to the manufacturer's recommendation and with a minimum of SSPC-SP-3 surface preparation and coated with one prime coat of Gray Epoxy-Mastic Primer (non-aluminum) in accordance with Sec 1081. The surfaces of existing steel that will become faying surfaces for slip critical new connections, typically primary members, shall be in accordance with contact surfaces in Sec 1081. Primary member connections include girder/beam splices, end diaphragms and intermediate diaphragms in curved structures.

3.6 Exposed girder/beam areas that are not faying surfaces or not covered by concrete that are scratched, damaged by the contractor or by field welding operations shall be touched up with Gray Epoxy-Mastic Primer (non-aluminum) in accordance with Sec 1081. The areas shall receive the coating system as shown on the plans.

4.0 Method of Measurement. No measurement will be made.

5.0 Basis of Payment. Payment for the above described work will be considered completely covered by the contract unit price for the structural steel items included in the contract. No payments or adjustments will be made where new members are affected due to any deviation of the dimensions shown on plans or shop drawings.

D. RAPID SET CONCRETE PATCHING MATERIAL – HORIZONTAL REPAIRS

1.0 Description. This specification covers cementitious concrete, polymer-modified concrete and polymer concrete that are suitable for repairing concrete surfaces on bridges or roadways, particularly under fast setting or special conditions. The repairs would involve horizontal applications. The work shall consist of removing, furnishing, preparing, and placing materials at locations as shown on the plans or as directed by the engineer.

2.0 Material. All materials shall be in accordance with MoDOT specifications and as noted herein.

2.1 Aggregate for Extending Commercial Mixture. Coarse and fine aggregates shall be in accordance with Sec 1005, except the requirements for gradation and percent passing the No. 200 sieve shall not apply. Coarse aggregate meeting Gradation E requirements shall be used for repairs greater than one inch (25 mm) in depth. Fine aggregate will be allowed for repairs

less than one inch (25 mm). Aggregate specified, bagged, labeled and furnished by the rapid set concrete patching material manufacturer may also be used for mortar extension.

2.2 Material Applications. The contractor shall select and use the product most suitable for the work and field conditions in accordance with these specifications.

2.3 Curing. Rapid set concrete patching material shall be cured until the minimum compressive strength 3200 psi is attained using standard curing specifications, unless otherwise specified by the manufacturer.

2.4 Qualification and Project Acceptance.

2.4.1 Inspection. All materials shall be subject to inspection and sampling by MoDOT at the source of manufacture, intermediate shipping terminal or destination. MoDOT will be allowed free access to all facilities and records as required to conduct inspection and sampling.

2.4.2 Qualification. Prior to use, rapid set concrete patching material shall be qualified. In order to become qualified, a material shall have completed testing through AASHTO's National Transportation Product Evaluation Program (NTPEP). The manufacturer shall contact the AASHTO/NTPEP coordinator to obtain the testing location for the rapid setting concrete patching material.

2.4.2.1 Requested Information. The manufacturer shall submit with samples of the materials, a written request to Construction and Materials with the following information:

(a) Brand name of the product.

(b) Certification that the material meets this specification.

(c) NTPEP test results showing compliance with this special provision.

(d) Specific mixing, handling and curing instructions.

(e) Application type (i.e., bridge or roadway).

2.4.2.2 Qualified List. Upon approval by the engineer, the brand name and manufacturer will be placed on a qualified list of rapid set concrete patching materials. The listing of qualified materials is available from Construction and Materials or on MoDOT’s web site. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed. The material will be subject to removal from the qualified list if there is evidence of unsatisfactory performance or a change in manufacturing process or formulation, or when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

2.4.3 Provisional Approval. Provisional approval may be granted provided the following requirements have been met:

(a) New Products Evaluation Form

(b) Certified test results from an independent laboratory showing compliance with this special provision.

(c) Documentation prepared by MoDOT covering two years of field performance on MoDOT's system. MoDOT will need to approve the location of the test site. Documentation will contain the placement date, field observations (semiannual), description of field performance and photographs of in-place material.

(d) During placement the manufacturer's representative shall be present on the project to provide technical expertise.

2.4.3.1 Disqualification. If during the two-year observation period the repair area(s) fails provisional approval will not be granted. Repair area(s) experiencing any cracking, debonding or spalling will be considered a failure.

2.4.3.2 Length of Provisional Approval. Provisional approval will be granted for three years or until NTPEP testing is completed.

2.5 Certification. The contractor shall supply a manufacturer's certification to the engineer for each lot of material furnished. The certification shall include the name of the manufacturer, a manufacturer certification statement that the material supplied is the same as that qualified and listing the date of qualification.

2.6 Acceptance. Acceptance of the material will be based on the use of a qualified or provisionally approved material, the manufacturer's certification that the material supplied is the same as that approved and upon the results of such tests as may be performed by the engineer.

3.0 Mixture. Unless otherwise specified, rapid set concrete patching material shall be approved commercial mixtures meeting Sections 3.1 – 3.1.3 or deck repair cementitious mortar meeting Section 3.2. Rapid set concrete patching materials shall be specifically designed for the application needed.

3.1 Commercial Mixtures. Rapid set concrete patching material in its sacked form and mixtures when properly prepared in accordance with the manufacturer's specifications, shall meet the minimum test requirements given in Table 1. Mixtures may be supplied, as required, as a patching mortar or as a patching mortar with aggregate extension. If the material is to be supplied with extender aggregate, this shall also pass the required tests in Table 1 using the maximum allowed amount of extender aggregate.

3.1.1 Mixture Requirements. Rapid set concrete patching material shall be single packaged dry mix requiring the addition of water or other liquid component just prior to mixing. The material shall be capable of ½ inch (13 mm) to full depth repair and require no bonding agent. The material shall not contain soluble chlorides as an ingredient of manufacture. The material shall be placed in accordance with the manufacturer's recommendations.

Table 1
(English Unit)

Physical Test Property	**Specification**	**Requirement for cementitious concrete**	**Requirement for polymer-modified concrete**	**Requirement for polymer concrete**
	ASTM	min. 1000 psi @		min. 1000 psi @

Bond Strength by Slant Shear[1]	C882/C928 [3]	24hrs.& min. 1500 psi @ 7 days	n/a	24hrs.& min. 1500 psi @ 7 days
Linear Coefficient of Thermal Expansion[1, 2] (for bagged mortar only, without extension aggregate)	ASTM C531	n/a	n/a	4 – 8 X 10-6 in/in/deg F
Resistance to Rapid Freezing & Thawing[1]	AASHTO T161 or ASTM C666	80% min. using Procedure B[5] (300 Cycles)	80% min. using Procedure B[5] (300 Cycles)	n/a
Compressive Strength[1]	AASHTO T22 or ASTM C39	3200 psi @ 3 hr & 4000 psi @ 7 days	3200 psi @ 3 hr & 4000 psi @ 7 days	n/a
Rapid Chloride Permeability[1]	AASHTO T277 or ASTM C1202	Bridge Decks 1000 coulombs @ 28 days Roadway 2000 coulombs @ 28 days	Bridge Deck 1000 coulombs @ 28 days Roadway 2000 coulombs @ 28 days	Bridge Deck 1000 coulombs @ 28 days Roadway 2000 coulombs @ 28 days
Length Change[1, 4]	AASHTO T 160 or ASTM C157	In water Storage (+0.15) In air storage (-0.15)	In water storage (+0.15) In air storage (-0.15)	n/a
Color		gray	gray	gray

[1]The commercial mix test values can be located in the AASHTO's National Transportation Product Evaluation Program (NTPEP) reports for Laboratory Evaluations of Rapid Set Concrete Patching Materials. Data for provisionally approved materials is located at the Construction and Materials Division.
[2]Not required for extended mixtures if the mortar passes this requirement.
[3] ASTM C882 shall be performed on non-water based materials. ASTM C928 shall be performed on water-based materials.
[4] As modified by ASTM C928.
[5] Procedure A may be used in lieu of Procedure B

3.1.2 Construction Requirements. The manufacturer shall provide with the bagged mixture, specifications for the mixing procedure, amount and kind of liquid to be added, and the amount of aggregate extension allowed, if any. All mixing, handling and curing practices recommended by the manufacturer shall be followed and will be considered a part of these specifications.

3.1.3 Removal from Qualified List. All mixtures shall be approved before use. Reoccurring failures of any mixture for any reason will be cause for removal from the qualified list.

3.2 Deck Repair Concrete. A qualified rapid set concrete patching material indicated for horizontal use and intended for patching concrete bridge decks may be used when specified on the plans and as approved by the engineer. If this option is selected, the contractor shall provide a trial mix to determine the total cure time needed to achieve a compressive strength of 3200 psi (22 MPa). Compressive specimens shall be prepared in accordance with current MoDOT test methods and cured to simulate actual field conditions. Testing of compressive specimens shall be performed by methods and at facilities acceptable to the engineer. The repaired deck shall not be opened to traffic until at least 4 hours after the last placement of deck repair concrete, the established cure time has elapsed and until such concrete has achieved a

compressive strength of 3200 psi (22 MPa). A new trial mix may be required if the engineer determines the field conditions vary substantially from trial mix conditions. The engineer will make field cylinders to verify the 3200 psi (22 MPa) minimum strength.

4.0 Construction Requirements.

4.1 Mixing. Rapid set concrete patching material shall be mixed and finished according to the manufacturer's recommendation.

4.2 Preparation of Repair Area. Deteriorated, damaged or defective concrete as shown on the plans, required by the specifications or as directed by the engineer, shall be removed. All exposed reinforcement shall be thoroughly cleaned as shown on the plans, required by the specifications or as directed by the engineer. Unless otherwise specified by the commercial mixture manufacturer, the existing surface shall be damp and all free water shall be removed prior to placement of the required material.

4.3 Bonding Agent. A bonding agent may be used if recommended by the rapid set concrete patching material manufacturer.

5.0 Method of Measurement. No measurement will be made for rapid set concrete patching material.

6.0 Basis of Payment. Rapid set concrete patching material will be paid for at the contract unit price for other items and will be considered full compensation for all labor, equipment, and material to complete the described work.

E. ALTERNATE WEARING SURFACES

1.0 Description. On Bridge No. A18503, this work shall consist of either placing a latex modified concrete wearing surface or a polyester polymer concrete wearing surface. Each wearing surface alternate includes different substrate preparation, repair, and surface finish requirements.

2.0 Bidding. To exercise this option, separate plan sheets for each wearing surface are included in the contract, and separate pay items, descriptions and quantities are included in the itemized proposal for each alternate. The bidder shall bid only one of the alternates and either enter "0" or leave blank in the contract unit price column for any pay item listed for the other alternate.

3.0 Method of Measurement. The quantities of the alternates will be measured in accordance with the plans and the Specifications.

4.0 Basis of Payment. The pay items included in the contract for the chosen alternate will be paid for at the contract unit price in accordance with the plans and the Specifications.

F. SPECIAL CONSIDERATION OF CHANGE ORDERS AND VALUE ENGINEERING

1.0 Description. Increased Federal Share has been approved by the FHWA for an innovative technology or practice. The Commission will receive an additional five percent Federal Share of the overall contract value due to innovations within the following pay item(s).

Bridge No.	Pay Item Number	Pay Item Description	Innovation
A49364	502-99.07	Furnish Polyester Polymer Concrete Materials	Use as wearing surface
A49364	505-99.05	Place Polyester Polymer Concrete Wearing Surface	Use as wearing surface

Due to the increased Federal Share, the project components related to the innovation(s) described above must be constructed with the materials, quantities, methods and innovations as shown on the project plans and specifications. If the contractor requests materials, quantities, methods or innovations other than those included in the plans and specifications, the request must be reviewed and approved by the Commission and FHWA. Approved changes to the innovation items above shall be at no additional cost to the Commission and shall not increase the contract time.

2.0 Special Consideration of Change Orders and Value Engineering Change Proposals (VECP). Change ordering and/or value engineering the pay item(s) listed in section 1.0 jeopardize the ability for the Commission to receive an additional Federal Share for the overall contract value. Special consideration should be given to the change order value for removing or modifying such item(s) from the contract ensuring the benefit outweighs the cost.

3.0 Contacting Financial Services. If it is determined that the proposed change order and/or VECP outweighs the additional overall five percent Federal Share value, the engineer shall notify the MoDOT project manager.

G. RAPID SET CONCRETE PATCHING MATERIAL – VERTICAL AND OVERHEAD REPAIRS

1.0 Description. This specification covers cementitious concrete, polymer-modified concrete and polymer concrete that are suitable for repairing concrete surfaces on bridges or concrete structures, particularly under fast setting or special conditions. The repairs would involve vertical or overhead applications. The work shall consist of removing, furnishing, preparing, and placing materials at locations as shown on the plans or as directed by the engineer.

2.0 Material. All materials shall be in accordance with MoDOT specifications and as noted herein.

2.1 Aggregate For Extending Commercial Mixture. Coarse and fine aggregates shall be in accordance with Sec 1005, except the requirements for gradation and percent passing the No. 200 sieve shall not apply. Coarse aggregate meeting Gradation E requirements shall be used for repairs greater than one inch (25 mm) in depth. Fine aggregate will be allowed for repairs less than one inch (25 mm). Aggregate specified, bagged, labeled and furnished by the rapid set concrete patching material manufacturer may also be used for mortar extension.

2.2 Material Applications. The contractor shall select and use the product most suitable for the work and field conditions in accordance with these specifications.

2.3 Curing. Rapid set concrete patching material shall be cured until the minimum compressive strength 1500 psi is attained using standard curing specifications, unless otherwise specified by the manufacturer.

2.4 Qualification and Project Acceptance.

2.4.1 Inspection. All materials shall be subject to inspection and sampling by MoDOT at the source of manufacture, intermediate shipping terminal or destination. MoDOT will be allowed free access to all facilities and records as required to conduct inspection and sampling.

2.4.2 Qualification. Prior to use, rapid set concrete patching materials need to be qualified.

2.4.2.1 Requested Information. The manufacturer shall submit with samples of the materials, a written request to Construction and Materials with the following information:

(a) New Products Evaluation Form

(b) Brand name of the product.

(c) Certification that the material meets this specification.

(d) Certified test results from an independent laboratory showing compliance with this specification.

(e) Specific preparation instructions of repair area.

(f) Specific mixing, handling and curing instructions.

(g) Application type (i.e., vertical or overhead).

2.4.2.2 Field Evaluation. Final approval will be granted when the following requirements are met:

(a) MoDOT report documenting two years of field performance on MoDOT system. The report will contain the placement date, field observations (semi annual), description of field performance and photographs of in-place material.

(b) A manufacturer's representative shall be present during placement of the material to provide technical expertise.

2.4.2.2.3 Disqualification. If during the two year observation period the repair area(s) fails the product will not be added to the qualified list.

2.5 Qualified List. The listing of qualified products are available from Construction and Materials or on MoDOT's web site. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed. The material will be subject to removal from the qualified list if there is evidence of unsatisfactory performance or a

change in manufacturing process or formulation, or when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

2.6 Certification. The contractor shall supply a manufacturer's certification to the engineer for each lot of material furnished. The certification shall include the name of the manufacturer, a manufacturer certification statement that the material supplied is the same as that qualified and listing the date of qualification.

2.7 Acceptance. Acceptance of the material will be based on the use of a qualified product, the manufacturer's certification that the material supplied is the same as that approved and upon the results of such tests as may be performed by the engineer.

3.0 Mixture. Unless otherwise specified, rapid set concrete patching material shall be approved commercial mixtures meeting Sections 3.1 – 3.1.3. Rapid set concrete patching materials shall be specifically designed for the application needed.

3.1 Commercial Mixtures. Rapid set concrete patching material in its sacked form and mixtures when properly prepared in accordance with the manufacturer's specifications, shall meet the minimum test requirements given in Table 1. Mixtures may be supplied, as required, as a patching mortar or as a patching mortar with aggregate extension. If the material is to be supplied with extender aggregate, this shall also pass the required tests in Table 1 using the maximum allowed amount of extender aggregate.

3.1.1 Mixture Requirements. Rapid set concrete patching material shall be single packaged dry mix requiring the addition of water or other liquid component just prior to mixing. The material shall not contain soluble chlorides as an ingredient of manufacture. The material shall be placed in accordance with the manufacturer's recommendations.

Table 1
(English Unit)

Physical Test Property	Specification	Requirement for cementitious concrete	Requirement for polymer-modified concrete	Requirement for polymer concrete
Bond Strength by Slant Shear	ASTM C882/C928 [2]	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days	n/a	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days
Linear Coefficient of Thermal Expansion [1] (for bagged mortar only, without extension aggregate)	ASTM C531	n/a	n/a	4 – 8 X 10-6 in/in/deg F
Resistance to Rapid Freezing & Thawing	AASHTO T161 or ASTM C666	80% min. using Procedure B[3] (300 Cycles)	80% min. using Procedure B[3] (300 Cycles)	n/a
Compressive Strength	AASHTO T22 or ASTM C39	1500 psi @ 3 hr & 3000 psi @ 24 hr	1500 psi @ 3 hr & 3000 psi @ 24 hr	n/a
Rapid Chloride	AASHTO T277 or	1000 coulombs	1000 coulombs	1000 coulombs

Permeability	ASTM C1202	@ 28 days	@ 28 days	@ 28 days
Length Change	AASHTO T 160 or ASTM C157	In water Storage (+0.15) In air storage (-0.15)	In water storage (+0.15) In air storage (-0.15)	n/a
Color		gray	gray	gray

[1] Not required for extended mixtures if the mortar passes this requirement.
[2] ASTM C882 shall be performed on non-water based materials. ASTM C928 shall be performed on water-based materials.
[3] Procedure A may be used in lieu of Procedure B

3.1.2 Construction Requirements. The manufacturer shall provide with the bagged mixture, specifications for the mixing procedure, amount and kind of liquid to be added, and the amount of aggregate extension allowed, if any. All mixing, handling and curing practices recommended by the manufacturer shall be followed and will be considered a part of these specifications.

3.1.3 Removal from Qualified List. All mixtures shall be approved before use. Reoccurring failures of any mixture for any reason will be cause for removal from the qualified list.

3.2 Vertical Repair. A qualified rapid set concrete patching material approved for vertical use may be used when specified on the plans and as approved by the engineer. The engineer will make field cylinders to verify the 1500 psi (10 MPa) minimum strength. The material shall adhere to the concrete surface without sagging.

3.3 Overhead Repair. A qualified rapid set concrete patching material approved for overhead use may be used when specified on the plans and as approved by the engineer. The material shall be placeable in layers of at least 1 inch on overhead applications without the use of formwork or anchoring devices. The material shall adhere to the concrete surface without sagging. The engineer will make field cylinders to verify the 1500 psi (10 MPa) minimum strength.

4.0 Construction Requirements.

4.1 Mixing. Rapid set concrete patching material shall be mixed and finished according to the manufacturer's recommendation.

4.2 Preparation of Repair Area. Deteriorated, damaged or defective concrete as shown on the plans, required by the specifications or as directed by the engineer, shall be removed. All exposed reinforcement shall be thoroughly cleaned as shown on the plans, required by the specifications or as directed by the engineer. Unless otherwise specified by the commercial mixture manufacturer, the existing surface shall be damp and all free water shall be removed prior to placement of the required material.

4.3 Bonding Agent. A bonding agent may be used if recommended by the rapid set concrete patching material manufacturer.

5.0 Method of Measurement. No measurement will be made for rapid set concrete patching material.

6.0 Basis of Payment. Rapid set concrete patching material will be paid for at the contract unit price for other items and will be considered full compensation for all labor, equipment and material to complete the described work.

H. SHOTCRETE CONCRETE REPAIR

1.0 Description. This work shall consist of repairing concrete elements or components of the bridge with shotcrete. Repairs shall be in accordance with Sec 704 and as shown on the contract plans. Shotcrete shall be used for barrier curb repairs and unformed substructure repairs. Additionally, shotcrete may be used at the contractor's option for formed substructure repairs subject to approval of the engineer. The work includes deteriorated concrete removal, preparing the repair surface and application of shotcrete to the repair locations.

1.1 Shotcrete shall be in accordance with the current requirements of American Concrete Institute (ACI) 506.2-13, "Specification for Shotcrete", except as otherwise specified. Shotcrete shall consist of an application of one or more layers of mortar or concrete conveyed through a hose and pneumatically projected at a high velocity against a prepared surface.

1.2 Shotcrete shall be produced by a dry-mix process. The dry-mix process shall consist of thoroughly mixing all the ingredients except accelerating admixtures and mixing water and conveying the mixture through the hose pneumatically and the mixing water is introduced at the nozzle. For additional descriptive information, the contractor's attention shall be directed to the ACI 506R-16, "Guide to Shotcrete".

2.0 Contractor Experience Requirements.

2.1 Workers, including foremen, nozzlemen and delivery equipment operators, shall be fully experienced to perform the work.

2.2 Initial qualification of nozzlemen will be based on ACI or EFNARC certification for the application process being used. The nozzlemen shall submit documented proof they have been certified in accordance with the ACI 506.3R-91 "Certification of Shotcrete Nozzlemen" or EFNARC "Nozzleman Certification Scheme". The certification shall have been done by an ACI or EFNARC recognized shotcrete testing lab and/or recognized shotcreting consultant and have covered the type of shotcrete to be used (plain dry-mix).

2.3 The contractor may supply 1 reference project for the project nozzleman in lieu of completing test panels in accordance with Paragraph 5.1 of this specification to demonstrate the experience of the nozzleman in similar shotcrete application work. Owner contact information for the reference project shall be provided to allow for the engineer to confirm satisfactory results.

3.0 Materials.

3.1 Shotcrete materials shall consist of one of the following premixed and packaged materials:

- BASF MasterEmaco S 211SP
- Euclid Chemical Eucoshot F
- King Shotcrete MS-D1

- CTS Cement Low-P

3.2 No material testing is anticipated. Acceptance will be based on the prequalified materials listed, approval of the nozzleman prior to material placement, and visual inspection. If questions arise based on visual examination, placement methods, curing methods or other potentially undesirable influences the engineer reserves the right to test any material properties listed on the published product data sheet for the material selected. Testing will be done at the contractor's expense.

3.3 Material shall be delivered, stored and handled to prevent contamination, segregation, corrosion or damage.

3.4 Proportioning and Use of Admixtures. Admixtures will not be permitted unless approved by the engineer.

3.5 Bonding Agents. Bonding agents will not be permitted.

3.6 Air Entrainment. Additional air entrainment admixtures will not be required.

4.0 Construction Submittals.

4.1 At least 15 days before the planned start of the shotcrete repair(s), a copy of the following information shall be submitted in writing to the engineer for review and approval:

- Written documentation of the nozzlemen's qualifications including proof of ACI or EFNARC certification;

- Proposed methods of shotcrete placement and of controlling and maintaining facing alignment including equipment models;

- Shotcrete mix; and

- One reference project including: Nozzleman's name, material used, process used, and whether a blow pipe was utilized. Owner contact information shall be provided to ensure satisfactory results were accomplished on the reference project; or

- A satisfactory test panel shall be provided with the material to be used.

4.2 The engineer will approve or reject the contractor's submittals within 10 days after the receipt of a complete submission. The contractor will not be permitted to begin repair with shotcrete until the submittal requirements are satisfied and found acceptable to the engineer. Changes or deviations from the approved submittals shall be re-submitted for approval. No adjustment in contract time will be allowed due to incomplete submittals.

4.3 A pre-construction meeting scheduled by the engineer will be held prior to the start of work. Attendance shall be mandatory. The shotcrete contractor shall attend.

5.0 Field Quality Control.

5.1 Production test panels will not initially be required if a reference project for the nozzleman is provided as outlined in Paragraph 2.3 of this specification. The engineer may halt repair work if satisfactory results are not produced by the contractor and require production test panels.

5.2 If a comparable project demonstrating satisfactory results cannot be provided, the skills of the nozzleman shall be demonstrated and tested with at least one production test panel being furnished prior to performing repairs.

5.3 Production Test Panels (If Required).

5.3.1 Qualified personnel shall perform shotcreting and coring of the test panels with the engineer present. The contractor shall provide equipment, materials and personnel as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring.

5.3.2 Production test panels shall be made with the minimum full thickness and dimension of 18 x 18 inch and at least 3½ inch thick with 2-#4 bars placed in each direction. The #4 bars shall be centered in the 3½ inch dimension and evenly spaced in each direction with the bars touching at the 4 intersecting locations.

5.4 Test Panel Curing, Test Specimen Extraction and Testing (If Required).

5.4.1 Immediately after shooting, the test panels shall be field moist cured by covering and tightly wrapping with a sheet of material meeting the requirements of ASTM C 171 until delivered to the testing lab or test specimens are extracted. The test panels shall not be immersed in water. The test panels for the first 24 hours after shooting shall not be disturbed.

5.4.2 At the direction of the engineer at least two 3 inch diameter core samples shall be cut at two of the bar intersections to ensure consolidation around the bars. If voids are present the material and nozzleman are not approved for use. The contractor may continue with changes to the materials or nozzleman. The same process will be followed until no voids are present.

6.0 Shotcrete Facing Requirements.

6.1 Shotcrete Alignment Control. The final surface of the shotcrete shall maintain the existing concrete plane surface.

6.2 Surface Preparation. In addition to the manufacturer's recommendations, the surfaces to be shotcreted shall be cleaned of loose materials, mud, rebound, overspray or other foreign matter that could prevent or reduce shotcrete bond. Shotcrete shall not be placed on frozen surfaces.

6.3 Delivery and Application. In addition to the manufacturer's recommendations, a clean, dry, oil free supply of compressed air sufficient for maintaining adequate nozzle velocity shall be maintained at all times. The equipment shall be capable of delivering the premixed material accurately, uniformly and continuously through the delivery hose. Shotcrete application thickness, nozzle technique, air pressure and rate of shotcrete placement shall be controlled to prevent sagging or sloughing of freshly applied shotcrete.

6.3.1 The shotcrete shall be applied from the lower part of the area upwards to prevent accumulation of rebound. The nozzle shall be oriented at a distance and approximately

perpendicular to the working face so that rebound will be minimal and compaction shall be maximized. Special attention shall be paid to encapsulating reinforcement. Care shall be taken while encasing reinforcing steel and mesh to keep the front face of the reinforcement clean during shooting operations, so that the shotcrete builds up from behind, to encase the reinforcement and prevent voids and sand pockets from forming. If a blow pipe was used to qualify, a blow pipe shall be required. The blow pipe is used to remove rebound and overspray immediately ahead of the nozzle. Rebound shall not be worked back into the construction. Rebound that does not fall clear of the working area shall be removed. Hardened rebound and hardened overspray shall be removed prior to the application of additional shotcrete using abrasive blast cleaning, chipping hammers, high pressure water blasting or other suitable techniques.

6.3.2 When using multiple layer shotcrete construction, the surface of the receiving layer shall be prepared before application of a subsequent layer, by either:

- Brooming the stiffened layer with a stiff bristle broom to remove all loose material, rebound, overspray or glaze, prior to the shotcrete attaining initial set.

- If the shotcrete has set, surface preparation shall be delayed 24 hours, at which time the surface shall be prepared by sandblasting or high pressure water blasting to remove all loose material, rebound, hardened overspray, glaze or other material that may prevent adequate bond.

6.4 Defective Shotcrete. The engineer will have authority to accept or reject the shotcrete work. Shotcrete that is not in accordance with the project specifications may be rejected either during the shotcrete application process, or on the basis of tests. Shotcrete surface defects shall be repaired as soon as possible after placement. Shotcrete that exhibits segregation, honeycombing, laminations, voids or sand pockets shall be removed and replaced. In-place shotcrete determined not meeting the published technical information for the product used will be subject to remediation as approved by the engineer. Possible remediation options range from required latex over coating for excessive cracking up to removal and replacement at the contractor's expense

6.5 Construction Joints. Construction joints shall be tapered uniformly toward the excavation face over a minimum distance equal to the thickness of the shotcrete layer. Square joints will not be permitted except at the expansion joint. The surface of the joints shall be rough, clean and sound. A minimum reinforcement overlap at reinforcement splice joints shall be provided. The surface of a joint shall be clean and wet before adjacent shotcrete is applied.

6.6 Final Face Finish. Shotcrete finish shall be a wood float, rubber float, steel trowel or smooth screeded finish.

6.7 Additional Construction Requirements.

6.7.1 The work is to be performed is in the vicinity of a major waterway. Consequently, care shall be taken to avoid any rebound from entering the regulated waterway.

6.7.2 If the work to be performed is in the vicinity of an enclosed drainage system, care shall be taken to avoid any rebound from entering the drainage system.

6.8 Weather Limitations.

6.8.1 The shotcrete shall be protected if placed when the ambient temperature is below 40°F and falling or when likely to be subject to freezing temperatures before gaining sufficient strength. Cold weather protection shall be maintained until the compressive strength of the shotcrete is greater than 725 psi. Cold weather protection includes blankets, heating under tents or other means acceptable to the engineer. The temperature of the shotcrete mix, when deposited, shall be not less than 50°F or more than 85°F. The air in contact with the shotcrete surfaces shall be maintained at temperatures above 32°F for a minimum of 7 days.

6.8.2 If the prevailing ambient temperature conditions (relative humidity, wind speed, air temperature and direct exposure to sunlight) are such that the shotcrete develops plastic shrinkage and/or early drying shrinkage cracking, shotcrete application shall be suspended. The contractor shall reschedule the work to a time when more favorite ambient conditions prevail or adopt corrective measures, such as installation of sunscreens, wind breaks or fogging devices to protect the work. Newly placed shotcrete exposed to rain that washes out cement or otherwise makes the shotcrete unacceptable shall be removed and replaced at the contractor's expense.

6.9 Curing. Permanent shotcrete shall be protected from loss of moisture for at least 1 day after placement. Shotcrete shall be cured by methods that keep the shotcrete surfaces adequately wet and protected during the specified curing period. Curing shall commence within one hour of shotcrete application. When the ambient temperature exceeds 80°F, the work shall be planned such that curing can commence immediately after finishing. Membrane curing shall be in accordance with the following requirements.

- **Membrane Curing.** Membrane curing is required on overhead surfaces that cannot be adequately wet cured. Curing compounds will not be permitted on any surface against which additional shotcrete or other cementitious finishing materials are to be bonded unless the surface is thoroughly sandblasted in a manner acceptable to the engineer. Membrane curing compounds shall be spray applied as quickly as practical after the initial shotcrete set at rate of coverage of not less than 7.1 square feet per gallon.

7.0 Safety Requirements. Nozzlemen and helpers shall be equipped with gloves, eye protection and adequate protective clothing during the application of shotcrete. Whip checks are required on air lines. The contractor shall be responsible for meeting all federal, state and local safety requirements.

8.0 Method of Measurement. Measurement of Substructure Repair (Formed) and Substructure Repair (Unformed) shall be in accordance with Sec 704.

8.1 Measurement of Barrier Curb Repair shall be per linear foot of barrier to receive repair. The extent of the repair may vary from the estimated quantities, but the contract unit price shall prevail regardless of the variation.

9.0 Basis of Payment. Payment for Substructure Repair (Formed) and Substructure Repair (Unformed) shall be in accordance with Sec 704.

9.1 Payment for Barrier Curb Repair will be made at the contract unit price bid per linear foot of barrier rail to receive repair. Payment will be considered full compensation for all materials, labor, equipment, and incidentals to complete the repairs as outlined in this specification and shown in the plans.

I. FABRIC TROUGH

1.0 Description. This specification covers a material to be installed as a trough below the finger type expansion joints (or for other applications as shown on the Plans) to carry drainage, to the drainage system, and prevent chloride-laden water and debris from running onto other bridge members.

2.0 Materials.

2.1 The fabric trough material shall be resistant to abrasion, sunlight, oils, and saltwater and be composed of one or two ply tightly woven nylon fabric bonded to, laminated, or covered on both sides with a high density neoprene, ethylene-propylene-diene-monomer (EPDM), or buna-nitrile PVC, and shall comply with the requirements listed below:

- Thickness (inches) – 0.25 in. (-0.0 in. tolerance)
- Weight (minimum) - 105 oz./sq.yd.
- Durometer Hardness (Shore A) - 50A to 75A. ASTM test method, D2240.
- Low Temperature Brittleness, No Cracking (wrapped around a 3" dia. Mandrel for 22 hrs. @ -20oF)
- Tensile Strength - 800 lbs./in. (minimum, both directions). ASTM test method, D412.
- Elongation (maximum) - 30%. ASTM test method, D412.
- Tear (Die C) - 120 lbs./in. ASTM test method, D624.
- Ozone Resistance - No Cracks for 100 hours of exposure of 20% elongated samples @ 100oF and 100 PPHM ozone. ASTM test method, D1149.

2.2 The contractor shall furnish a manufacturer's certification to the engineer for each lot furnished, certifying that the materials supplied are in accordance with all requirements specified. The certification shall include results of all required tests. Acceptance of the material will be based on the manufacturer's certification and upon results of such tests as may be performed by the engineer. The certification shall show the quantity and lot number that is represented.

3.0 Method of Measurement. No measurement will be made.

4.0 Basis of Payment. Payment for the above-described work, including all material, equipment, labor and any other incidental work necessary, will be considered completely covered under the contract unit price for Finger Joint Expansion Joint System (Abut 1 & Bent 5) or Finger Joint Expansion Joint System (Bents 9 & 13).

J. ULTRA-HIGH PERFORMANCE CONCRETE

1.0 Description. This work shall consist of furnishing and installing ultra-high performance concrete (UHPC) at the locations shown on the plans or as directed by the engineer. Ultra-high performance concrete (UHPC) to be installed at expansion device joint header slabs. It does not include bridge deck overlays.

2.0 Materials.

2.1 Water. Water shall meet the requirements of Section 1070.

2.2 Ultra-High Performance Concrete (UHPC). The material shall be a fiber-reinforced UHPC with a minimum steel fiber content of 2% by volume. The UHPC shall meet the performance requirements outlined in the table below, at an age of 28 days unless otherwise noted. Test data substantiating these results shall be conducted by an AASHTO-accredited lab.

Ultra-High Performance Concrete (UHPC)		
Property	**Requirement**	**Test Method**
Compressive Strength	4 days: 12 ksi, minimum 28 days: 17.4 ksi, minimum	ASTM C1856
Flexural Strength	First-peak strength: 1.4 ksi, minimum; Peak strength: 2.0 ksi, minimum; Ratio, peak to first-peak strength: 1.25, minimum	ASTM C1856
Length Change	800 microstrain, maximum; Initial reading at 24 hours, store in air for 28 days (no moist cure after initial reading)	ASTM C1856
Indication of Resistance to Chloride Ion Penetration	300 Coulombs, maximum, after 56 days extended moist cure Test on samples cast without fibers	ASTM C1856
Scaling Resistance	Visual rating 0 or 1 after 50 cycles	ASTM C672
Abrasion Resistance	0.1 ounces lost, maximum after 6 minutes Test on ground* surface	ASTM C1856
Resistance to Freezing and Thawing	RDM after 600 cycles: 95%, minimum	ASTM C1856

* Surface to be ground using method used for project. Testing may be performed on cores sampled from mock-up slab.

2.2.1 UHPC Materials. Materials commonly used in UHPC include:

- Fine aggregate
- Cementitious material
- Mineral admixtures Superplasticizer Accelerator
- Steel fibers
- All components shall be supplied by one UHPC manufacturer.

2.2.1.1 Aggregates. Aggregates used in UHPC shall be innocuous (0.10% maximum expansion after 14 days of immersion) when tested either according to ASTM C1260 alone or according to ASTM C1567 in combination with the specific supplementary cementitious materials and mineral admixtures to be included in the UHPC. If tested by ASTM C1567, the proportions of supplementary cementitious materials and mineral admixtures used in the test specimens shall not exceed those used in the UHPC mixture. The water-to-binder ratio used for testing shall not be less than 0.47, where the binder includes both the cementitious materials and the mineral admixtures.

2.2.1.2 Steel fibers. Steel fibers used in UHPC shall conform to ASTM A820, Type I. Fibers shall have a minimum tensile strength of 190 ksi.

2.2.1.3 Chemical admixtures. Chemical admixtures used in UHPC shall conform to AASHTO M 194.

2.3 High Molecular Weight Methacrylate (HMWM). The high molecular weight methacrylate (HMWM) resin used as repair for leaking joints shall be low viscosity and non-fuming. The HMWM shall comply with the following requirements:

High Molecular Weight Methacrylate (HMWM) Resin		
Property	**Requirement**	**Test Method**
Viscosity	25 cps, maximum	ASTM D2849
Density	8.4 lb./gal., minimum (at 77°F)	ASTM D1475
Flash Point	200°F, minimum	ASTM D3278
Vapor Pressure	1.0 mm Hg, maximum (at 77°F)	ASTM D323
Glass Transition Temperature	136°F, minimum	ASTM D3418
Gel Time	40 minutes, minimum (for 100 gram mass)	ASTM C881
Percent Solids	90% by weight, minimum	
Bond Strength	1500 psi, minimum	ASTM C882

2.3.1 HMWM Sand. The sand used for the HMWM shall be a commercial quality dry blast sand. 95% of the sand shall pass the No. 8 sieve and 95% of the sand shall be retained on the No. 30 sieve.

2.4 Delivery of Materials. All materials shall be delivered in their original containers bearing the manufacturer's label, date of manufacturing, batch number, trade name, and

quantity. Each shipment of HMWM resin shall be accompanied by a Safety Data Sheet (SDS). **2.5 Storage of Materials.** The contractor shall assure the proper storage of the UHPC premix, fibers, and additives as required by the supplier's specifications to protect materials against loss of physical and mechanical properties. Sufficient material to perform the entire UHPC installation shall be in storage at the site prior to any field application, so that there shall be no delay in procuring the material for each day's application.

2.6 Technical Support. The contractor shall arrange for a representative of the UHPC supplier to be on site during the mixing and placement of UHPC until the contractor's own staff has become trained in the use of the material and until approved by the engineer. The representative shall be knowledgeable in the supply, mixing, delivery, placement, and curing of the UHPC material.

3.0 Submittals. The contractor shall submit to the engineer the following items for review and approval at least 30 days prior to UHPC placement:

3.1 Material Certifications.

3.1.1 UHPC Certifications. The contractor shall furnish a test report confirming that all materials for the UHPC have been pretested and will meet all requirements listed in Section 2.0. All testing shall be conducted by an AASHTO-accredited testing lab on the same UHPC mix design used by the project. The test report shall include the following information:

- The type and source of each constituent material.
- The mixture proportions, including limits on water and admixture quantities.
- Mixing procedures
- Curing procedures, including thermal treatment procedures (if used).
- The properties of the UHPC in accordance with Section 2.0.

3.1.2 HMWM Certifications. The contractor shall furnish documentation from the HMWM manufacturer certifying that it conforms to the requirements listed in Section 2.0.

3.2 Qualifications.

3.2.1 Manufacturer Qualifications. The manufacturer of the UHPC shall be ISO 9001:2000 certified and have a quality assurance program independently audited on a regular basis.

3.2.2 Contractor Qualifications. The contractor shall be experienced in the field application of UHPC joints and have 5 years of experience in similar project types. The contractor shall furnish documentation of experience with UHPC in similar project types, including location and scope UHPC use and identifying personnel for the current project. The contractor shall maintain technical personnel at the site who have received product training by a manufacturer's representative for a minimum of one day during a Mockup Test. If the contractor does not have 5 years of experience in similar project types, a manufacturer's representative shall be on-site during the placement of the UHPC for the duration of the project.

3.3 UHPC Field Installation Plan. The contractor shall submit a UHPC Field Installation Plan

that includes drawings of proposed joint locations and forming details and describes the equipment, batching sequence, placement sequencing, UHPC temperature limits, and curing methods for the UHPC installation. When using the maturity method, the contractor shall use the maturity method data provided in the UHPC Field Installation Plan to demonstrate the proposed method of curing will achieve the required strength at the required time. All safety and weather conditions required by the manufacturer shall be in compliance with applicable rules and regulations of local, state, and federal authorities having jurisdiction.

4.0 Construction.

4.1 Mockup Test. A mockup test shall be performed by the contractor at least one week prior to the UHPC placement. The test will verify that the contractor is familiar with UHPC operations and troubleshooting installation procedures. The mockup shall closely replicate the placement conditions, operations, and dimensions of the UHPC to be installed. The mockup shall be a minimum 10 feet in length and match the cross-slope of the planned joint. If hydrostatic pressure head will be used on the project to consolidate the joints, the pressure head during the mockup should replicate the maximum pressure head anticipated on the project.

4.2 Pre-Pour Meeting. Prior to the initial placement of the UHPC, the contractor shall arrange for an on-site meeting with the UHPC representative. The contractor's staff and the engineer and Inspectors shall attend the site meeting. The objective of the meeting is to clearly outline the procedures for mixing, transporting, finishing, and curing of the UHPC material.

4.3 Formwork. The design and fabrication of forms shall follow approved drawings provided in the UHPC Field Installation Plan and shall follow the recommendations of the UHPC manufacturer. The forms shall be non-absorptive or coated to prevent absorption of water and shall be installed water-tight to prevent leakage of the UHPC during placement. A top form shall be used.

4.4 Surface Preparation. The precast concrete or existing concrete surfaces to be in contact with UHPC shall have a roughened surface with an amplitude of 1/4" +/- 1/8". The concrete surfaces shall be cleaned of debris and pre-wetted with water continuously for a minimum of 24 hours immediately prior to UHPC placement. Standing water shall be removed from the concrete and formwork surfaces prior to UHPC placement.

4.5 Batching. The contractor shall follow the batching sequence as specified in the approved UHPC Field Installation Plan. Mixers used for batching UHPC shall be suitable for mixing UHPC and shall be approved for use by the UHPC supplier prior to construction.

4.5.1 Temperature Control. The temperature of the UHPC shall be measured for each batch prior to placement, in accordance with ASTM C1064. The temperature shall be between 55°F and 85°F, unless otherwise approved by the on-site UHPC representative. When batching in warm weather, ice may be required as a full or partial substitute for the mixing water to control the UHPC mix temperature to within acceptable limits. If ambient temperatures are expected to drop below 40°F during the UHPC placement or within 48 hours after placement, cold weather placement procedures shall be used.

4.5.2 Flow Spread. The contractor shall measure the flow spread for each batch of UHPC prior to placement, in accordance with ASTM C1856. The flow shall be between 7 and 10 inches unless otherwise approved by the on-site UHPC representative. There shall be no visual sign of fiber segregation.

4.6 Placement. The material shall be placed starting at the low end of the joint and working toward the high end. The material shall not travel more than 10 feet during placement. Provide port/pour holes with a minimum diameter of 3 inches when top forms are used. The surface of the UHPC field joints shall be filled to a minimum of +1/4 inch above the intended final elevation. Internal vibration shall not be used during UHPC placement.

4.7 Curing. The UHPC shall be covered and cured in the forms according to the UHPC Field Installation Plan to attain the required strength shown on the contract documents. The UHPC shall not be disturbed until a minimum compressive strength of 10 ksi is achieved. The UHPC shall be ground flush with the precast panels after the material has attained a minimum compressive strength of 10 ksi. Strength shall be verified by a cylinder compression test conducted on field-cured cylinders or by the maturity method.

4.8 Removal of Forms. Forms shall not be removed until the UHPC has attained a compressive strength of at least 10 ksi. Strength shall be verified by a cylinder compression test conducted on field-cured cylinders or by the maturity method.

4.9 Installation of Wearing Surface. Installation of wearing surface onto UHPC joint header slab surfaces shall not be initiated until the UHPC has attained a compressive strength of at least 14 ksi. Strength shall be verified by a cylinder compression test conducted on field-cured cylinders or by the maturity method.

5.0 Testing. The contractor shall fabricate for every 25 cubic yards or a minimum of once per day, whichever is more frequent, a minimum of six field-cured 3-inch by 6-inch cylinders and six standard-cured 3-inch by 6-inch cylinders in accordance with ASTM C1856. The six standard-cured cylinders shall be used for acceptance testing. If early strength is to be validated by the maturity method as defined in Section 6.0, cast additional cylinders as required.

5.1 QC Testing. The following process control tests shall be performed by the contractor on-site during each day of UHPC casting and submitted to the engineer:

<table>
<tr><th colspan="6">QC Testing</th></tr>
<tr><th>Property</th><th>Test Method</th><th>No. of Specimens</th><th>Test Age</th><th>Test Result</th><th>Test Frequency</th></tr>
<tr><td>Flow</td><td>ASTM C1856</td><td>1 test</td><td>Prior to placement</td><td>7 to 10 inches*; no visual sign of fiber segregation</td><td>Each batch</td></tr>
<tr><td>Temperature</td><td>ASTM C1064</td><td>1 test</td><td>Prior to placement</td><td>55 to 85°F*</td><td>Each batch</td></tr>
<tr><td rowspan="2">Compressive Strength</td><td rowspan="2">ASTM C1856, field cured samples or ASTM C1074, maturity method</td><td rowspan="2">3 at each age**</td><td>As needed for formwork removal and grinding</td><td>> 10 ksi</td><td rowspan="2">Every 25 cy, with a minimum once per day</td></tr>
<tr><td>As needed for installation of overlay</td><td>> 14 ksi</td></tr>
</table>

* Unless otherwise approved by the on-site UHPC representative.
** Testing for compressive strength for formwork removal and grinding or for installation of overlay may alternatively be eliminated if using the ASTM C1074 maturity method as described in Section 6.0.

5.2 Acceptance Testing. The contractor will perform the following testing for acceptance:

Acceptance Testing					
Property	**Test Method**	**No. of Specimens**	**Test Age**	**Test Result**	**Test Frequency**
Compressive Strength	ASTM C1856, standard cured samples	3	7 days	N/A (informational)	Every 25 cy, with a minimum once per day
		3	28 days	> 17.4 ksi	

6.0 Estimation of In-Place Strength using Maturity Method. In-place strength may be estimated using the maturity method in accordance with ASTM C1074. The maturity function used to estimate strength shall be calculated with using same formula that is defined in the UHPC Field Installation Plan. All testing shall be performed by an AASHTO-accredited testing lab.

6.1 Development of Strength-Maturity Relationship. If maturity method is used, develop Strength-Maturity Relationship prior to submission of UHPC Field Installation Plan as outlined in ASTM C1074, except that 3-inch by 6-inch cylinders shall be used for maturity testing.

6.2 Thermocouple Placement. Two thermocouples or maturity meter probes shall be installed per UHPC placement, one at each end, at half the depth of the placement and no nearer to an edge than half the depth. The locations of the thermocouple installations shall be shown on the installation drawings. The thermocouple wiring may be connected to reinforcing steel, but probe endings shall not be in direct contact with the steel.

6.3 Monitoring. Record and save the maturity data from the thermocouple or maturity meter until the strength reaches 17.4 ksi. Disconnect the meter and clip all wires flush to the concrete surface.

6.4 Validation of Strength-Maturity Relationship. Validate the strength-maturity relationship at mock-up or first placement. Fabricate and field cure a minimum of 10 cylinders. Equip one cylinder with a thermocouple or maturity meter probe. Test the other cylinders in sets of three as close as possible to maturity values corresponding to 8, 10, and 14 ksi. Record the maturity value immediately prior to testing. If the average value of compressive strength for each set of cylinders is within 10% of the estimated value, the strength-maturity relationship is validated. If the average cylinder value is more than 10% below the estimated value at any age, the strength-maturity relationship shall be re-established.

7.0 Watertight Integrity.

7.1 Watertight Integrity Test. After the joints and blockouts have been ground, each joint and blockout shall be flooded with water for a minimum of 15 minutes. The contractor shall provide the engineer safe access for inspecting the underside of the joints. The concrete surfaces under the joint will be inspected by the engineer during this 15 minute period and also for a minimum of 45 minutes after the supply of water has stopped, for any evidence of dripping water or moisture.

Should the joint system exhibit evidence of water leakage whatsoever, the contractor shall locate the leak and repair the joint with HMWM.

7.2 HMWM Repair of Leaking Joints. The repair shall be performed at the contractor's expense and at no time extensions to the project. The contractor shall abrasive blast clean the area to be treated, removing all contaminants from the surface, and clean adjacent surfaces of the leaking joints using compressed air free of oil and moisture. The HMWM shall be mixed and applied according to the manufacturer's instructions with no more than 5 gallons applied at a time. The HMWM shall be poured over the joints. HMWM shall be applied to clean, dry surfaces when the surface temperature is at least 50°F and, if near 50°F, rising. HMWM shall not be applied if rain is expected within 12 hours of completion. A subsequent watertight integrity test may be required at the direction of the engineer after the repair has been made.

7.2.1 Driving Surfaces. When the HMWM surface will be used as a driving surface, sand shall be applied to provide friction. After the HMWM has been applied, at least 20 minutes but not more than 40 minutes shall elapse before applying the sand. The sand shall be broadcast at a rate of approximately two pounds per square yard, completely covering the HMWM. Once the HMWM is cured, any loose sand shall be removed from the surface.

7.2.2 Opening to Traffic. The HMWM must be tack-free before construction traffic is permitted to resume.

8.0 Method of Measurement. This work will be measured as the number of cubic yard of ultra-high performance concrete (UHPC) satisfactorily furnished and installed.

9.0 Basis of Payment. The contract unit price for ultra-high performance concrete (UHPC) will be full compensation for all materials and other items entering into the construction of the UHPC. The accepted quantity of UHPC will be paid for at the contract unit price.

K. DRAINAGE SYSTEM

1.0 Description.

1.1 The work under this item consists of furnishing, fabricating, installing, and modifying the drainage items necessary to complete the entire drainage system as shown on the design plans. In addition, the work will include cleaning and verifying the integrity of the complete drainage system.

1.2 Detailed shop drawings of the drainage system shall be prepared and submitted to the engineer. Shop drawings shall be in accordance with Sec 1080. Catalog data may be furnished for components that are standard manufactured items in lieu of detailed drawings, providing, governing dimensions are given.

2.0 Materials.

2.1 Reinforced fiberglass pipe, collection basins and fittings shall be a Reinforced Thermosetting Resin Pipe (RTRP) system in accordance with the requirements of ASTM D 2996. The RTRP system shall have a minimum short time rupture strength hoop tensile stress of 30,000 psi (207 MPa). The RTRP system shall be pigmented resin throughout the wall. The

color of the RTRP system shall be concrete gray or as specified on the bridge plans. The RTRP system shall not be coated with paint, gel-coat or any other exterior coating.

2.2 The contractor shall furnish a manufacturer's certification to the engineer for each lot furnished, certifying that the materials supplied is in accordance with all requirements specified. The certification shall include results of all required tests. Acceptance of the material will be based on the manufacturer's certification and upon results of such tests as may be performed by the engineer. The certification shall show the quantity and lot number that is represented.

3.0 Construction Requirements.

3.1 All connections shown on the plans to facilitate future removal for maintenance cleanout or flushing shall be made with a threaded gasket coupler system, bolted gasket flange system or a female to male threaded PVC plug. Adhesive bonded joints will be permitted for runs of pipe between such connections.

3.2 Runs of pipe shall be supported at a spacing of not greater than the lesser of those as recommended by the manufacturer of the pipe or as shown on the bridge plans. Supports that have point contact or narrow supporting areas shall be avoided. Standard sling, clamp, clevis hangers and shoe supports designed for use with steel pipe may be used. Minimum hanger thickness shall be 3/16 inch (5 mm) with the minimum strap width for the pipe sizes shown in the table below. Straps shall have 120 degree minimum contact with the pipe. Pipe supported on a surface with less than 120 degrees of contact shall have a split fiberglass pipe protective sleeve bonded in place with adhesive. All new steel, hangers and miscellaneous hardware for drainage system shall be ASTM A 709 Grade 36 (250) steel except as noted on the bridge plans. All new steel, hangers and miscellaneous hardware for drainage system shall be galvanized in accordance with ASTM A 153 except as noted on the bridge plans.

Pipe Sizes inches (mm)	**Minimum Strap Width inches (mm)**
3 (76.2)	1.25 (32)
4 (101.6)	1.25 (32)
6 (152.4)	1.50 (38)
8 (203.2)	1.75 (45)
10 (254.0)	1.75 (45)
12 (304.8)	2.00 (51)
14 (355.6)	2.00 (51)

3.3 The RTRP system shall be handled and installed in accordance with guidelines and procedures as recommended by the manufacturer.

4.0 Method of Measurement. No measurement will be made.

5.0 Basis of Payment. Payment for the above-described work, including all material, equipment, labor and any other incidental work necessary, will be considered completely covered under the contract unit price for Finger Joint Expansion Joint System (Abut 1 & Bent 5) or Finger Joint Expansion Joint System (Bents 9 & 13).

L. WELD INSPECTION AND REPAIR

1.0 Description. This work involves a multi-step process to identify and remove/repair weld cracks at critical connections in the bridge. Specific welds on the tie girders as detailed in the plans will be inspected using nondestructive evaluation techniques by a qualified inspector after removal of the coating. Weld crack limits will be marked on the steel and a weld repair plan provided to the engineer for approval. Following the approved plan, the contractor will grind the welds as required to remove cracks up to a depth of 3/16-inch. Crack removal will be verified by nondestructive test methods. Cracks deeper than 3/16-inch will also be fully removed through grinding but will then be replaced with new weld metal to restore the original weld profile. All welding will conform to the approved weld repair plan procedures consistent with Sec 1080 unless modified herein. Verification of weld crack removal will use nondestructive test methods throughout the welding process and after weld bake-out.

2.0 Equipment. The equipment for this work shall be as described below:

2.1 Magnetic Particle Inspection. A certified electromagnetic yoke using a contrasting color, dry iron powder for magnetic particle examination of all accessible welds. Yokes can be AC-powered or a combination of AC/DC powered. Yokes shall be in accordance with ASTM E709.

2.2 Ultrasonic Inspection. Conventional or phased array ultrasonic flaw detector with display screen and electronic file storage capabilities to be used with piezoelectric transducers of the size, frequency, and orientation needed to adequately interrogate the welds.

2.3 Grinding. Hand-held die grinders equipped with carbide cutting burrs of various shapes and diameters as the primary weld removal tool. Hand-held right-angle grinders with carborundum cut-off wheels for removal of weld material at depths greater than ½ inch.

2.4 Welding. Multiple-port portable heating system utilizing insulated ceramic heater pads controlled by electronic temperature controllers with thermocouples to monitor and regulate heat input and cool-down profiles and to produce a record of all weld repair temperature profiles. Certified, shielded metal arc welding equipment sized and powered to produce replacement welds. Appropriate storage and warming ovens to maintain welding consumable integrity.

3.0 Weld Inspection Requirements The following provides the requirements for weld inspection of selected welds in the bridge.

3.1 Welds and/or plate cuts to be inspected are as provided in the plans and as directed by the engineer. The inspection includes fabrication welds used to join plate components of the bridge members, as well as shop cuts of plate members as indicated. Items described below shall be construed as applicable to inspection of bridge welds as well as those plate cuts or other surfaces as indicated in the plans or as directed by the engineer.

3.2 All existing coating is to be removed at least six inches each side of the weld centerline for the full length of the weld prior to weld inspection. Cleaning of existing steel shall be in accordance with Sec 1081.10.4. Additional cleaning is anticipated after weld inspection and repair to achieve a properly cleaned surface for application of Coating System H.

3.3 Contractor will provide safe and stable access for all welds to be inspected. The engineer will be provided access as requested. The area inside the arch-to-tie girder connection shall be treated as a confined space.

3.4 Weld inspections shall be performed by an AWS Certified Welding Inspector.

3.5 Magnetic Particle Testing (MT) shall be performed on 100% of all cleaned welds shown in the plans, with the exception of those to be inspected by ultrasonic testing (UT). Previous inspection at the bridge has identified that visual inspection is insufficient to detect all of the defects in the welds or base metal. All inspection equipment will be certified.

3.6 Conventional ultrasonic testing (UT) or phased array ultrasonic testing (PAUT) will be performed on welds designated for such testing in the plans or as directed by the engineer if visual and MT inspection is not feasible. Flaw indications identified as being cracks shall be captured and stored electronically as part of the inspection record.

3.7 The contractor shall prepare and submit for approval a weld inspection plan, which should address any means of access, surface preparation, weld inspection (visual and MT and/or UT) and documentation procedures for the inspection. The nondestructive testing procedure shall be developed and approved by an individual or individuals who have been certified Level III in MT (for MT inspection) and UT (for UT or PAUT inspection) by testing in conformance with ASNT SNT-TC-1A, and who are further qualified by experience in examination of similar testing procedures. The weld inspection plan shall include, but is not limited to, the following:

- Qualifications of individual(s) developing/approving the procedure and of the individual(s) performing the inspection
    - The MT inspection shall be performed by an individual(s) certified as Level II in MT or greater
    - The UT inspection shall be performed by an individual(s) certified as Level II in UT or Level II in PAUT or greater in conformance with ASNT SNT-TC-1A for UT or PAUT inspection, respectively
- UT or PAUT scan plan showing the scanning pattern and coverage of the fillet welded region
- Discontinuity reporting criteria (i.e., amplitude and/or size measurements) for UT or PAUT testing
- Type of UT or PAUT equipment (manufacturer, model number, serial number
- Type of MT equipment and equipment certification
- Type of transducer, including frequency, size, shape, number of elements (PAUT only), angle and type of wedge
- Scanning parameters
    - For PAUT, this shall include the following at a minimum:
        - Location and number of active elements
        - Active aperture size
        - Angular range and angular increment
        - Depth and type of focusing, if included

- Scanning surface preparation and couplant requirements
- Type of calibration test block with appropriate reference reflectors
- Method of calibration and calibration interval
- Method for examining for laminations prior to crack scanning
- Reporting of inspection data shall include the following at a minimum:
    - Weld identification
    - Discontinuity location, depth (as applicable), height, length, and amplitude level (for UT or PAUT, as applicable)
    - Screenshot (or UT or PAUT signal trace) including a portion of each suspected crack

3.8 Weld inspections shall employ grinders as necessary to verify the presence of cracks in combination with the nondestructive testing. Previous inspections have identified several weld fabrication defects that are not likely to be cracked but must be investigated closely to verify whether cracks are present. Overlap of the final bead of the weld to the base metal may not be fused at the exposed surface, resulting in the original primer coat flowing into the small gap between the cooled weld metal and plate (tie girder web or stiffener plate). Grinding of the weld toe to remove this primer coat and verify the presence of a more significant weld defect should be anticipated. Roughened surfaces from plate cuts should also be anticipated to require grounding to achieve a smooth surface to permit for MT or UT inspection, as applicable. Photographs of cracks highlighted by MT powder shall be provided to the engineer at all weld terminations where the crack appears to extend behind the lower hanger cable castings.

3.9 Verified cracks shall be legibly marked with a paint stick on the steel adjacent to the crack and their lengths and positions recorded on representative weld inspection drawings. Weld crack start and stops shall be combined into a single repair length when within 3 inches of each other. Information to be provided to the engineer shall also include photographs of cracks in weld terminations at lower hanger cable castings and electronic output of UT scans where crack-like indications are identified.

3.10 All crack repairs including those removed by grinding only or requiring rewelding, shall be inspected for conformance with Sec 1080.3.3.4 and as modified by Sec 1080.3.3.5.

3.11 Welds shall be reinspected as follows: 1) as defect removal grinding progresses to verify crack removal up to a depth of 3/16 inch. 2) as grinding progresses to verify crack removal for cracks deeper than 3/16 inch. 3) After the root pass of a weld repair. 4) Periodically during installation of multi-pass welds. 5) Prior to the resumption of welding when welding inactivity exceeds 2 hours. 6) After any period where preheat, interpass, or post-weld bake-out temperatures deviated from the specifications by more than 200 deg. F. 7) At the conclusion of a weld repair prior to post-weld bake-out. 8) After post-weld bake-out at ambient temperatures. 9) At the direction of the engineer.

3.12 The weld inspector shall append the initial crack drawings from 3.9 to indicate the length of weld in inches where grinding removed the crack and the length of weld in inches where a weld repair was performed. The inspector shall provide their AWS stamp on all crack drawings

when the weld repairs are complete. The inspection documentation shall include locations of weld cracks identified from the inspections and pay item breakdown of weld repairs.

4.0 Weld Repair Requirements. The following requirements shall be met during repair of weld cracks throughout the bridge.

4.1 The contractor shall submit a weld repair plan after the inspection is complete for at least one arch to the engineer for approval before commencing repairs. Previous findings of weld-related defects and cracking at the structure indicate that they formed as hydrogen-induced cracks, most likely from a combination of welding-related factors during original fabrication. The weld repair plan shall take measures to prevent recurrence of similar fabrication related cracking in repair welds. All welding shall be conducted in accordance with AWS D1.5, and as modified or stated herein. The weld repair plan shall include the following, at a minimum:

- Locations of weld cracks identified from the inspections

- Order of weld repairs

- Repair welding procedures, including weld joint details. Areas to receive repair welds shall be ground to white metal prior to welding, which will completely remove all moisture, oil, grease, rust, debris, paint, etc. before welding, including any tack welding, onto any surface. Each weld repair groove shall be welded out with a series of stringer beads rather than by weaving the electrode from side to side as the deposited layers increase in width. Slag shall be completely removed from each stringer bead prior to depositing the next bead. Any discontinuities identified during weld placement or subsequent MT inspection shall be ground out and rewelded before depositing of the next layer.

- Electrode selection. Electrodes shall be E7018 electrodes for SMAW with an H8 (low hydrogen) or H4 (extra-low hydrogen) rating, or as approved by the engineer.

- Means for proper electrode maintenance. Electrode handling and storage shall be in accordance with AWS D1.5.

- Means for heat treatment of the base metal before, during, and after welding. Heat treatment shall, at a minimum for over a distance of ten (10) inches in any transverse direction from the repair groove include the following:

    - preheat the full thickness of the plates to a temperature of at least 300° F and maintain this temperature for a minimum of one (1) hour prior to beginning welding
    - maintain a temperature of 300-450° F as the interpass temperature range until the entire length of a given repair groove has been fully welded out
    - upon completion of each repair groove, maintain the temperature of the preheated area at 300° F for at least three (3) additional hours to maximize the effusion of hydrogen
    - on any given repair groove, if the completion of the welding plus a three-hour post-weld hydrogen bake-out is threatened by inclement weather or other adverse circumstances, welding should be stopped early enough to enable an interim three-hour bake-out prior to the likely work stoppage or precipitation event (which could rapidly cool the base metal). A second and final three-hour bake-out should then be required upon subsequent completion of the repair groove

- Welder certifications

4.2 After review and approval of the weld inspection report, and at the direction of the engineer, the contractor shall proceed with crack or defect removal by grinding. Removal shall be completed by grinding using angle grinders (for cut plate surfaces) or die grinders with carbide burrs (for cut plate surfaces, fillet welds and other welds). Flame cutting or arc gouging will not be permitted. A nominal removal of up to a 3/16-inch depth of affected weld or base metal shall be completed to completely remove the defect or crack. If the defect or crack cannot be removed, the portion of portions of affected weld or base metal shall be documented similar to the procedure outlined in 3.9 (marking the area with paint stick or other clearly legible marking, document the limits and defect type, submit to the engineer) with the addition of the depth of weld or base metal removal documented.

4.3 After review and approval of locations requiring further material removal than 3/16 inch by the engineer, proceed with weld or affected base metal removal until the defect or crack is completely removed. Most repairs are anticipated at double-sided fillet welds. Care should be taken to avoid exposing the original root face between the two sides while grinding. If the root face is exposed during grinding, consult the engineer to determine any necessary modifications to the repair welding procedure.

4.4 Verification of defect or crack removal shall be achieved using MT and/or UT, as applicable, in accordance with the inspector qualifications and inspection procedures outlined herein. After complete defect or crack removal, document the lengths, positions, and depth(s) of material removal on representative weld inspection drawings for inclusion with the final as-built drawings. At all material removal locations, care shall be taken to limit effects of the grinding removal to adjacent components. For material that will not be rewelded, a smooth thickness transition of approximately 10:1 should be maintained from maximum depth of removal to original material thickness. Any deficiencies including but not limited to excessive material removal, damage or gouging to adjacent components, or damage in the final surface due to improper contractor operations or equipment shall be corrected by the contractor, at the contractor's expense.

4.5 After review and approval of weld defect or crack removal documentation, and at the direction of the engineer, proceed with repair welding. Repair welding is required to restore weld or base metal removal in excess of 3/16 inch, or at the direction of the engineer. Repair welding shall be conducted in accordance with the contractor's submitted and approved welding procedure. Unapproved deviations from the contractor's welding procedure shall be grounds for repair rejection, up to and including complete removal of nonconforming welds and re-welding at the contractor's expense. Welds shall be inspected with MT in accordance with 3.11.

4.6 Submittals. Submittals required to perform the weld inspection and repair work include, but at not limited to the following:

- Weld Inspection plan including qualifications of personnel, certification of equipment, and procedure for surface preparation and inspection as outlined herein.

- Weld Inspection summary report summarizing defect locations and characterization, as outlined herein.

- Information of locations where weld defect or cracks could not be removed by grinding up to 3/16 inch

- As-built details of complete defect removal and repair weld placement
- Repair welding plan and procedures

5.0 Method of Measurement.

5.1 Measurement for Weld Inspection will be made to the nearest linear foot of inspected welds, based on the length of welds shown in the plans. Lengths of welds to be inspected as depicted in the plans are based on previous field measurements and available bridge shop drawings. Actual weld lengths in the field may vary slightly. No re-measurement of those weld or plate cut locations is anticipated or required. No additional measurement will be made for minor variations in actual weld lengths for the listed welds compared to what is shown on the plans. Subsequent inspection of welds during defect removal or repair welding will not be measured. Additional welds, plate cuts, or other areas to be included with the inspection at the direction of the engineer that are not explicitly shown on the plans will be measured to the nearest linear foot.

5.2 Measurement for Crack Removal - Grinding will be made to the nearest linear foot for ground welds or ground plate surfaces for the purposes of removal of weld defects or cracks at a depth of 3/16-inch or less. Grinding shall only be measured at documented locations with defects or cracks based on the findings from the Weld Inspection. Measurement will be made along the length of the completed and accepted weld removal or around the edge of a cut plate surface, regardless of weld or plate thickness or depth of grinding removal. Only locations approved by the engineer for grinding removal will be measured. The quantity provided in the estimate is based on previous inspection findings of the anticipated defect lengths for the total inspected weld length for the A1850 structure. The estimated quantities may vary, but the contract unit price shall prevail regardless of the variation. No measurement will be made for grinding of unacceptable welds placed by the contractor.

5.3 Measurement for Weld Repair will be made to the nearest linear foot for length of repair welds placed at locations where defect removal by grinding exceeded 3/16 inch, or at the direction of the engineer. Measurement will be along the completed and approved weld, regardless of weld thickness or number of weld passes. The quantity provided in this estimate is based on previous inspection findings and weld repair quantities from Bridge No. A1850. The estimated quantities may vary, but the contract unit price shall prevail regardless of the variation. No measurement will be made for re-welding of welds rejected by the engineer.

6.0 Basis of Payment.

6.1 Payment for Weld Inspection will be paid for at the contract unit price per linear foot of inspected weld or cut plate surface. Payment for Weld Inspection will be considered full compensation for all labor, equipment, material, and incidentals to complete this work, including mobilization of access and inspection equipment, qualification of personnel and inspection personnel labor, incidental grinding as part of the inspection, documentation of findings and furnishing of an inspection summary report(s). Weld inspections required to complete the crack removal or weld repair will not be paid under Weld Inspection. Surface preparation including removal of the coating system to facilitate the inspection shall be included with Surface Preparation for Recoating Structural Steel and will not be measured or paid as part of the Weld Inspection. Any additional cleaning and surface preparation necessary for the inspection shall be considered incidental to the cost of the Weld Inspection.

6.2 Payment for Crack Removal - Grinding will be made at the contract unit price per linear foot of ground weld or cut plate surface. Payment for Crack Removal - Grinding will be considered full compensation for all labor, equipment, material, consumables, and incidentals to complete this work, including mobilization of access and repair equipment, labor to perform defect or crack removal up to a depth of 3/16 inch, inspection(s) to verify defect removal, and documentation of areas where 3/16 inch of plate or weld thickness removal does not remove the defect or crack. Crack Removal will not be paid for cracks deeper than 3/16 inch.

6.3 Payment for Weld Repair will be made at the contract unit price per linear foot of completed and accepted weld repair. Payment for Weld Repair will be considered full compensation for all labor, equipment, material, consumables, and incidentals to complete this work, including removal of defects and cracks deeper than 3/16-inch, development of an approved welding procedure, any required welder or weld procedure qualification, furnishing and installation of required heating equipment and temperature monitoring, inspection(s) of welds during placement, placement of field welds in accordance with AWS D1.5 and accepted by the engineer, and furnishing as-built drawings that summarize weld placement locations approved by the engineer.

M. HANGER TESTING, JACKING, TENSION ADJUSTMENT AND CABLE REPLACEMENT

1.0 Description. This work involves multiple work items including testing of hanger cables to measure tension in the existing cables, installation of a shoring system to transfer reaction forces from the supported tie girder and floor beam to the individual hanger cables without using the existing lower hanger cable connection casting, adjustment of individual cable tension as needed in locations where measured tension is nonuniform among cables at a given hanger location, replacement of hanger cables at locations where the existing lower hanger cable connection casting will be removed to facilitate inspection of the weld between the connection stiffener and tie girder web, and monitoring or surveying of the distance between the upper and lower hanger anchorages before, during, and after replacement in order to verify that the distance is not altered,. The work shall consist of furnishing all labor, materials, equipment, services, and incidentals necessary to execute this work as outlined in the plans and discussed herein.

2.0 Materials and Equipment. The materials and equipment for this work shall be as described below:

2.1 Hanger Cable Testing Agency and Equipment. Instrumentation or nondestructive testing equipment capable of determining the approximate tension in each cable. One acceptable system is a vibration analyzer with built-in fast Fourier transform (FFT) capability that will take readings from an accelerometer temporarily attached to each hanger cable to determine natural cable vibration frequencies using the natural vibration of the bridge to excite the accelerometer. Data collected from such a system can be used with the physical properties of the hanger cables to calculate cable tension. Other techniques such use of a laser vibrometer are also acceptable.

- A qualified testing agency with experience in similar nondestructive testing and instrumentation shall perform the hanger cable testing. The testing agency shall be able to demonstrate, at the request of the engineer, similar project experience performed within the

last 10 years of cable measurements similar to those required for this project. The proposed testing agencies qualifications, testing methods, and instrumentation shall be submitted to the engineer for approval prior to performing any cable testing.

2.2 Hanger Shoring System. Weldments, cable and/or threaded rod components, hydraulic rams, instrumentation, and other necessary components to facilitate individual cable removal and detachment of the existing hanger cables from the existing lower hanger connection casting to the tie girder.

2.3 Fabricated Structural Steel. Fabrication of steel components, including but not limited to steel weldments that are part of the jacking system, shall conform to Sec 1080.

2.4 High Strength Bolts. Bolts shall be ASTM F3125, Grade A325 and in accordance with Sec 712.7. Bolts shall be of the size specified on the plans or shall match the size of existing bolts that they are replacing, as applicable. Bolts shall be full pretensioned in accordance with Sec 712.7.3, unless specified otherwise. Once pretensioned, bolts shall not be reused.

2.5 Structural Strand. Structural strand shall conform to ASTM A586 Grade 1, Class A weight zinc-coated inner wires and Class C weight zinc-coated outer wires. 2 1/8-inch diameter strands shall have a minimum breaking strength of 538 kips. All strands shall be pre-stretched to 55% of the breaking strength in accordance with ASTM A586. The load shall be maintained and/or repeated until the strand reaches a stable condition and shows a well-defined and uniform elastic stretch and recovery under stressing. The modulus of elasticity shall be determined in accordance with ASTM A586. A minimum modulus of elasticity of 23,000 ksi shall be required for pre-stretched strands. The manufacturer of the structural strand shall be ISO 9001 certified.
2.5.1 Wires used in each hanger shall be made in one continuous piece. The splicing of wire will not be allowed. Strand shall be of long lay but shall not be of such length to prevent keeping the center in its true position during any of the operations before the hangers are in their final positions.

2.5.2 Prior to fabrication, the zinc-coated steel wire used in the manufacture of structural strand shall be tested for physical properties in accordance with ASTM A586 and the following:

- No less than 10 percent of the coils of any lot of zinc-coated wire shall be tested for tensile strength. If any of these coils fails to meet the requirements, the engineer may require that all coils of such lot be tested and reject all individual coils which do not meet the requirements for tensile strength.

- No less than 10 percent of the coils of any lot of zinc-coated wire shall be tested for stress at 0.7 percent extension. If any of these coils fails to meet the requirements, the engineer may require that all coils of such lot be tested and reject all individual coils which do not meet the requirements of stress.

- No less than 5 percent of the coils of any lot of zinc-coated wire shall be tested for zinc coating (weight and adherence). If any of these coils fails to meet the requirements, the engineer may require that all coils of such lot be tested. Unless at least 80 percent of the coils pass the test, the entire lot will be rejected.

2.5.3 Any coil failing to meet the requirements will be rejected.

2.5.4 The strand shall be manufactured in machines of adequate size to ensure first-class workmanship and fabrication to the final length. Once the manufacture of strand has started, no changes shall be made in wire grade, construction, or lay of strand, or other factors that would affect the uniformity of the finished product. Bent wires shall not be straightened or used. Any kinked or damaged strands will be rejected.

2.5.5 A test for modulus of elasticity and breaking strength shall be performed for each manufactured length of strand in accordance with ASTM A586. The gauge length of the specimen shall be 100 inches. The strand shall have the anchor sockets attached to each end and shall be loaded through the sockets. The socketing procedures used for the test specimen and assemblies shipped to site shall be identical.

2.5.6 If the test specimen fails to meet the minimum breaking strength requirement, another test sample shall be cut from the same manufactured length and tested. Should it also fail, the manufactured length of strand may be rejected. If rejected, the contractor shall furnish new strand length that is subject to the same testing and approval procedures outlined herein. No compensation will be made for the cost of the rejected strand, including testing costs. All tests results shall be submitted to the engineer for review and approval.

2.5.7 The strand hanger lengths shall be measured after prestressing using calibrated steel tapes while under a known tension equal to the dead load shown on the plans. After marking for length, the load shall be released and then reapplied. A second measurement shall be taken and the two measurements shall check within a tolerance of 0.25 inches.

2.5.8 At the time strands are measured for cutting, a continuous paint stripe shall be made on one side of the strand for its entire length to assure correct alignment of the strands during socketing and erection.

2.5.9 The strand shall then be cut and the sockets shall be put on carefully to ensure socket and strand alignment. The sockets shall be attached to the strands by using High Grade zinc spelter as specified in ASTM B6, and following recognized fabrication practices that will permit the strand, when stressed to 80 percent of minimum breaking strength under the test specified hereafter, to slip less than 1/6 the cable diameter. If a greater movement should occur, the method of attachment shall be changed until a satisfactory one is found. Each end fitting of the finished assembly shall be proof loaded to a minimum of 50 percent of the strand breaking strength.

2.5.10 When cutting the strand, include an allowance for obtaining test specimens shall be included as stated previously in this section.

2.5.11 Strand identification marks shall be provided to facilitate erection. Each strand shall be marked with a legible waterproof tag attached to it giving the fabricated length and cable ID number as noted in the plans.

2.5.12 All hanger assemblies shall be preassembled and delivered to the site as complete units. Strands shall be properly coiled on reels in such a manner so that no permanent deformation of wires in the strand will occur. Strands shall be stored in a well-protected location. Strands shall be handled, transported, and stored in accordance with the AISI Wire Rope Users' Manual. Any strands damaged by the handling, transporting or storing shall be replaced at the contractor's expense.

2.6 Socket Assemblies. All anchor sockets shall be cast steel conforming to ASTM A148. Sockets and the socketed zinc connections shall at least be Grade 105/85 and meet or exceed 100% of the breaking strength of the designated structural strand attached. Each socket installed as part of the structure shall be proof loaded to 50% of the breaking strength of the attached structural strand following attachment of the structural strand. All anchor sockets and components shall be Class A galvanized conforming to the requirements of ASTM A153.

2.6.1 Only cast sockets designed for strand shall be supplied. The compatibility of the pin and anchor socket dimensions and structural steel dimensions shall be certified by the socket manufacturer. Shop drawings and design calculations shall be submitted for each type of anchor socket.

2.6.2 Pin holes for open strand sockets shall be line bored to the final dimensions in accordance with Sec 1080.3.3.10. The resulting diameter of the pin hole accounting for galvanizing of the inside surface of the pin hole and of the pin itself shall conform to the limit set in Sec 1080.3.3.10. All socket pins shall have one end headed and one end fitted for a retaining device. The pin retaining device may be a threaded pin cap or cotter pin. The pin head and retaining device must be capable of sustaining a force along the axis of the pin equal to or greater than 5% of the minimum breaking strength of the attached structural strand. Charpy V-notch testing shall be performed per ASTM E23 at 40 ℉ on one pin per lot and the results shall be submitted to the engineer.

2.6.3 All components shall be designed to develop the minimum breaking strength of the attached structural strand without experiencing stresses beyond the yield point of the socket steel or excessive creep of the zinc filler under load. All sockets, rods and pins shall be considered fracture critical and shall adhere to the requirements of AASHTO/AWS D1.5.

2.6.4 All sockets shall be given a visual inspection and evaluated for defects. The inspection procedures in accordance with ASTM A802 or other visual standards may be used to define acceptable surface discontinuities and finish. Visual surface discontinuities that are unacceptable shall be removed and the removal verified by visual examination of the resultant cavities.

2.6.5 If visual examination reveals any defect, nondestructive tests deemed appropriate by the engineer for the type of defect observed, shall be required. Nondestructive tests shall be performed by the same approved laboratory, in accordance with the appropriate Supplementary Requirements of ASTM A781. The engineer will determine the acceptability of sockets evaluated in accordance with this standard.

2.6.7 In addition to the above nondestructive testing, all sockets shall be fully inspected by magnetic particle examination conforming to ASTM A 781, supplemental requirement S1 in accordance with:

- ASTM E 709 – Standard Guide for Magnetic Particle Testing
- ASTM E 125 – Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings.

2.6.8 Each socket type shall be subjected to radiographic examination conforming to ASTM A781, supplemental requirement S2. Contractor shall submit radiographic shot schedule of castings to the engineer for approval for each socket type.

2.6.9 Radiographic inspection shall be performed in accordance with the following specifications, as applicable:

- ASTM E 94 – Standard Guide for Radiographic Examination.

- ASTM E 446 – Standard Reference Radiographs for Steel Casting up to 2 inches in Thickness.

2.6.10 The surface of the casting shall be examined visually and free of adhering sand, scale, cracks and hot tears. Large sand spots, inclusions and blow holes shall be cause for rejection of the casting. Defects exceeding the degree shown in the following table shall be cause for rejection of a socket.

SEVERITY LEVEL – RADIOGRAPHICALLY INSPECTED CASTINGS*

Category ASTM E446 up to 2 inches	**Defect**	**Acceptable Severity Level****
A	Gas Porosity	3
B	Sand Slag Inclusions	3
C	Shrinkage:	
	Type 1	3
	Type 2	3
	Type 3	3
	Type 4	3
D	Crack	Not Acceptable
E	Hot Tear	Not Acceptable
F	Insert	Not Acceptable
G	Mottling	Not Acceptable

2.6.11 If a socket is rejected, all other sockets from the same heat shall be radiographically inspected at no additional expense. Rejected castings may be repaired at the sole discretion of the engineer. If approved by the engineer, repairs shall be performed repairs at no additional expense. Minor defects may be removed by grinding or chipping without welding repair, provided the following requirements are complied with:

- The depth of the defect does not exceed 3% of the specified dimension.
- The removal of metal does not appreciably affect the strength of the casting, as determined by the engineer.
- The remaining wall thickness is equal to or greater than the required wall thickness.
- The surrounding metal is ground to a smooth contour with the elimination of apparent stress risers.

2.6.12 Defects exceeding those defined above may be repaired by welding if approved by the engineer. All proposed repair procedures shall be submitted to the engineer in writing. The request shall include a description of the defect, the size and shape of the excavation, the welding specification, and the amount of preheat and post heat to be utilized.

2.6.13 Contractor shall perform and provide certification for radiographic inspections to the engineer for review and approval. Inspections shall be performed by approved American Society for Nondestructive Testing ASNT-TC-1A examiners.

2.6.14 The anchor sockets shall be Charpy V-notch impact tested in accordance with ASTM A 781, supplemental requirement S9. The testing frequency shall be performed at the same frequency as for the radiographic testing. The samples shall withstand an impact of 25 foot-pound at 40°F. Contractor shall submit the documented results to the engineer.

2.6.15 Sockets shall be attached to the strands in accordance with the procedures submitted to the engineer prior to socketing. After being splayed in preparation for socketing, the wires of a strand shall be cleaned of grease and other impurities by a carefully controlled process that will assure no harm is done to the wire zinc coating. After socketing, the strand wires shall be re-lubricated adjacent to the socket.

2.6.16 The socket basket of the socket shall be preheated to expel moisture and to prevent the molten zinc from congealing before it completely fills the narrow lower end of the basket. The strand will be rejected if the socketing procedure results in bare wires within the socket. The socket shall be filled with molten zinc in one continuous operation. The molten zinc shall be placed at the lowest practical temperature, usually approximately 925°F but never exceeding 1000°F, to minimize the effect of heat on the strands. The zinc temperature at the time of pouring shall be recorded.

2.6.17 Socket and strand alignment, and that the lengths of the cable assemblies, shall be verified after socketing. A tabulation of shop-measured lengths of each assembly shall be submitted to the engineer for use in erection. The ambient temperature in the shop at the time the final strand assembly lengths are determined shall be recorded.

2.7 Pins. Pins connecting the open strand sockets to the anchor plate shall conform to the requirements of ASTM A668, Class F. Supplemental requirement S6 magnetic particle test and S7 ultrasonic test shall apply. Ultrasonic testing shall be performed at the same frequency as for the radiographic testing of the anchor sockets. Charpy V-notch impact testing shall be performed on the pins in accordance with ASTM A673, P frequency. The samples shall withstand an impact of 25 foot-pounds (force) at 40°F. Pins shall be fabricated in accordance with Sec 1080.3.3.9. Pins shall be galvanized in accordance with ASTM A153. The galvanizing thickness on the pin shall not exceed 0.03125 inch.

2.8 Cotter Pins. Stainless steel type 316 cotter pins shall be supplied with the pin assembly.

2.9 Studs. Threaded studs for lower Type 6 sockets shall conform to ASTM A576, Grade 1045. Alternatively, ASTM F1554 Grade 55 or Grade 105 rod may be used provided calculations and testing demonstrate adequate capacity of the stud to exceed the breaking strength of the strand. Studs shall be of the appropriate size for the specified bridge strand diameter as stipulated by the socket manufacturer.

2.10 Nuts. Heavy hex nuts for threaded studs shall conform to ASTM A563 Grade DH.

2.11 Threaded Coupler. Threaded couplers shall be high-tensile special manufactured components provided by a qualified socket manufacturer or similar. The coupler shall be certified by the manufacturer and demonstrated by calculations to exceed the maximum anticipated jacking forces in the shoring system for each cable.

3.0 Construction Requirements.

3.1 Field Verification. Complete field survey and measurement of all steelwork and work locations shall be performed as necessary to furnish complete and accurate shop drawings. Adjustment or modification in the field may be necessary to assure a reasonable fit.

3.1.1 Shop drawings of the existing materials are available for the contractor's use. However, field measurements are recommended to be taken to confirm dimensions where necessary. Fully dimensioned shop drawings of all new materials shall be submitted in accordance with Sec 1080.3.2.

3.2 Hanger Cable Testing Requirements. Prior to deck scarification, the contractor shall verify the dead load tension in each of the existing hanger cables (four cables per hanger). The testing procedure proposed for use shall be submitted to the engineer for review and approval prior to performing any testing at the bridge. The contractor shall perform tension testing to approximate a "no live load" condition and shall specify means to achieve a minimal live load force effect in the testing procedure. A complete summary of all hanger dead load tension readings shall then be provided to the engineer for review and approval upon completion of the testing. The approved dead load summary table shall also be made available to the hanger strand manufacturer for use in the fabrication of any hanger strands.

3.2.1 A similar testing procedure shall be conducted at the completion of the tie girder weld inspection, hanger cable replacement, and deck overlay work to verify the final dead load tension in the hanger cables (at all new and remaining existing cables). After review of the initial or final hanger cable testing results, the engineer may direct the contractor to use the approved cable shoring and jacking system to adjust cable tension. The contractor's shoring and jacking system shall satisfy the requirements outlined herein.

3.3 Temporary Jacking System. The contractor shall be responsible to design, furnish, fabricate, and construct a temporary cable shoring and jacking system for the hanger cables to facilitate existing lower hanger cable casting connection removal as part of the tie girder weld inspection, and to allow for hanger cable tension adjustments at the direction of the engineer.

3.3.1 As part of the weld inspection and repair work for the tie girder, it is anticipated that up to six lower hanger connection castings will need to be removed to expose and repair welds between the floor beam connection stiffener and tie girder web for Bridge No. A1850. The four cables at a given panel point are bolted to castings forming a cruciform shape defined by the tie girder web and floor beam stiffener. The removal of a casting is anticipated to require partial removal of two adjacent castings because the bolts that connect the casting to the structure pass through the adjacent castings. One proposed shoring system is shown in the plans. The contractor may propose an alternate shoring system subject to the approval of the engineer to support the means and methods of weld inspection and hanger cable replacement.

3.3.2 Calculations and working drawings for the cable shoring and jacking system shall be submitted to the engineer for approval. The system shall be capable of supporting the relevant in-service loads and construction loads in the cables, based on historic cable design values and the findings of the cable testing. At a minimum, the shoring system shall not adversely damage cables or structural steel components that are to remain as part of the structure at the completion of the work, shall permit for the removal of at least one full hanger cable to facilitate cable replacement, shall be capable of adjusting cable tension and fully relaxing and tensioning

a single hanger cable, and shall be capable of transferring cable forces or shoring loads to the structure with hydraulic pressure in the jacks released, either via shims, threaded studs, or other attachment. The system should also be capable of maintaining dimensional control of the floor beam, tie girder, and hanger cable connection during the work. It is anticipated that three hanger cables (of the four at a given panel point) are sufficient to transfer the dead load reaction from the floor beam to tie girder connection to the arch. It is also anticipated that lateral bracing members can be removed from the tie girder connection to facilitate shoring system installation at one panel point at a time. Individual cable replacements at several connections and lateral bracing member replacements have been performed in the past.

3.3.3 The contractor shall furnish and submit a work plan and shoring system design to the engineer for approval prior to any cable shoring work. The shoring system design shall be signed and sealed by a licensed Professional Engineer in the state of Missouri. If the contractor elects to use a shoring system similar to the ones shown in the plans, calculations and shop drawings of the shoring system shall be submitted to the engineer, along with verification that the work plan is consistent with the contractor's intended means for weld inspection and repair. Differing or alternate shoring systems will also be considered. A proposed sequence for the work and jacking procedure is provided in the plans.

3.3.4 All cable jacking shall be performed in the presence of the engineer or a designated representative. Actual jacking forces, including increments of load application at each jack, shall be carefully monitored and recorded. The relative displacement of the tie girder and floor beam shall also be measured from a reference datum and recorded. These deflections shall be continuously monitored during jacking. The contractor's plan shall include a limit of measured deflections where jacking operations will be halted.

3.3.5 Jacking operations shall not be allowed and/or shall be ceased immediately when the sustained wind velocity exceeds 30 mph. The contractor shall only be allowed to perform jacking operations at one hanger at a time anywhere on the span.

3.3.6 Following jacking operations, the contractor shall test the existing hanger strand to ensure that all load has been successfully transferred to the temporary support (or adjacent supporting cables) and no residual tension is carried by the existing hanger strand prior to its cutting and/or removal. The method for performing this testing shall be defined by the contractor as part of the jacking procedure.

3.4 Hanger Cable Replacement. At locations where the existing hanger cable lower connection castings are to be removed as part of the tie girder weld inspection, hanger cables shall be replaced. Hanger cable strands, socket assemblies, pins, and other components shall conform to the requirements outlined herein.

3.4.1 All structural strand, socket components and socket installation shall be performed by a fabricator having a minimum of 10 years of experience in the manufacturing of the specific components. The fabricator shall submit their quality procedures plan and manual to the engineer for review. The fabricator's quality procedures plan and manual are subject to approval by the engineer. Fabricators of structural strand, cast sockets, and pins shall demonstrate a familiarity with procedures required to produce fracture critical members in accordance with a fracture control plan as defined by AASHTO/AWS D1.5.

3.4.2 Certification of the following type shall be submitted prior to hanger assembly delivery:

- Manufacture of strand
- Tensile strength of strand
- Modulus of elasticity of strand
- Pre-stretching, measuring, and proof loading
- Material certification of sockets and pins

3.4.3 Working drawings for all hanger assemblies suitable for approval for construction purposes relevant to the hanger replacement work shall be submitted to the engineer in accordance with Sec 1080.3.2. Fabrication or construction shall not start on an item of work before working drawings are approved.

3.4.4 Erection plans for the hanger replacement shall be submitted which completely describe the method of cable erection. Details of all lifting equipment and attachments to the bridge members shall be included. An erection sequence for all anticipated phases and conditions of erection showing crane capacities, crane locations and lifting points shall also be included. Cable force calculations shall be provided to demonstrate that the cable allowable stress will not be exceeded.

3.4.5 The cable assemblies shall be inspected prior to shipping and again prior to installation. The assemblies shall be transported to the job site in a manner such that no permanent deformation of the strand occurs (see Paragraph 2.5.12). Any cable assembly damaged by handling, transporting, or storing shall be replaced at the contractor's expense. The new assemblies shall be stored under a roofed structure. Assemblies shall not be dragged at any time. Assemblies with damage to the zinc coating will be rejected. The assemblies shall be stored off the ground to keep strands dry.

3.4.6 At the completion of hanger installation, the contractor shall measure the load in the newly installed hangers to ensure it is approximately equal to the anticipated loads in the cable and that load sharing between the four cables at a given panel point is approximately equal.

3.4.7 All hanger cables to be replaced including all associated cable socket hardware shall be kept intact as an assembly and undamaged when removed from the bridge. The contractor shall store each removed cable on drums or reels consistent with Paragraph 3.4.5. The engineer will direct the contractor to release the used cables to MoDOT or to dispose of the cables.

4.0 Submittals. Submittals required to perform the outlined hanger cable work include, but at not limited to the following:

- Design calculations and working drawings for the temporary shoring and jacking system for the cables
- Qualifications of the testing agency, description of the testing equipment and inspection/ testing procedure to measure cable tension
- Qualifications of the fabricator who will supply the cable strands, sockets, pins, and other components

- Testing results for hanger strands, sockets, and other components as outlined herein.
- Material certifications for hanger strands, sockets, pins, and other components as outlined herein.
- Working drawings for the supplied hanger cable assemblies and components
- Erection procedures and drawings for the existing hanger cable removal and new hanger cable installation, as outlined herein.

5.0 Method of Measurement.

5.1 Measurement for Cable Tension Measurement Inspection will be per each inspection of all 34 hanger locations with 4 cables at each hanger location in the tied-arch span (136 cables total for both tied arches). A quantity of two (2) inspections has been included. The first inspection will be completed prior to deck scarification and commencement of the hanger work. The second inspection will occur after installation of the new wearing surface and after all cable work is complete. Either inspection may result in a request by the engineer for cable tension adjustments using the temporary shoring and jacking system.

5.2 Measurement for Cable Shoring, System Installation, Cable Tension Adjustment will be per each installation and use of the contractor's designed and furnished temporary shoring and jacking system. Each installation will be at a single panel point on the tie girder. The number of installations reflects the six (6) locations shown in the plans for Bridge No. A18503 where hanger cable lower connection casting removal and cable replacement is anticipated as part of the tie girder weld inspection work. An allowance for two (2) additional shoring locations for each bridge has been included with locations to be determined by the engineer. Additional shoring installations may be used to provide weld access behind the hanger casting, for adjustment of existing hanger cable tensions, or as required by the engineer. The quantity of the additional two (2) shoring installations may be as few as zero or at an additional number of locations up to and including half the hanger cable locations in the span (17).

5.3 Measurement for Hanger Cable Replacement will be per linear foot of supplied and installed hanger cable at the structure. The quantity includes each of the six (6) anticipated hanger cable replacement locations in Bridge No. A18503. Additional hanger cable replacements as required by the engineer will be measured per linear foot of additional supplied and installed hanger cables.

6.0 Basis of Payment.

6.1 Payment for Cable Tension Measurement Inspection will be paid at the contract unit price per single measurement of all 136 hanger cable tensions in both tied arches. Payment for the testing will be considered full compensation for all labor, equipment, material, and incidentals to complete the required testing, and furnish a summary report of the cable tension measurements to the engineer for review and approval. No payment will be made for intermediate cable tension measurement as part of the shoring and jacking work.

6.2 Payment for Cable Shoring, System Installation, Cable Tension Adjustment will be paid at the contract unit price per each hanger location where the shoring system is installed. Payment for the installation will be considered full compensation for all labor, equipment, material, and

incidentals to design, furnish, fabricate, install, and utilize the contractor's shoring system at an installation location. No payment will be made for quantities shown in the contract or plans where the engineer directs the contractor to not install or utilize the shoring system (such that no cable jacking or tension adjustment is required).

6.3 Payment for Hanger Cable Replacement will be paid at the contract unit price per linear foot of supplied and installed hanger cables and disposal of removed cables if requested. No payment will be made for discarded or rejected strand length or hanger components. Any additional replacement cables at the direction of the engineer will be paid at the contract unit price per linear foot of additional supplied and installed cables under this item.

N. CLEARANCE GAUGE

1.0 Description. This work shall consist of providing a clearance gauge on the downstream face and the upstream face for the piers as shown on the plans.

2.0 Materials. All material shall be in accordance with Division 1000, Material Details, and specifically as follows.

Item	Section
Water	1070

2.1 The paint base type shall be a vinyl resin, copolymer type or chlorinated natural rubber that is compatible in all respects with the intended use. The paint shall be suitable for use on concrete masonry under severe exposure or submersion in water as recommended by the manufacturer. Paint applications shall meet the maximum dry mil thickness as recommended by the manufacturer. The white second coat and the black finish coat for the gauge markings shall have a glossy finish. All paint proposed for use shall be as approved by the engineer. The first coat shall be one of the following.

2.1.1 The first coat shall be adaptable for use as a primer under the succeeding coats with the undercoat tint the same as the second coat.

2.1.2 The first coat shall be the same as the second coat with the manufacturer certifying the paint to be self-priming.

2.2 In lieu of painting the gauges, the contractor may use a durable material shall be of such strength and durability as to provide a clearance gauge resistant to weather, tide and current as approved by the engineer.

3.0 Construction Requirements.

3.1 The area to be painted shall be prepared by removing all dirt, oil or other foreign substance. Prior to the application of the first coat, the surface shall be etched with approximately a 10 percent solution of muriatic acid in water. The surface shall than be flushed down with clear water and allowed to dry.

3.2 The first coat shall be worked well into the pores of the concrete. Paint shall not be applied when the air temperature is below 45°F (7°C) or when the air temperature exceeds 90°F (32°C). Painting shall not be started unless it can be reasonably expected that the gauge can be

completed with all coats plus 7 days' time before any portion of the gauge becomes submerged, unless the material used will permit earlier submersion without detriment to the finished work. The area to be painted shall receive two coats of white paint. The gauge numbers and foot markings shall be painted with two coats of black paint on top of the white paint coats. Each coat shall be thoroughly dry with a minimum of 24 hours between succeeding coats.

3.3 In lieu of painting the gauges, the contractor may use a durable material that shall be permanently fixed to the bridge pier as recommended by the manufacturer. Cleaning of the pier shall be in accordance with section 3.1 of this provision.

4.0 Method of Measurement. No measurement will be made.

5.0 Basis of Payment.

5.1 Payment for the above described work, including all material, equipment, labor and any other incidental work necessary to complete this item, will be considered completely covered by the contract lump sum price for Clearance Gauge.

5.2 In the event the river stage conditions are such that the contractor is unable to perform this work or for any other reason, the State retains the option to eliminate the work or parts thereof from the contract without alteration of the contract unit prices for other work or the option to permit the contractor to delay the performance of the work beyond the end of the contract period.

O. POLYESTER POLYMER CONCRETE WEARING SURFACE

1.0 Description. This work shall consist of constructing a wearing surface of polyester polymer concrete on a prepared surface in accordance with these specifications as shown on the plans or as directed by the engineer. Polyester polymer concrete shall be composed of the following three components – polyester resin binder, high molecular weight methacrylate (HMWM) resin and aggregate.

1.1 Hydro-demolition shall not be used with polyester polymer concrete.

2.0 Materials.

2.1 Primer. The prepared surface shall receive a wax-free low odor, high molecular weight methacrylate prime coat. The primer shall comply with the following requirements:

High Molecular Weight Methacrylate (HMWM) Resin		
Property	**Requirement**	**Test Method**
Viscosity *	0.025 Pa-s, maximum (Brookfield RVT with UL adapter, 50 RPM at 77°F)	ASTM D2196
Specific Gravity *	0.90, minimum (at 77°F)	ASTM D1475
Volatile Content *	30%, maximum	ASTM D2369
Flash Point *	180°F, minimum	ASTM D3278
Vapor Pressure *	1.0 mm Hg, maximum	ASTM D323

High Molecular Weight Methacrylate (HMWM) Resin		
Property	**Requirement**	**Test Method**
	(at 77°F)	
Tack Free Time	400 minutes, maximum (at 77°F)	ASTM C679
PCC Saturated Surface-Dry Bond Strength	500 psi, minimum (24 hrs at 70 +/- 1°F)	California Test 551

*Tested prior to adding initiator

2.1.1 Mixing Requirements. The prime coat initiator shall consist of a metal drier and peroxide. If supplied separately from the resin, at no time shall the metal drier be mixed directly with the peroxide.

2.1.2 Storage. The containers shall be stored in a manner that will not allow leakage or spillage from one material to contact the containers or materials of the other.

2.2 Aggregates.

2.2.1 Polyester Concrete. The aggregates shall comply with Sec 1005, except as specified herein.

2.2.1.1 Crushed Particles. Aggregate retained on the No. 8 sieve shall have a maximum of 45 percent crushed particles as determined by AASHTO T 335.

2.2.1.2 Absorption. The aggregate absorption shall not exceed one percent as determined by AASHTO T 85.

2.2.1.3 Moisture Content. At the time of mixing with the resin, the moisture content of the aggregate, as determined by AASHTO T 255, shall not exceed one half of the aggregate absorption.

2.2.1.4 Temperature. The aggregate temperature shall be between 45°F and 100°F at the time of mixing.

2.2.1.5 Combined Gradation. Aggregate for polyester polymer concrete shall comply with the following requirements:

Combined Aggregate		
Sieve Size	**1/2" Max. Percent Passing**	**3/8" Max. Percent Passing**
½"	100	100
3/8"	83 – 100	100
#4	65 – 82	62 – 85
#8	45 – 64	45 – 67
#16	27 – 48	29 – 50
#30	12 – 30	16 – 36
#50	6 – 17	5 – 20
#100	0 – 7	0 – 7
#200	0 - 3	0 – 3

2.2.1.6 Fine Aggregate. The fine aggregate shall consist of natural sand.

2.2.2 Finishing Sand. The sand for abrasive finish shall be commercial quality blast sand having at least 95 percent passing the No. 8 sieve and at least 95 percent retained on the No. 20 sieve when tested in accordance with AASHTO T 27. The absorption of the sand shall not exceed 1% when tested in accordance with AASHTO T 84.

2.3 Polyester Resin Binder. The resin shall be an unsaturated isophthalic-styrene co-polymer conforming to the following requirements:

Polyester Resin Binder		
Property	**Requirement**	**Test Method**
Viscosity *	0.075 to 0.200 Pa-s (RVT, No. 1 Spindle, 20 RPM at 77°F)	ASTM D2196
Specific Gravity *	1.05 to 1.10 (at 77°F)	ASTM D1475
Elongation	35%, minimum (Type I at 0.45”/min. Thickness = 1/4“ +/- 0.04”)	ASTM D638
	Sampling Condition: 18 hrs/77°F/50% + 5 hrs/158°F	ASTM D618
Tensile Strength	2,500 psi, minimum (Type I at 0.45”/min. Thickness = 1/4“ +/- 0.04”)	ASTM D638
	Sampling Condition: 18 hrs/77°F/50% + 5 hrs/158°F	ASTM D618
Styrene Content *	40 to 50% (by weight)	ASTM D2369
Silane Coupler	1.0%, minimum (by weight of polyester-styrene resin)	
PCC Saturated Surface-Dry Bond Strength	500 psi, minimum (24 hrs at 70 +/- 1°F)	California Test 551

*Tested prior to adding initiator

2.3.1 Silane Coupler. The silane coupler shall be an organsilane ester, gammamethacryloxpropyltrimethoxysilane.

2.3.2 Hardener. The promoter/hardeners shall be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators. MEKP initiators shall be used when the surrounding concrete temperatures are above 60°F. A blend of initiators may be used as approved by the engineer when the surrounding concrete temperature is 50 – 60°F.

2.4 Delivery of Materials. All materials shall be delivered in their original containers bearing the manufacturer’s label, specifying date of manufacturing, batch number, trade name, and quantity. Each shipment of polyester resin binder and HMWM resin shall be accompanied by a Material Safety Data Sheet (MSDS).

2.5 Storage of Materials. The material shall be stored to prevent damage by the elements and to ensure the preservation of their quality and fitness for the work. The storage space shall be kept clean and dry, and shall contain a high-low thermometer. The temperatures of the storage

space shall not fall below nor rise above that recommended by the manufacturer. Every precaution shall be taken to avoid contact with flame.

2.5.1 Inspection. Stored materials shall be inspected prior to their use, and shall meet the requirements of this Specification at the time of use.

2.5.2 Failure. Any material which is rejected because of failure to meet the required tests or that has been damaged so as to cause rejection shall be immediately replaced at no additional expense to the Commission.

2.5.3 Required Amount. Sufficient material to perform the entire polyester concrete application shall be in storage at the site prior to any field application, so that there shall be no delay in procuring the material for each day's application.

2.6 Training. The contractor shall arrange to have the material supplier furnish technical service related to application of material and health and safety training for personnel who are to handle the polyester polymer concrete and the HMWM resin prime coat.

2.7 Technical Support. The materials supplier shall have a representative onsite during placement of the polyester polymer concrete.

3.0 Mix Design. The contractor shall prepare and submit the polyester polymer concrete mix design and mixing procedures to the Construction and Materials Division for approval. The mix design shall include a recommended initiator percentage for the expected application temperature. The contractor shall not begin ordering materials for application of the polyester polymer concrete until the polyester polymer concrete mix design and mixing procedures are approved. Any change in mix design or proportions shall be approved by the engineer.

4.0 Construction.

4.1 Surface Preparation. The concrete surface shall be prepared by removing all material which may act as a bond breaker between the surface and the polyester polymer concrete.

4.1.1 Existing Bridge Decks. On existing concrete decks, the surface shall be uniformly scarified in accordance with Sec 216. If the existing deck is to be removed to a specified depth, then the surface shall be scarified to the removal depth specified in the drawings. The surface receiving the polyester polymer concrete is to be scarified to achieve a texture with an approximate amplitude of 1/4 inch. The scarifier shall not produce a polished or slick surface. Any epoxy patches or other existing repairs encountered shall be completely removed to sound, natural concrete. Sound concrete repairs may remain. Concrete deck repair is to be in accordance with Sec 704 except as modified by Section 4.1.4 of this specification. Surfaces of concrete patches placed in the deck after scarifying shall be textured to an approximate depth of 1/4 inch before placing the overlay.

4.1.2 Existing Approach Slabs Containing Wearing Surface. On existing approach slabs with an existing wearing surface, the wearing surface shall be removed prior to scarifying the substrate and placing the polyester polymer concrete. The exposed concrete surface shall meet the requirements contained in Section 4.1.1 of this specification.

4.1.3 Concrete Deck Repair. Polyester polymer concrete may be substituted for Class B-2 concrete at locations of half-sole and full depth repairs. Polyester polymer concrete cannot be

substituted for ultra-high performance concrete used to repair expansion device header slabs and must be placed after the slab has cured. Deck repairs using polyester polymer concrete shall be placed following the procedures recommended by the manufacturer. The maximum lift height recommended by the manufacturer is not to be exceeded. Monolithic repairs are permitted when half the diameter or less of the top bar is exposed.

4.1.4 Removing Contaminates. The textured or scarified deck shall be sand blasted followed by an air blast. The sand blasting shall remove all dirt, oil and other foreign materials, as well as any unsound concrete or laitance from the surface and edges against which new polyester polymer concrete is to be placed. The compressor shall be equipped to prevent oil in the air supply. Any loose or foreign material detected on the concrete surface prior to placement of the polyester polymer concrete shall be removed by sand or air blasting. The concrete surface may require retexturing where penetration of foreign material is evident. No contamination of the retextured or scarified concrete surface shall be permitted. With approval from the engineer, the contractor may use automatic shot blasting units in lieu of sand blasting. The automatic shot blasting units shall be self-propelled and include a vacuum to recover spent abrasive. The abrasive shall be steel shot. Magnetic rollers shall be used to remove any spent shot remaining on the deck after vacuuming. Cleaned surfaces shall not be exposed to vehicular or pedestrian traffic other than that required by the overlay operation.

4.1.5 Steel Surfaces. All steel surfaces that will be in contact with the overlay shall be cleaned in accordance with SSPC-SP10, Near–White Blast Cleaning, except that wet blasting methods shall not be allowed.

5.0 Application of Prime Coat. One coat of HMWM prime coat shall be applied to the prepared concrete and steel surfaces immediately before placing the polyester polymer concrete. The prime coat shall be uniformly applied to completely cover the surface to receive the overlay. The area receiving the prime coat shall be dry and have had no exposure to any moisture within the past 24 hours. Prior to applying the prime coat, the surface shall be cleaned with compressed air to remove accumulated dust and any other loose material.

5.1 Surface Temperature. The concrete bridge deck surface shall be between 50°F and 100°F when applying the prime coat.

5.2 Relative Humidity. Polyester polymer concrete shall not be placed when the relative humidity is above 90 percent.

5.3 Prime Coat Contaminated. If the primed surface becomes contaminated, the contaminated area shall be cleaned by abrasive blasting and re-primed at no additional expense to the Department.

6.0 Placement of Polyester Polymer Concrete.

6.1 Placement Time. The polyester polymer concrete shall be placed on the prime coat within two hours of placing the prime coat.

6.2 Surface Temperature. The surface temperature of the area to receive polyester polymer concrete shall be the same as specified in Section 5.1 of this special provision.

6.3 Mixing Equipment. The concrete shall be volumetrically mixed at the bridge site by a continuous mixer in accordance with Sec 501.

6.3.1 Batching Information. The continuous mixer shall be equipped with a metering device that automatically measures and records the aggregate volumes and corresponding resin volumes. The volumes shall be recorded at no greater than five-minute intervals along with the time and date of each recording. A printout of the recordings shall be furnished to the engineer at the end of each shift. Readout gages shall be visible to the engineer at all times.

6.3.2 Mixture Consistency. The concrete discharged from the mixer shall be uniform in composition and consistency. Mixing capability shall be such that initial and final finishing operations can proceed at a steady pace.

6.4 Contamination. The contractor shall prevent any cleaning chemicals from reaching the polyester polymer concrete mix during the mixing operation.

6.5 Addition of Initiator. Polyester polymer concrete shall be placed prior to gelling and within 15 minutes following the addition of initiator, whichever occurs first. Polyester polymer concrete that is not placed within this time shall be discarded.

6.6 Amount of Polyester Resin. The polyester resin binder in the polyester polymer concrete shall be 12 percent +/- 1 percent by weight of the dry aggregate. The contractor shall determine the exact percentage as approved by the engineer.

6.7 Amount of Peroxide Initiator. The amount of peroxide initiator used shall result in a polyester polymer concrete set time between 30 and 120 minutes during placement. The initial set time will be determined by using an initial-setting time Gillmore needle in accordance with ASTM C266. Accelerators or inhibitors may be required as recommended by the polyester resin supplier and as approved by the engineer.

6.8 Finishing Equipment. Finishing equipment shall be capable of consolidating the polyester polymer concrete and striking off the polyester polymer concrete to the final grade, thickness and cross-sections as shown in the contract documents.

6.9 Overlay Thickness. The polyester polymer concrete overlay shall be placed to the thickness specified on the construction drawings.

7.0 Surface Texturing. The roadway surface, except within 12 inches of the inside face of the curb, shall be textured as soon as the condition of the polyester polymer concrete will permit. The roadway finishing shall otherwise be in accordance with Sec 502. Hand-operated devices producing a satisfactory texture will be permitted. At the contractor's option, a finned float with a single row of fins may be used. The grooves produced by the finned float shall be approximately 1/8 inch wide at 5/8 to 3/4-inch centers and shall be approximately 1/8 inch deep. This operation shall be performed at such a time and in such a manner that the desired texture will be achieved while minimizing displacement of the layer aggregate particles.

8.0 Curing. Traffic and construction equipment shall not be permitted on the polyester polymer concrete overlay for at least two hours and until the polyester polymer overlay has reached a minimum compressive strength of 3,000 psi as verified by the rebound number determined in accordance with ASTM C805. Rebound number shall be correlated to cylinder compressive strength through development of a calibration curve specific to this project, and as directed by the manufacturer.

9.0 Testing. Bond testing shall be performed for each placement on each day. Testing will be conducted at three locations 48 hours after placement. Testing will be performed in accordance with ACI 506R. A passing test is the failure of the concrete substrate or bond strength above 250 psi.

10.0 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Furnish Polyester Polymer Concrete Material will be measured by the actual volume of polyester concrete material complete-in-place measured in cubic yards. The volume shall include material used for the overlay and any other deck rehabilitation as directed by the engineer. Tickets provided to the engineer showing quantities of PPC produced shall be sufficient to calculate volume of material placed. Place Polyester Polymer Concrete Wearing Surface will be measured and paid for as the quantity of final surface finishing in square yards.

11.0 Basis of Payment. Payment for Furnish Polyester Polymer Concrete Material shall include all costs required to furnish the polyester concrete material including HMWM primer, freight to the project site, receiving, storage, and disposal of any unused overlay material. Payment by cubic yard will be based on 135 lbs. per cubic foot and recorded by calibrated mixer unit readouts. Payment for Place Polyester Polymer Concrete Wearing Surface will be full compensation for all labor, equipment, and all incidentals necessary to prepare the concrete surface and complete and finish the overlay placement.

P. BRIDGE WASHING

1.0 Scope. Work for this pay item includes the removal of loose debris and associated chlorides from the existing bridge structure by pressure washing the gutters, drains, superstructure below the deck, bent caps and bearing areas, and joints and associated diapers/drains, Deck flushing is not required with the exception of curb areas and open drains along these curbs.

2.0 Bridge Deck Sweeping. Prior to washing the structure, the contractor shall sweep the existing bridge deck to remove any debris.

3.0 Work over the UP Railroad. All bridge washing activities within Span 14 shall be coordinated with the UP Railroad. No washing in Span 14 will be permitted without approval of the UP Railroad. The contractor shall prevent wash water from eroding or damaging the track embankment and shall remove all trash or large debris items that fall within 15 feet each side of the centerline of tracks.

4.0 Structure Cleaning Notes

4.1 Tied Arch Span. Bridge washing in the tied arch span shall include the following:

- All floor beams, diagonal bracing, stringers, and other structural steel between the tie girders including the outside and bottom of exterior stringers.
- Curbs, joints, drains, diapers, troughs, open scuppers and railings.
- All bent caps and bearings.

- Compression joints only require washing of the joint surface, in order to remove debris from the top surface of the joint material.

4.2 Multi-girder Approach Spans. Bridge washing in the approach spans shall include the following:

- All deck joints, diapers, drains, and deck drains.
- Curbs, joints, drains, diapers, troughs, open scuppers and railings.
- All girders across the width of the bridge.
- All abutments, bent caps, and bearings.
- Compression joints only require washing of the joint surface, in order to remove debris from the top surface of the joint material.

5.0 Equipment Performance Requirements. Water flushing shall be performed such that all loose debris is removed, and no damage occurs to bridge components, paint/coatings, or adjacent roadway, shoulder or embankment. Any damage caused by the contractor's operation shall be repaired at the sole expense of the contractor. No debris accumulations shall remain on the adjacent portion of bridge structures as a result of the contractor's operation. Water flushing is required to remove chloride salts, however additional measures are allowable to ensure removal of debris. The contractor shall utilize a minimum 100 psi of water pressure, as measured at the cleaning surface, in order to remove all loose debris. Access equipment and methods shall be required in order to reach all noted components with pressure washing equipment. Potable water shall be used for all washing.

5.1 It is recommended that the contractor use a top-down approach to avoid having to repeat bridge washing/cleaning activities.

5.2 All bridge washing shall be completed within the same construction season prior to commencement of the field coating of structural steel work items.

6.0 Method of Measurement. No measurement of the washing area will be made. The contractor can reference the informational drawings, contract drawings, and the quantities prepared for the Surface Preparation for Coating Existing Steel, recognizing those quantities do not include the entire superstructure below the deck that is to be washed.

7.0 Basis of Payment. Payment for bridge washing as described within this job special provision shall include all material, water, equipment, tools, labor and work incidental thereto, and shall be completely covered by the lump sum pay item Bridge Washing.

Q. PROTECTIVE COATING - CONCRETE BENTS & PIERS (URETHANE)

1.0 Description. This work shall consist of the surface preparation and application of protective coatings for sealing and protecting exposed concrete elements. The work shall be performed in accordance with Sec 711 except as modified herein.

2.0 Material. All material shall be in accordance with Sec 711.2.

3.0 Construction Requirements. Construction requirements shall be in accordance with Sec 711.3.

3.0.1 Removal of Existing Coating. All existing coatings shall be removed from surfaces to receive protective coating in accordance with the manufacturer's requirements for surface preparation of the new protective coating. Overcoating existing coatings is not permitted.

4.0 Method of Measurement. When required, measurement will be made to the nearest square foot.

5.0 Basis of Payment. The accepted quantity of protective coatings for exposed concrete surfaces will be paid for at the contract unit price for Protective Coating - Concrete Bents & Piers (Urethane) per square foot. All existing coating removal will be considered completely covered by this item.

R. METALLIZING HANGER CABLES

1.0 Description. This work consists of furnishing all materials, equipment, labor, and other essentials necessary to accomplish the surface preparation and application of thermal spray metallizing to the lower 25 feet of the existing galvanized hanger cables in the tied arch span. New cables installed for this project will not be metallized.

2.0 Materials. Materials shall be in accordance with the following:

2.1 Metallizing Wire. All thermal spray feedstock (metallizing wire) shall be the products of a single manufacturer, meet the requirements below, and meet the thermal spray equipment manufacturer's specifications.

- The metallizing wire shall consist of 99.9% zinc complying with ASTM B-833 and ANSI/AWS C2.25/C2.25M

- The contractor shall provide a certificate of chemical composition of the proposed metallizing wire from the metallizing wire manufacturer.

2.2 Sealer or Top Coat. There is no sealer or top coat required for this item.

3.0 Prequalification. All contractors and subcontractors that perform surface preparation or coating application shall be accredited by the Society for Protective Coatings (SSPC) to the requirements of SSPC QP 1 or NIICAP AS-1 for field application and SSPC QP 6 for metallizing prior to contract award and shall remain accredited while accomplishing any surface preparation or metalizing application. The certification(s) shall remain current throughout the duration of the contract. Notify engineer of any change in contractor accreditation status.

3.0.1 The contractor or subcontractors performing the work shall have satisfactorily performed a minimum of three previous projects involving abrasive blast cleaning and metallizing. At least one project shall have been completed within the past two (2) years and shall have involved a bridge or similar industrial type application. The suitability of the contractor's qualifications and prior experience will be considered by the Department before granting approval to proceed.

4.0 Submittals. The contractor performing the work shall submit the following plans and information for engineer review and acceptance within 30 days of contract execution (unless written permission from the engineer states otherwise). Field operations shall comply with the requirements of Sec 1081. Work in the field shall not proceed until submittals are accepted by the engineer.

(a) Contractor Personnel Qualifications: Evidence of experience and the names and qualifications/experience/training of the personnel managing and implementing the Quality Control program, and for those performing the quality control tests. QC personnel qualification requirements are found under "Quality Control (QC) Inspection."

All metallizing applicators shall be qualified in accordance with AWS C2.16/C2.16M.

(b) Quality Control (QC) Plan: A Quality Control Plan that identifies: a designated Quality Control inspector or inspectors, test instruments to be used, a schedule of required measurements and observations, frequency of testing, procedures for correcting unacceptable work, and procedures for improving surface preparation and metallizing quality as a result of quality control findings.

(c) Surface Preparation Plan: The surface preparation plan shall include the methods of surface preparation and types of equipment that will be used to prepare the surfaces as specified herein. Any solvents proposed for solvent cleaning shall be identified and MSDS provided.

(d) Abrasives: Identify the type and brand name of the abrasive proposed for use, provide MSDS and manufacturer's data indicating that the abrasive meets requirements of SSPC SP 16 *Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals* as specified herein.

(e) Metallizing Plan: Written procedures for the shop application of metallizing, including the brand name and type of metallizing wire and application equipment to be used. Proof that the metallizing wire complies with ASTM B-833 and ANSI/AWS C2.25/C2.25M shall also be provided.

4.1 Submittals Acceptance. The engineer will provide written notification to the contractor when submittals are complete and acceptable. No surface preparation work shall begin until that notification is received. This acceptance shall not be construed to imply approval of any particular method or sequence for conducting the work, or for addressing health and safety concerns. Acceptance does not relieve the contractor from the responsibility to conduct the work according to the requirements of Federal, State, or Local regulations and this specification, or to adequately protect the health and safety of all workers involved in the project and any members of the public who may be affected by the project. The contractor remains solely responsible for the adequacy and completeness of the programs and work practices, and adherence to them.

4.2 Quality Control (QC) Inspections. The contractor performing the field work shall perform first line, in process QC inspections. The contractor shall implement the accepted QC Program to ensure that the work complies with these specifications. The designated Quality Control inspector shall be onsite full time during any operations that affect the quality of the system (e.g., surface preparation, metallizing application, and final inspection at project completion). The contractor shall use forms to record the results of quality control tests and inspections. The

completed reports shall be given to the engineer before work resumes the following day. QC inspections shall include, but are not limited to the following:

- Ambient conditions.
- Surface preparation (solvent cleaning, abrasive blast cleanliness, surface profile depth, etc.).
- Metallizing application (specified materials used, bend test, continuity and coverage, adhesion, dry film thickness).

4.2.1 The personnel managing the QC Program shall possess a minimum classification as a NACE CIP Level 2, or shall provide evidence of successful inspection of three projects of similar or greater complexity and scope completed in the last two years. References shall include the name, address, and telephone number of a contact person employed by the facility owner.

4.2.2 The personnel performing the QC tests shall be trained in all tests, inspections, and instrument use required for the inspection of surface preparation and metallizing. Documentation of training shall be provided. The QC personnel shall be solely dedicated to quality control activities and shall not perform any production work. QC personnel shall take the lead in all inspections. The contractor shall not replace the QC personnel assigned to the project without advance notice to the engineer, and acceptance of the replacement(s), by the engineer.

4.2.3 The contractor performing the work shall supply all necessary equipment to perform the QC tests and inspections as specified. Equipment shall include the following at a minimum:

- Psychrometer or comparable equipment for measurement of dew point and relative humidity, including weather bureau tables or psychrometric charts
- Surface temperature thermometer
- SSPC Visual Standard VIS 1
- Surface profile replica tape and spring micrometer or electronic micrometer designed for use with replica tape; or electronic profilometer designed for measuring blast profile.
- Blotter paper for compressed air cleanliness checks
- Type 2 Electronic Dry Film Thickness Gage
- Calibration standards for dry film thickness gage
- Bend test coupons and bend test mandrel
- Adhesion testing instrument
- All applicable ASTM, ANSI, AWS, and SSPC Standards used for the work (reference list attached)

4.2.4 The same model of adhesion testing instrument shall be used throughout the project and for both QC and QA testing. Contractor shall provide adhesion testing equipment to MoDOT with this item.

4.2.5 All inspection equipment used for measurements must be calibrated by the manufacturer or a qualified lab. A current Certificate of Calibration or other documentation showing traceability to a national standard is required. The instruments shall be verified for accuracy and adjusted by the contractor's personnel in accordance with the equipment manufacturer's recommendations and the contractor's QC Program. All inspection equipment shall be made available to the engineer for QA observations as needed.

4.3 Quality Assurance (QA) Observations. The engineer will conduct QA observations of any or all phases of the work. The presence or activity of engineer observations in no way relieves the contractor of the responsibility to perform all necessary daily QC inspections of their own and to comply with all requirements of this specification. The engineer has the right to reject any work that was performed without adequate provision for QA observations.

5.0 Construction Requirements. The surface preparation and metallizing shall be according to the SSPC Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc and their Alloys and Composites for the Corrosion Protection of Steel, SSPC-CS 23.00/AWS C2.23M/NACE No. 12 except as modified herein. In the event of a conflict, the requirements of this specification shall prevail.

5.1 Surface Preparation and Metallizing. The contractor shall provide surface preparation and metallizing as needed to perform the work as specified herein.

5.1.1 Metallizing application equipment shall be portable electric arc thermal spray units that are set-up, adjusted and operated in accordance with the manufacturer's written instructions.

5.1.2 All cleaning equipment shall include gages capable of accurately measuring fluid and air pressures and shall have valves capable of regulating the flow of air or water as recommended by the equipment manufacturer. The equipment shall be maintained in proper working order.

5.1.3 Hand tools, power tools, pressure washing equipment, and abrasive blast cleaning equipment shall be of suitable size and capacity to perform the work required by this specification. Appropriate filters, traps and dryers shall be provided for the compressed air used for abrasive blast and final air blast cleaning.

5.2 Test Plates and Cable(s). Prior to proceeding with production work on the project, the contractor shall prepare hot-dipped galvanized steel test plates with a galvanizing thickness of 2.5 to 4.5 mils. Plate thickness shall be as required to provide the required hot-dipped galvanized thickness, but of suitable thickness to resist warpage from the effects of abrasive blasting. Additional test plates may be required depending on the outcome and acceptance of the initial test plates. After acceptance of the test plates, the contractor shall provide a segment of cable that matches size and construction of the existing cable for similar acceptance testing. The contractor may elect to test a cable(s) in lieu of the test plate(s). The test cable must be a minimum of 10 feet long.

5.2.1 The test specimens (plates or cables) shall be solvent-cleaned, abrasive blast cleaned, hand-tool brushed, compressed-air cleaned, and metallized in accordance with the requirements specified herein using the same equipment, materials and procedures that will be

used for the production. Each of the identified abrasive media shall each be used on separate test plates, the surfaces cleaned, and the metallizing applied thereafter. The size and gradation of the abrasive media shall be as needed to produce the specified surface profile range. The engineer will select one or two abrasives to be used on the trial cables based on the test plate results. At the conclusion of the cable testing, the engineer will select the abrasive media producing the surface profile, surface profile density, and minimum embedment most consistent with Paragraph 8.2 to be used for the production metallizing work. The test cables will be examined for evidence of pitting in the steel wires caused by the abrasive.

5.2.2 At the conclusion of the QC testing, each test plate or cable shall be scratched and damaged so that the contractor can demonstrate an appropriate repair procedure to restore the metallized surface. This process will be used to inform the repairs in Paragraph 9.2.

5.2.3 During the blast cleaning and metallizing of the test specimens, in the presence of the engineer, the contractor shall perform all quality control tests and inspections required by this specification including complete documentation of all QC testing. In addition, the contractor shall allow sufficient time for the engineer to perform any or all quality assurance tests and inspections desired. Production work shall not proceed until the engineer agrees that the blast cleaning and metallizing work, along with the quality control testing, inspection, and documentation are acceptable.

5.2.4 No additional compensation will be paid for the preparation of the test plates and cables.

5.3 Protective Coverings and Damage. The contractor shall apply protective coverings to all surfaces of the structure that are not scheduled for surface preparation and metallizing. Metallized or painted surfaces damaged by any contractor's operation shall be repaired, and re-metallized and/or re-painted, as directed by the engineer, at no additional cost to MoDOT.

5.4 Ambient Conditions. Surfaces prepared for metallizing shall be free of moisture and other contaminants. The contractor shall control operations to ensure that dust, dirt, or moisture do not come in contact with surfaces on which work will take place. The surface temperature shall be at least 5 deg. F (3 deg. C) above the dew point during final surface preparation operations, and the application of metallizing. Metallizing shall only be applied when the surface and air temperatures are above 32 deg. F (0 deg. C). The wire and equipment manufacturers' published literature shall be followed for specific temperature, dew point, and relative humidity restrictions during metallizing application. Metallizing shall not be applied in rain, wind, snow, fog or mist. Work may need to be postponed if required ambient conditions are forecast to change during the drying period specified by the manufacturer.

5.5 Compressed Air Cleanliness. Prior to using compressed air for blast-cleaning, blowing down surfaces, or metallizing applications, the contractor shall verify that the compressed air is free of moisture and oil contamination according to the requirements of ASTM D 4285. The tests shall be conducted at the start of each shift and at least one time every four hours for each compressor system in operation. If air contamination is evident, the contractor shall change filters, clean traps, add moisture separators or filters, or make other adjustments as necessary to achieve clean, dry air. The contractor shall also examine the work performed since the last acceptable test for evidence of defects or contamination caused by the contaminated compressed air. Contaminated work shall be repaired at no additional cost to MoDOT.

6.0. Water Source. Do not use water sources with unacceptable chloride content that increase surface chloride contamination for surface preparation. Chloride content of the water shall be

less than 200 ppm. Retest water whenever the source changes; this includes each delivery if the water is delivered to the site. Test source water more frequently when required by the engineer.

6.0.1 Chloride Ion Test Kit for Water. Chlor*Test W, manufactured by Chlor*Rid International, Inc. PO Box 908, Chandler Arizona (800)422-3217 www.chlor-rid.com.

7.0 Solvent Cleaning. All traces of oil, grease, and other detrimental contaminants on the surfaces to be metallized shall be removed by solvent cleaning in accordance with SSPC-SP 1. The brand name of proposed cleaning solvent(s) and/or proprietary chemical cleaners including manufacturers' product data sheet and MSDS shall be submitted for engineer acceptance prior to use.

7.0.1 Under no circumstances shall abrasive-blast cleaning be performed in areas containing surface contaminants or in areas where the engineer has not accepted the solvent cleaning. Rejected surfaces shall be re-cleaned to the specified requirements at no additional cost to MoDOT.

8.0 Abrasives. All surfaces to be metallized shall be abrasive blast cleaned to SSPC SP 16 *Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals*. The intent of this cleaning is to remove all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter, and produce a dense and uniform surface profile on the bare galvanized substrate. The peaks and valleys on the surface shall form a continuous pattern, leaving no smooth, unprofiled areas. Perform work to effect minimal removal of the existing galvanize coating from the cable wires. Should the blast-cleaning operation remove the galvanized coating on the cable where steel substrate becomes exposed beyond that accepted in the trial cable, the contractor shall stop operations and notify the engineer.

8.1 Abrasive Media. Abrasive blast cleaning shall be performed using expendable abrasives meeting the requirements of SSPC SP16 and additionally SSPC AB1, Type 1 for mineral abrasives. Expendable abrasives shall be used one time and discarded. The abrasives shall be clean, oil-free, and shall have a size and gradation such that the abrasive will produce a uniform profile within the specified range. Abrasives shall be free from contaminants such as excessive fine particles, paint, oils, moisture, chlorides, and heavy metals, or toxic material prohibited by OSHA or federal, state, or local regulations. The abrasive selected shall be capable of providing the required angular surface profile and angular profile density with minimal damage to the existing galvanized coating. The abrasive for full-scale work will be based upon results of the trial testing. The following abrasive media will be included in the trial plate tests: crushed walnut shells, crushed bottle glass, garnet, and staurolite. The contractor may propose an additional abrasive for trial. Slag and coal abrasives will not be accepted. The selected abrasive media shall produce minimal embedment.

8.2 Abrasive Blast Cleaning Pressure. Abrasive blast cleaning shall initially occur at a pressure range of 65 to 75 psi. Techniques that may reduce the risk of eroding the existing galvanized coating include lower nozzle pressures, increased stand-off distances, and angle of abrasive blast application. Abrasive blasting pressures can be increased as approved by the engineer if needed to achieve the desired surface profile without adversely affecting the existing galvanize cable substrate. Abrasive blast cleaning pressures and techniques shall be developed and refined during trial testing.

8.3 Abrasive Suppliers. Abrasive suppliers shall provide written certification that expendable abrasives meet the requirements of SSPC SP 16/SSPC AB1. Abrasive suppliers shall certify that abrasives are not oil or chloride contaminated and shall have a water extract pH value within the range of 6 to 8.

8.3.1 Chlorides in Abrasive. New batches of abrasives shall be tested for chloride content using a Chloride Ion Test Kit for Abrasive in accordance with the test kit manufacturer's directions. An acceptable kit is provided by Chlor*Test A, manufactured by Chlor*Rid International, Inc. PO Box 908, Chandler Arizona (800)422-3217 www.chlor-rid.com or as accepted by the engineer. Abrasives shall have a chloride content no greater than 7 ppm when tested with the Chloride Ion Test Kit for Abrasive.

8.4 Blast Cleaning Acceptance. All surfaces that are found to have been prepared using abrasives not meeting the applicable SSPC SP 16 requirements, are oil or chloride contaminated, or have a pH outside the specified range, shall be solvent cleaned or low pressure water cleaned, and re-blast cleaned at no cost to MoDOT. Low pressure water shall be less than 5,000 psig. Contractor shall develop the maximum water pressures, tip types, and stand-off distances necessary for cleaning, but minimally invasive to the void space within the cables during trial testing.

9.0 Surface Preparation. Prepare all surfaces for metallizing by blast cleaning in accordance with SSPC SP16 to remove all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter, and produce a dense and uniform surface profile on the bare galvanized substrate. The peaks and valleys on the surface shall form a continuous pattern, leaving no smooth, unprofiled areas.

9.0.1 Remove trapped/embedded media. Upon completion of abrasive blasting, examine the interface between individual wires of the cable for embedded and trapped abrasive media. If present, use hand tools to carefully clean the interface between individual wires to remove all embedded and trapped abrasive media taking all due care so as not alter the previously accepted blast profile. Avoid use of steel brushes and wire wheels unless approved by engineer.

9.0.2 Remove dust and debris from all surfaces. Once the trapped abrasive debris has been removed, remove the remainder of all abrasive, dust, abrasive residue, and other debris from surfaces with a commercial grade vacuum cleaner with a brush-type cleaning tool and/or blow-down the cable using pressurized clean air at a pressure range determined from the test cable trials.

9.0.3 Test surfaces for cleanliness. Surfaces shall be compliant with ISO 8502-3 Level 1 or better. Test surfaces prepared for metallizing for cleanliness per ISO 8502-3 immediately prior to metallizing application. Dust quantity rating shall be 1 or better. Use Scotch Transparent 3/4-inch Tape Cat. 600 for performance of the ISO 8502-3 test. Apply pressure to the tape in accordance with ISO 8502-3 Paragraph 6.5 a).

9.1 Surface Chloride Testing. At the conclusion of the surface preparation on each cable, the contractor shall field test the cable surface to identify the presence of chlorides using an approved surface contamination analysis test. Acceptable methods include swabbing or washing method or sleeve retrieval method as provided in the SSPC Technology Guide 15. Tests exceeding a chloride level of 3 $\mu g/cm^2$ or as specified by the metallizing coating supplier shall result in re-cleaning of the surface at no extra costs to MoDOT. The test method used will

depend upon its efficacy of application to cable surfaces. These test methods will be applied during trials and the most suitable methods and frequency of testing established at that time.

9.1.1 Chloride Test Kit for Swabbing or Washing Method. SCAT Kit Surface Contamination Analysis Test Kit for surface chloride testing. An acceptable kit is provided by Farwesat Corrosion Control Company 12029, Regentview Ave Downey, CA 90241, (888) 532-7937 https://www.farwestcorrosion.com/scat-kit-surface-contamination-analysis-test-kit-1865.html or as accepted by the engineer.

9.1.2 Chloride Test Kit for Sleeve Retrieval Method. Chlor*Test manufactured by Chlor*Rid International, Inc. PO Box 908, Chandler Arizona (800)422-3217 www.chlor-rid.com. or as accepted by the engineer.

9.1.3 Chloride Removal Procedure. If chloride contamination greater than manufacturer's Maximum Permissible Surface Chloride Concentration, pressure washing at 3,000 to 5,000 psi with clean potable water shall be re-applied to the non-compliant area. Repeat pressure washing as necessary to achieve recommended chloride levels. Do not use water sources with unacceptable chloride content that increase surface chloride contamination. Upon completion of pressure washing, prepare surfaces to Paragraph 9.0 as required. If chloride contamination greater than manufacturer's recommendations persist after pressure washing, include Salt Remover in the clean potable water in accordance with the salt remover manufacturer's directions and pressure wash surface at 3,000 to 5,000 psi. Repeat as necessary to achieve recommended chloride levels.

9.1.3.1 Acid-Based Surface Chloride Removal Product (Salt Remover). Chlor*Rid, manufactured by Chlor*Rid International, Inc. PO Box 908, Chandler Arizona (800) 422-3217 www.chlor-rid.com.

9.2 Surface Profile. In order to maintain as much of the existing galvanized coating thickness as possible while promoting adhesion of the metallized coating, the sweep-blast shall impart to the galvanized surface an anchor profile of 2.0 to 3.0 mils (profile requirement subject to change pending results of trial testing) and the peak density should be sufficiently dense to provide a uniform appearance. An average surface profile shall be determined each work day with a minimum frequency of one location every 10 feet of cable. Measure the abrasive blast and power tool surface profile of cable surfaces in accordance with SSPC-PA 17. Measurement of surface profile by ASTM D4417 Method B (Electronic Depth Micrometer) and measurement of surface profile by ASTM D4417 Method C (Replica Tape) shall be evaluated for form, fit, and function over the irregular cable substrate during trial testing. The measurement method for abrasive blast and power tool surface profile will be selected by the engineer for use on the project. Where ASTM D4417 Method C is used for surface profile measurement, the replica tape shall be retained and included with the daily QC report.

9.3 Surface Condition Prior to Metallizing. Prepared surfaces shall meet the requirements of the specification immediately prior to metallizing, and shall be metallized within six hours of final surface preparation or as determined from the test cable trials. If rust appears or bare steel or galvanizing has been exposed for more than six hours, the affected area shall be re-cleaned at no additional cost to MoDOT.

9.3.1 All dust and surface preparation residue on steel surfaces shall be removed prior to metallizing using a compressed air cleaning. The cable must be dry.

9.3.2 The quality of surface preparation and cleaning of surface dust and debris shall be accepted by the engineer prior to metallizing. The engineer has the right to reject any work that was performed without adequate provision for QA observations to accept the degree of cleaning. Rejected metallizing work shall be removed and replaced at no additional cost to MoDOT.

9.4 Daily Metallizing Operator-Equipment Qualification – Bend Tests. Unless directed otherwise by the engineer, each day that metallizing will be applied, the contractor shall perform bend testing prior to beginning production work. For each metallizing applicator, five hot-dipped galvanized carbon steel coupons with a coating thickness of 2.5 to 4.5 mils measuring 2 inch wide x 8 inch long x 0.05 inch (50mm x400 mm x 1.3 mm) thick or as determined by galvanizer to achieve galvanizing thickness shall be cleaned using the same equipment used for the production work. Each applicator shall apply the metallizing to five coupons in accordance with the requirements of this job special provision to a dry film thickness of 8.0 to 12.0 mils (200 to 300µm). 180-degree bend testing shall be performed on all five coupons using a 13mm (1/2") mandrel in accordance with the requirements and acceptance criteria of SSPC-CS 23/AWS C2.23M/NACE No. 12. Minor cracks that cannot be lifted from the substrate with knife blade are acceptable. If lifting occurs on any coupon, the surface preparation and/or metallizing process shall be modified until acceptable results are achieved before proceeding with production work.

10.0 Application of Metallizing. Application shall be done in overlapping passes in a cross-hatch pattern (i.e., a second set of overlapping passes shall be applied at right angles to the first set of overlapping passes) to ensure uniform coverage. The applicator gun shall be held at such a distance from the work surfaces that the metal is still molten on impact. The metallizing shall be applied as a continuous film of uniform thickness, firmly adhered, and free from thin spots, misses, lumps or blisters, and have a fine sprayed texture. The space between the individual wires shall not be completely filled with metallizing.

10.0.1 Thin spots and misses shall be re-metallized. If touch up metallizing or the application of additional metallizing to previously applied metallizing does not occur within 24 hours, the surface of the metallizing shall be brush off blast cleaned according to SSPC-SP 16 to remove oxidation and surface contaminates prior to the application of additional metallizing. Prior to this corrective work, the contractor shall submit and have approved the equipment, procedures, and abrasives to be used consistent with the trial plate tests. The final appearance of the metallizing shall be uniform without excessive blotchiness or contrast in color. If the surface does not have a uniform appearance, remove and replace the metallizing shall be removed and replaced at no cost to MoDOT. If the configuration of the surface being metallized does not allow for a proper gun-to-work piece standoff distance, the contractor shall notify the engineer.

10.1 Metallizing Thickness. The thickness of the metallizing shall be 8.0 to 12.0 mils (200-300 microns). Thickness shall be measured as specified by SSPC-PA 2 (use a Type 2 Electronic Gauge only).

10.2 Metallizing Adhesion. Adhesion testing of applied metallizing shall be determined with a self-adjusting pull-off strength tester in accordance with ASTM D 4541. All parties performing adhesion testing shall use the same brand and model of pull-off strength tester throughout the project. Unless otherwise directed by the engineer, a minimum of one test shall be conducted for every metallized cable. If any of the tests exhibit adhesion less than 500 psi (3.45 MPa), additional tests shall be conducted to determine the extent of the deficient material. All deficient metallizing shall be removed by blast cleaning and re-applied at no additional cost to MoDOT.

10.2 Touch-Up of Completed Metallizing. The contractor shall repair all damaged and/or unacceptable areas of the completed metallizing consistent with the results of the test plate trials. Initial trial damage repairs will use the following approach and will be adjusted based on the trial tests: Damage to the metallizing or galvanizing that does not expose the substrate shall be prepared by solvent cleaning in accordance with SSPC-SP 1 followed by power tool cleaning in accordance with SSPC-SP 3 to remove loose material. For the repair of damaged metallizing or galvanizing that exposes the substrate, the surface shall be spot power tool cleaned to SSPC-SP11 and impart a 2.0 to 3.0 mil profile (profile requirement subject to change pending results of trial testing). For surface preparation in accordance with SSPC SP3 and SSPC SP11, operate power tools in a manner that prevents damage to the surface and the formation of burrs, sharp ridges, and sharp cuts. Avoid excessive pressure, dwell times, and burnishing of the surface; power tools that burnish the surface shall not be used. The metallizing or galvanizing surrounding each repair area shall be feathered for a distance of 1 to 2 inches (25 to 50 mm) to provide a smooth, tapered transition into the existing intact material. If it is no longer feasible to apply metallizing, spot-apply an organic zinc primer meeting the requirements of Sec 1081 as approved by the engineer.

10.3 Special Instructions. The contractor shall take care as to not damage any dampers or other hardware mounted on the cables during the cleaning and metallizing process.

11.0 Method of Measurement. Work for this item will be measured by the linear foot of cable abrasively cleaned and metallized.

12.0 Basis of Payment. This work shall include all materials, equipment, access, labor, acceptance test specimens, QC testing and documentation to solvent clean, abrasive sweep-blast clean, hand tool clean and install metallized coating for the pay item Metalizing Hanger Cables.

13.0 Appendix 1 – Reference List. Field contractor(s) shall maintain the following regulations and references on site for the duration of the project:

American Society of Testing Material

- ASTM D 4285, Standard Test Method for Indicating Oil or Water in Compressed Air
- ASTM D4417, Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel
- ASTM B833, Standard Specifications for Zinc Wire for Thermal Spraying (Metallizing)
- ASTM D4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers

Society of Protective Coatings

- SSPC AB1, Abrasive Specification No. 1, Mineral and Slag Abrasives
- SSPC-PA 2, Measurement of Dry Coating Thickness with Magnetic Gages
- SSPC-QP 1, Field Application to Complex Industrial and Marine Structures
- SSPC-QP 6, Thermal Spray (Metalizing) Contractor Certification Program
- SSPC-SP 1, Solvent Cleaning
- SSPC-SP 3, Power Tool Cleaning
- SSPC-SP 11, Power Tool Cleaning to Bare Metal
- SSPC-SP 12/NACE No. 5, Surface Preparation and Cleaning of Metals by Water Jetting Prior to Recoating
- SSPC SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel,

Stainless Steels, and Non-Ferrous Metals.
- SSPC-PA17, Procedure for Determining Conformance to Steel Profile/Surface Roughness/Peak Count Requirements.
- SSPC-CS 23.00/AWS C2.23M/NACE No. 12, Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel
- SSPC: Technology Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates
- SSPC-Vis 1 - Standard Pictorial Surface Preparation Standards for Painting Steel Surfaces

American National Standards Institute/American Welding Society

- ANSI/AWS C2.25/C2.25M, Specification for Solid and Composite Wires, and Ceramic Rods for Thermal Spraying
- AWS C2.6/C2.6M, Guide for Thermal-Spray Operator Qualification

S. FLOOR BEAM TO TIE GIRDER WELD INSPECTION AT HANGER CABLE CASTINGS

1.0 Scope. Prior to closing Bridge No. A49364 to traffic for the first phase of construction, the contractor shall complete the weld inspection of all the floor beam to tie girder connections in Bridge No. A18503 above and below the hanger cable castings. The objective of this work is to identify hanger connections requiring removal of the castings because of weld cracks extending behind the castings.

2.0 Execution. The weld inspection shall be performed in accordance with the Weld Inspection and Repair job special provision and shall include the floor beam connection fillet welds A1, A2, A3, and A4 as defined in the drawings.

2.1 Repairs. Any weld cracks identified through this inspection will be repaired as part of the second phase of work when Bridge No. A18503 is closed to traffic.

2.2 Coating. Removal of the existing coating is required prior to completing the weld inspection. The contractor may elect to apply a primer coat in advance of the second phase coating work. All surfaces will be re-cleaned prior to installation of the new coating system.

3.0 Method of Measurement. Measurement should be made per linear foot of weld inspected consistent with the method of measurement in the Weld Inspection and Repair job special provision.

4.0 Basis of Payment. Payment for this work will be in accordance with the basis of payment as defined in the Weld Inspection and Repair job special provision and will include all traffic control, access, coating removal, and prime coat application needed to complete the inspection.

T. MoDOT ACCESS FOR BRIDGE INSPECTIONS AND BARRIER SEALING

1.0 Description. The contractor will provide access to MoDOT personnel and equipment to complete the biennial bridge inspection and to seal the barriers for each structure when requested. These tasks will be performed for each bridge when each is closed to traffic.

2.0 Timing. MoDOT will coordinate with the contractor to identify a time when the inspections and barrier work can be completed. The inspection will occur after the work on each structure is substantially complete and before the structure is open to traffic. Each inspection is anticipated to take one (1) week to complete. The barriers will be sealed after the barrier curb repairs are fully cured and is anticipated to take two (2) days to complete for each structure.

3.0 Method of Measurement. There will be no measurement for this access.

4.0 Method of Payment. The contractor will not receive compensation for providing access to MoDOT.

U. MILLING PRIOR TO WEARING SURFACE INSTALLATION

1.0 Description. The wearing surface rehabilitation for either alternate work shall require removal of existing concrete substrate and placement of a new wearing surface at the plan thickness and final grade shown on the contract drawings. Contractor shall determine appropriate means and methods to prepare the existing bridge deck to receive new wearing surface in accordance with the plans and Specifications.

2.0 Removals. To achieve the depth of removal shown on the plans, removals through mechanical milling, or similar, shall be performed in multiple passes. All removals shall be performed to prevent damage to the substrate and embedded rebar, while also providing an adequately prepared surface for application of the new wearing surface.

2.1 Contractor may elect to perform mock-ups or trial operations to demonstrate appropriate means and methods for removal using a single pass. The engineer may approve use of a single pass if the resulting removal depth and substrate profile are found to be sufficient and in accordance with the plans and Specifications.

3.0 Method of Measurement. There will be no additional measurement for multiple passes of milling required to achieve the depth of removals shown on the contract drawings.

4.0 Basis of Payment. There will be no additional payment for multiple passes of milling beyond the pay items included in the contract. There will be no additional payment for mock-ups or trial operations to demonstrate removal operations using a single pass.

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	**MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION** 105 W. CAPITOL AVE. JEFFERSON CITY, MO 65101 Phone (888) 275-6636
	Wiss, Janney, Elstner Assoc, Inc. **330 Pfingsten Road** **Northbrook, IL 60062** **Certificate of Authority:** **Consultant Phone: 847-272-7400**
	JOB NO. J6I3500 St. Louis County, MO Date Prepared: 8/6/2021
Date:	**Addendums only, blank otherwise** **Addendum No. #**
Only the following items of the Job Special Provisions (Bridge) are authenticated by this seal: A-J	

A. CONSTRUCTION REQUIREMENTS

1.0 Description. This provision contains general construction requirements for this project.

2.0 Construction Requirements. The plans and the asbestos and lead inspection report for the existing structures are included in the contract in the bridge electronic deliverables zip file for informational purposes only.

2.1 In order to assure the least traffic interference, the work shall be scheduled so that the bridge closure is for the absolute minimum amount of time required to complete the work. The bridge shall not be closed until material is available for continuous construction and the contractor is prepared to diligently pursue the work until the closed bridge is opened to traffic. Work shall be coordinated with the bridge closures and maintenance of traffic for Job No J613413.

2.2 Qualified special mortar shall be a qualified rapid set concrete patching material in accordance with Sec 704. A qualified rapid set concrete patching material will not be permitted for half-sole repair, deck repair with void tube replacement, full depth repair, modified deck repair and substructure repair (formed) unless a note on the bridge plans specifies that a qualified special mortar may be used.

2.3 Any damage sustained to the remaining structure as a result of the contractor's operations shall be repaired or the material replaced as approved by the engineer at the contractor's expense.

2.4 Provisions shall be made to prevent damage to any existing utilities. Any damage sustained to the utilities as a result of the contractor's operations shall be the responsibility of the contractor. All costs of repair and disruption of service shall be as determined by the utility owners and as approved by the engineer.

3.0 Existing Bridge Information. Bridge No. A2590 consists of two adjacent four-span reinforced concrete bridges, spanning over Koch Road in Melville, Missouri. The bridges were reportedly constructed in 1977, with the westbound structure being constructed first. The decks are 190-feet long, with approximate roadway widths of 60-feet, and the decks are skewed approximately 60 degrees. The original construction drawings indicate a concrete voided slab deck and superstructure with an original 2-1/4 inch thick wearing surface.

3.1 Existing Wearing Surface. Reportedly, an asphalt wearing surface and liquid-applied membrane were applied in 2009 (apparently after removal of the existing wearing surface). Based on a limited survey performed in 2019, asphalt overlay thickness and concrete cover are variable. Removal of existing wearing surface shall be in accordance with Sec. 216.30.

3.2 Environmental Contact. Environmental Section may be contacted at the below address or phone number. The Missouri Department of Health may be contacted at (573) 751-6102.

MoDOT - Design Division - Environmental Section
P.O. Box 270
105 W. Capitol Ave., Jefferson City, MO 65102
Telephone: (573) 526-4778

4.0 Method of Measurement. No measurement will be made.

5.0 Basis of Payment. Payment for the above described work will be considered completely covered by the contract unit price for other items included in the contract.

B. DIAMOND GRINDING

1.0 Description. This work will only be performed at the discretion of the engineer and will be underrun if not required by the engineer. This work shall consist of grinding the new concrete surface to provide good riding characteristics, a surface texture and proper drainage. If the engineer determines it necessary to provide good riding characteristics, grinding shall be performed on all or part of the bridge approach slabs and sealed in accordance with Sec 703.3.8. The finished surface shall be in accordance with Sec 703.3.7 and as shown on the plans or as directed by the engineer except as modified below.

2.0 Equipment. The equipment shall be of a size that will grind a strip at least 3 feet wide using diamond blades and shall not cause spalls at cracks, joints or other locations.

3.0 Construction Requirements. The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Auxiliary or ramp lane grinding shall transition from the edge of the mainline as required to provide drainage and an acceptable riding surface.

3.1 Deck repair, if required, shall be completed prior to any grinding.

3.2 Grinding shall be accomplished in a manner that eliminates joint or crack faults and provides lateral drainage by maintaining a constant cross slope between grinding extremities in each lane. A maximum tolerance of 1/16 inch will be allowed for adjacent sides of joints and cracks, except that under no circumstances shall the grinding depth exceed 1/4 inch from the top of the original surface. When grinding across faulted joints, a minimum of a 20-foot transition onto the approach side slab shall be used.

3.3 The cross slope of the pavement shall be as shown on the plans and shall have no depressions or misalignment of slope greater than 1/4 inch in 12 feet when measured with a 12-foot straightedge placed perpendicular to the centerline. Areas of deviation shall be reground. Straightedge requirements will not apply across longitudinal joints or outside the ground area.

3.4 As soon as practical after grinding, the surface will be straight edged longitudinally, and all variations exceeding 1/8 inch in 10 feet will be plainly marked. Areas of deviation shall be reground.

3.5 Substantially all of the pavement surface shall be textured. Extra depth grinding to eliminate minor depressions in order to provide texturing on 100 percent of the pavement surface will not be required. No unground surface area between passes will be permitted, except as specified otherwise in the contract documents.

3.6 The grinding process shall produce a final pavement surface that is true to grade and uniform in appearance with a longitudinal line-type texture. The line-type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy-type appearance. The peaks of the ridges shall be approximately 1/32 inch higher than the bottoms of the grooves. The grooves shall be evenly spaced. There shall be approximately 50-55 grooves per foot, measured perpendicular to the centerline.

3.7 The contractor shall remove and dispose of all residue from the grinding in a manner and at a location to satisfy environmental regulations. The contractor shall have the engineer's approval for the method of spreading and disposal of the residue prior to beginning any grinding operations.

3.8 Solid residue shall be removed from the pavement surface before any residue is blown by traffic action or wind.

3.9 Residue shall not be permitted to encroach on open lanes.

3.10 The residue shall not enter into gutters or closed drainage systems.

3.11 The contractor may disperse residue onto unpaved shoulders, adjacent roadside embankments, or median ditch areas of divided highways where the residue runoff can percolate into the soil, unless specified otherwise in the contract. The spread rate shall not generate surface runoff. If surface runoff occurs at a grinding location, the contractor shall haul the residue to an approved location at the contractor's expense.

3.12 Discharge of any residue runoff shall not flow into adjacent rivers, streams, lakes, ponds or other open bodies of water.

3.13 Residue shall not be spread within 100 feet of any streams, lakes or other open bodies of water, or within 15 feet of a water filled ditch.

3.14 The contractor shall use appropriate equipment and methods so the discharging of the residue does not cause erosion of soil or damage to established vegetation along the roadway. The contractor shall repair and reseed any areas where the discharge of grinding residue causes damage to roadway slopes or vegetated areas at the contractor's expense.

3.15 If the solids concentration of discharged residue at any particular area is determined to be excessive by the engineer, the contractor shall provide equipment and material to flush the areas with water as directed by the engineer, at the contractor's expense.

3.16 The pavement shall be cleaned prior to opening to traffic as directed by the engineer.

4.0 Smoothness Requirements.

4.1 No diamond grinding shall be performed until the pavement has attained a strength sufficient to be opened to all types of traffic. All diamond grinding shall be completed on any section prior to opening that section to other than construction traffic, unless approved by the engineer.

4.2 The engineer will be the sole authority for determining if the driving surface is sufficiently smooth.

4.3 The engineer will evaluate the smoothness of the concrete wearing surface after the concrete has cured and direct the contractor to diamond grind where deemed necessary.

4.4 After initial diamond grinding operations, if any, the engineer will again evaluate the smoothness of the concrete wearing surface and approach slab, repeating as many times as necessary to achieve the desired surface smoothness.

4.5 Any deficiencies in the final surface due to improper contractor operations or equipment shall be corrected by the contractor at the contractor's expense.

4.6 All areas shall be tested with a 10-foot straightedge in accordance with section 3.4 of this job special provision.

5.0 Method of Measurement. Measurement for diamond grinding will be made to the nearest square yard. Measurement will be based upon the area of initial diamond grinding completed as directed by the engineer. Subsequent passes of diamond grinding over a previously ground area will not be measured. No deduction will be made for gaps to avoid striping or raised pavement markers. No additional measurement will be made for diamond grinding bridge approach slabs.

6.0 Basis of Payment. Payment for diamond grinding will be paid for at the contract unit price per square yard. Payment for diamond grinding will be considered full compensation for all labor, equipment, material, and incidentals to complete this work, including hauling and disposal of grinding residue and cleaning the pavement prior to opening to traffic.

C. RAPID SET CONCRETE PATCHING MATERIAL – HORIZONTAL REPAIRS

1.0 Description. This specification covers cementitious concrete, polymer-modified concrete and polymer concrete that are suitable for repairing concrete surfaces on bridges or roadways, particularly under fast setting or special conditions. The repairs would involve horizontal applications. The work shall consist of removing, furnishing, preparing, and placing materials at locations as shown on the plans or as directed by the engineer.

2.0 Material. All materials shall be in accordance with MoDOT specifications and as noted herein.

2.1 Aggregate for Extending Commercial Mixture. Coarse and fine aggregates shall be in accordance with Sec 1005, except the requirements for gradation and percent passing the No. 200 sieve shall not apply. Coarse aggregate meeting Gradation E requirements shall be used for repairs greater than one inch (25 mm) in depth. Fine aggregate will be allowed for repairs less than one inch (25 mm). Aggregate specified, bagged, labeled and furnished by the rapid set concrete patching material manufacturer may also be used for mortar extension.

2.2 Material Applications. The contractor shall select and use the product most suitable for the work and field conditions in accordance with these specifications.

2.3 Curing. Rapid set concrete patching material shall be cured until the minimum compressive strength 3200 psi is attained using standard curing specifications, unless otherwise specified by the manufacturer.

2.4 Qualification and Project Acceptance.

2.4.1 Inspection. All materials shall be subject to inspection and sampling by MoDOT at the source of manufacture, intermediate shipping terminal or destination. MoDOT will be allowed free access to all facilities and records as required to conduct inspection and sampling.

2.4.2 Qualification. Prior to use, rapid set concrete patching material shall be qualified. In order to become qualified, a material shall have completed testing through AASHTO's National

Transportation Product Evaluation Program (NTPEP). The manufacturer shall contact the AASHTO/NTPEP coordinator to obtain the testing location for the rapid setting concrete patching material.

2.4.2.1 Requested Information. The manufacturer shall submit with samples of the materials, a written request to Construction and Materials with the following information:

(a) Brand name of the product.

(b) Certification that the material meets this specification.

(c) NTPEP test results showing compliance with this special provision.

(d) Specific mixing, handling and curing instructions.

(e) Application type (i.e., bridge or roadway).

2.4.2.2 Qualified List. Upon approval by the engineer, the brand name and manufacturer will be placed on a qualified list of rapid set concrete patching materials. The listing of qualified materials is available from Construction and Materials or on MoDOT's web site. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed. The material will be subject to removal from the qualified list if there is evidence of unsatisfactory performance or a change in manufacturing process or formulation, or when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

2.4.3 Provisional Approval. Provisional approval may be granted provided the following requirements have been met:

(a) New Products Evaluation Form

(b) Certified test results from an independent laboratory showing compliance with this special provision.

(c) Documentation prepared by MoDOT covering two years of field performance on MoDOT's system. MoDOT will need to approve the location of the test site. Documentation will contain the placement date, field observations (semiannual), description of field performance and photographs of in-place material.

(d) During placement the manufacturer's representative shall be present on the project to provide technical expertise.

2.4.3.1 Disqualification. If during the two-year observation period the repair area(s) fails provisional approval will not be granted. Repair area(s) experiencing any cracking, debonding or spalling will be considered a failure.

2.4.3.2 Length of Provisional Approval. Provisional approval will be granted for three years or until NTPEP testing is completed.

2.5 Certification. The contractor shall supply a manufacturer's certification to the engineer for each lot of material furnished. The certification shall include the name of the manufacturer, a

manufacturer certification statement that the material supplied is the same as that qualified and listing the date of qualification.

2.6 Acceptance. Acceptance of the material will be based on the use of a qualified or provisionally approved material, the manufacturer's certification that the material supplied is the same as that approved and upon the results of such tests as may be performed by the engineer.

3.0 Mixture. Unless otherwise specified, rapid set concrete patching material shall be approved commercial mixtures meeting Sections 3.1 – 3.1.3 or deck repair cementitious mortar meeting Section 3.2. Rapid set concrete patching materials shall be specifically designed for the application needed.

3.1 Commercial Mixtures. Rapid set concrete patching material in its sacked form and mixtures when properly prepared in accordance with the manufacturer's specifications, shall meet the minimum test requirements given in Table 1. Mixtures may be supplied, as required, as a patching mortar or as a patching mortar with aggregate extension. If the material is to be supplied with extender aggregate, this shall also pass the required tests in Table 1 using the maximum allowed amount of extender aggregate.

3.1.1 Mixture Requirements. Rapid set concrete patching material shall be single packaged dry mix requiring the addition of water or other liquid component just prior to mixing. The material shall be capable of ½ inch (13 mm) to full depth repair and require no bonding agent. The material shall not contain soluble chlorides as an ingredient of manufacture. The material shall be placed in accordance with the manufacturer's recommendations.

Table 1
(English Unit)

Physical Test Property	**Specification**	**Requirement for cementitious concrete**	**Requirement for polymer-modified concrete**	**Requirement for polymer concrete**
Bond Strength by Slant Shear[1]	ASTM C882/C928 [3]	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days	n/a	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days
Linear Coefficient of Thermal Expansion[1, 2] (for bagged mortar only, without extension aggregate)	ASTM C531	n/a	n/a	4 – 8 X 10-6 in/in/deg F
Resistance to Rapid Freezing & Thawing[1]	AASHTO T161 or ASTM C666	80% min. using Procedure B[5] (300 Cycles)	80% min. using Procedure B[5] (300 Cycles)	n/a
Compressive Strength[1]	AASHTO T22 or ASTM C39	3200 psi @ 3 hr & 4000 psi @ 7 days	3200 psi @ 3 hr & 4000 psi @ 7 days	n/a
Rapid Chloride Permeability[1]	AASHTO T277 or ASTM C1202	Bridge Decks 1000 coulombs @ 28 days Roadway	Bridge Deck 1000 coulombs @ 28 days Roadway	Bridge Deck 1000 coulombs @ 28 days Roadway

		2000 coulombs @ 28 days	2000 coulombs @ 28 days	2000 coulombs @ 28 days
Length Change[1, 4]	AASHTO T 160 or ASTM C157	In water Storage (+0.15) In air storage (-0.15)	In water storage (+0.15) In air storage (-0.15)	n/a
Color		gray	gray	gray

[1]The commercial mix test values can be located in the AASHTO's National Transportation Product Evaluation Program (NTPEP) reports for Laboratory Evaluations of Rapid Set Concrete Patching Materials. Data for provisionally approved materials is located at the Construction and Materials Division.
[2]Not required for extended mixtures if the mortar passes this requirement.
[3] ASTM C882 shall be performed on non-water based materials. ASTM C928 shall be performed on water-based materials.
[4] As modified by ASTM C928.
[5] Procedure A may be used in lieu of Procedure B

3.1.2 Construction Requirements. The manufacturer shall provide with the bagged mixture, specifications for the mixing procedure, amount and kind of liquid to be added, and the amount of aggregate extension allowed, if any. All mixing, handling and curing practices recommended by the manufacturer shall be followed and will be considered a part of these specifications.

3.1.3 Removal from Qualified List. All mixtures shall be approved before use. Reoccurring failures of any mixture for any reason will be cause for removal from the qualified list.

3.2 Deck Repair Concrete. A qualified rapid set concrete patching material indicated for horizontal use and intended for patching concrete bridge decks may be used when specified on the plans and as approved by the engineer. If this option is selected, the contractor shall provide a trial mix to determine the total cure time needed to achieve a compressive strength of 3200 psi (22 MPa). Compressive specimens shall be prepared in accordance with current MoDOT test methods and cured to simulate actual field conditions. Testing of compressive specimens shall be performed by methods and at facilities acceptable to the engineer. The repaired deck shall not be opened to traffic until at least 4 hours after the last placement of deck repair concrete, the established cure time has elapsed and until such concrete has achieved a compressive strength of 3200 psi (22 MPa). A new trial mix may be required if the engineer determines the field conditions vary substantially from trial mix conditions. The engineer will make field cylinders to verify the 3200 psi (22 MPa) minimum strength.

4.0 Construction Requirements.

4.1 Mixing. Rapid set concrete patching material shall be mixed and finished according to the manufacturer’s recommendation.

4.2 Preparation of Repair Area. Deteriorated, damaged or defective concrete as shown on the plans, required by the specifications or as directed by the engineer, shall be removed. All exposed reinforcement shall be thoroughly cleaned as shown on the plans, required by the specifications or as directed by the engineer. Unless otherwise specified by the commercial mixture manufacturer, the existing surface shall be damp and all free water shall be removed prior to placement of the required material.

4.3 Bonding Agent. A bonding agent may be used if recommended by the rapid set concrete patching material manufacturer.

5.0 Method of Measurement. No measurement will be made for rapid set concrete patching material.

6.0 Basis of Payment. Rapid set concrete patching material will be paid for at the contract unit price for other items and will be considered full compensation for all labor, equipment, and material to complete the described work.

D. RAPID SET CONCRETE PATCHING MATERIAL – VERTICAL AND OVERHEAD REPAIRS

1.0 Description. This specification covers cementitious concrete, polymer-modified concrete and polymer concrete that are suitable for repairing concrete surfaces on bridges or concrete structures, particularly under fast setting or special conditions. The repairs would involve vertical or overhead applications. The work shall consist of removing, furnishing, preparing, and placing materials at locations as shown on the plans or as directed by the engineer.

2.0 Material. All materials shall be in accordance with MoDOT specifications and as noted herein.

2.1 Aggregate For Extending Commercial Mixture. Coarse and fine aggregates shall be in accordance with Sec 1005, except the requirements for gradation and percent passing the No. 200 sieve shall not apply. Coarse aggregate meeting Gradation E requirements shall be used for repairs greater than one inch (25 mm) in depth. Fine aggregate will be allowed for repairs less than one inch (25 mm). Aggregate specified, bagged, labeled and furnished by the rapid set concrete patching material manufacturer may also be used for mortar extension.

2.2 Material Applications. The contractor shall select and use the product most suitable for the work and field conditions in accordance with these specifications.

2.3 Curing. Rapid set concrete patching material shall be cured until the minimum compressive strength 1500 psi is attained using standard curing specifications, unless otherwise specified by the manufacturer.

2.4 Qualification and Project Acceptance.

2.4.1 Inspection. All materials shall be subject to inspection and sampling by MoDOT at the source of manufacture, intermediate shipping terminal or destination. MoDOT will be allowed free access to all facilities and records as required to conduct inspection and sampling.

2.4.2 Qualification. Prior to use, rapid set concrete patching materials need to be qualified.

2.4.2.1 Requested Information. The manufacturer shall submit with samples of the materials, a written request to Construction and Materials with the following information:

(a) New Products Evaluation Form

(b) Brand name of the product.

(c) Certification that the material meets this specification.

(d) Certified test results from an independent laboratory showing compliance with this specification.

(e) Specific preparation instructions of repair area.

(f) Specific mixing, handling and curing instructions.

(g) Application type (i.e., vertical or overhead).

2.4.2.2 Field Evaluation. Final approval will be granted when the following requirements are met:

(a) MoDOT report documenting two years of field performance on MoDOT system. The report will contain the placement date, field observations (semi annual), description of field performance and photographs of in-place material.

(b) A manufacturer's representative shall be present during placement of the material to provide technical expertise.

2.4.2.2.3 Disqualification. If during the two year observation period the repair area(s) fails the product will not be added to the qualified list.

2.5 Qualified List. The listing of qualified products are available from Construction and Materials or on MoDOT's web site. New certified test results and samples shall be submitted any time the manufacturing process or the material formulation is changed. The material will be subject to removal from the qualified list if there is evidence of unsatisfactory performance or a change in manufacturing process or formulation, or when random sampling and testing of material offered for use indicates nonconformity with any of the requirements herein specified.

2.6 Certification. The contractor shall supply a manufacturer's certification to the engineer for each lot of material furnished. The certification shall include the name of the manufacturer, a manufacturer certification statement that the material supplied is the same as that qualified and listing the date of qualification.

2.7 Acceptance. Acceptance of the material will be based on the use of a qualified product, the manufacturer's certification that the material supplied is the same as that approved and upon the results of such tests as may be performed by the engineer.

3.0 Mixture. Unless otherwise specified, rapid set concrete patching material shall be approved commercial mixtures meeting Sections 3.1 – 3.1.3. Rapid set concrete patching materials shall be specifically designed for the application needed.

3.1 Commercial Mixtures. Rapid set concrete patching material in its sacked form and mixtures when properly prepared in accordance with the manufacturer's specifications, shall meet the minimum test requirements given in Table 1. Mixtures may be supplied, as required, as a patching mortar or as a patching mortar with aggregate extension. If the material is to be supplied with extender aggregate, this shall also pass the required tests in Table 1 using the maximum allowed amount of extender aggregate.

3.1.1 Mixture Requirements. Rapid set concrete patching material shall be single packaged dry mix requiring the addition of water or other liquid component just prior to mixing. The material shall not contain soluble chlorides as an ingredient of manufacture. The material shall be placed in accordance with the manufacturer's recommendations.

Table 1
(English Unit)

Physical Test Property	Specification	Requirement for cementitious concrete	Requirement for polymer-modified concrete	Requirement for polymer concrete
Bond Strength by Slant Shear	ASTM C882/C928 [2]	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days	n/a	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days
Linear Coefficient of Thermal Expansion [1] (for bagged mortar only, without extension aggregate)	ASTM C531	n/a	n/a	4 – 8 X 10-6 in/in/deg F
Resistance to Rapid Freezing & Thawing	AASHTO T161 or ASTM C666	80% min. using Procedure B[3] (300 Cycles)	80% min. using Procedure B[3] (300 Cycles)	n/a
Compressive Strength	AASHTO T22 or ASTM C39	1500 psi @ 3 hr & 3000 psi @ 24 hr	1500 psi @ 3 hr & 3000 psi @ 24 hr	n/a
Rapid Chloride Permeability	AASHTO T277 or ASTM C1202	1000 coulombs @ 28 days	1000 coulombs @ 28 days	1000 coulombs @ 28 days
Length Change	AASHTO T 160 or ASTM C157	In water Storage (+0.15) In air storage (-0.15)	In water storage (+0.15) In air storage (-0.15)	n/a
Color		gray	gray	gray

[1] Not required for extended mixtures if the mortar passes this requirement.
[2] ASTM C882 shall be performed on non-water based materials. ASTM C928 shall be performed on water-based materials.
[3] Procedure A may be used in lieu of Procedure B

3.1.2 Construction Requirements. The manufacturer shall provide with the bagged mixture, specifications for the mixing procedure, amount and kind of liquid to be added, and the amount of aggregate extension allowed, if any. All mixing, handling and curing practices recommended by the manufacturer shall be followed and will be considered a part of these specifications.

3.1.3 Removal from Qualified List. All mixtures shall be approved before use. Reoccurring failures of any mixture for any reason will be cause for removal from the qualified list.

3.2 Vertical Repair. A qualified rapid set concrete patching material approved for vertical use may be used when specified on the plans and as approved by the engineer. The engineer will

make field cylinders to verify the 1500 psi (10 MPa) minimum strength. The material shall adhere to the concrete surface without sagging.

3.3 Overhead Repair. A qualified rapid set concrete patching material approved for overhead use may be used when specified on the plans and as approved by the engineer. The material shall be placeable in layers of at least 1 inch on overhead applications without the use of formwork or anchoring devices. The material shall adhere to the concrete surface without sagging. The engineer will make field cylinders to verify the 1500 psi (10 MPa) minimum strength.

4.0 Construction Requirements.

4.1 Mixing. Rapid set concrete patching material shall be mixed and finished according to the manufacturer's recommendation.

4.2 Preparation of Repair Area. Deteriorated, damaged or defective concrete as shown on the plans, required by the specifications or as directed by the engineer, shall be removed. All exposed reinforcement shall be thoroughly cleaned as shown on the plans, required by the specifications or as directed by the engineer. Unless otherwise specified by the commercial mixture manufacturer, the existing surface shall be damp and all free water shall be removed prior to placement of the required material.

4.3 Bonding Agent. A bonding agent may be used if recommended by the rapid set concrete patching material manufacturer.

5.0 Method of Measurement. No measurement will be made for rapid set concrete patching material.

6.0 Basis of Payment. Rapid set concrete patching material will be paid for at the contract unit price for other items and will be considered full compensation for all labor, equipment and material to complete the described work.

E. ALTERNATE WEARING SURFACES

1.0 Description. This work shall consist of either placing a latex modified concrete wearing surface or a polyester polymer concrete wearing surface. Each wearing surface alternate includes different substrate preparation, repair, and surface finish requirements.

2.0 Bidding. To exercise this option, separate plan sheets for each wearing surface are included in the contract, and separate pay items, descriptions and quantities are included in the itemized proposal for each alternate. The bidder shall bid only one of the alternates and either enter "0" or leave blank in the contract unit price column for any pay item listed for the other alternate.

3.0 Method of Measurement. The quantities of the alternates will be measured in accordance with the plans and the Specifications.

4.0 Basis of Payment. The pay items included in the contract for the chosen alternate will be paid for at the contract unit price in accordance with the plans and the Specifications.

F. SHOTCRETE CONCRETE REPAIR

1.0 Description. This work shall consist of repairing concrete elements or components of the bridge with shotcrete. Repairs shall be in accordance with Sec 704 and as shown on the contract plans. Shotcrete shall be used for slab edge repairs and unformed substructure repairs. The work includes deteriorated concrete removal, preparing the repair surface and application of shotcrete to the repair locations.

1.1 Shotcrete shall be in accordance with the current requirements of American Concrete Institute (ACI) 506.2-13, "Specification for Shotcrete", except as otherwise specified. Shotcrete shall consist of an application of one or more layers of mortar or concrete conveyed through a hose and pneumatically projected at a high velocity against a prepared surface.

1.2 Shotcrete shall be produced by a dry-mix process. The dry-mix process shall consist of thoroughly mixing all the ingredients except accelerating admixtures and mixing water and conveying the mixture through the hose pneumatically and the mixing water is introduced at the nozzle. For additional descriptive information, the Contractor's attention shall be directed to the ACI 506R-16, "Guide to Shotcrete".

2.0 Contractor Experience Requirements.

2.1 Workers, including foremen, nozzlemen and delivery equipment operators, shall be fully experienced to perform the work.

2.2 Initial qualification of nozzlemen will be based on ACI or EFNARC certification for the application process being used. The nozzlemen shall submit documented proof they have been certified in accordance with the ACI 506.3R-91 “Certification of Shotcrete Nozzlemen” or EFNARC “Nozzleman Certification Scheme”. The certification shall have been done by an ACI or EFNARC recognized shotcrete testing lab and/or recognized shotcreting consultant and have covered the type of shotcrete to be used (plain dry-mix).

2.3 The contractor may supply 1 reference project for the project nozzleman in lieu of completing test panels in accordance with Paragraph 5.1 of this specification to demonstrate the experience of the nozzleman in similar shotcrete application work. Owner contact information for the reference project shall be provided to allow for the engineer to confirm satisfactory results.

3.0 Materials.

3.1 Shotcrete materials shall consist of one of the following premixed and packaged materials:

- BASF MasterEmaco S 211SP
- Euclid Chemical Eucoshot F
- King Shotcrete MS-D1
- CTS Cement Low-P

3.2 No material testing is anticipated. Acceptance will be based on the prequalified materials listed, approval of the nozzleman prior to material placement, and visual inspection. If questions arise based on visual examination, placement methods, curing methods or other potentially

undesirable influences the engineer reserves the right to test any material properties listed on the published product data sheet for the material selected. Testing will be done at the contractor's expense.

3.3 Material shall be delivered, stored and handled to prevent contamination, segregation, corrosion or damage.

3.4 Proportioning and Use of Admixtures. Admixtures will not be permitted unless approved by the engineer.

3.5 Bonding Agents. Bonding agents will not be permitted.

3.6 Air Entrainment. Additional air entrainment admixtures will not be required.

4.0 Construction Submittals.

4.1 At least 15 days before the planned start of the shotcrete repair(s), a copy of the following information shall be submitted in writing to the engineer for review and approval:

- Written documentation of the nozzlemen's qualifications including proof of ACI or EFNARC certification;
- Proposed methods of shotcrete placement and of controlling and maintaining facing alignment including equipment models;
- Shotcrete mix; and
- One reference project including: Nozzleman's name, material used, process used, and whether a blow pipe was utilized. Owner contact information shall be provided to ensure satisfactory results were accomplished on the reference project; or
- A satisfactory test panel shall be provided with the material to be used.

4.2 The engineer will approve or reject the contractor's submittals within 10 days after the receipt of a complete submission. The contractor will not be permitted to begin repair with shotcrete until the submittal requirements are satisfied and found acceptable to the engineer. Changes or deviations from the approved submittals shall be re-submitted for approval. No adjustment in contract time will be allowed due to incomplete submittals.

4.3 A pre-construction meeting scheduled by the engineer will be held prior to the start of work. Attendance shall be mandatory. The shotcrete contractor shall attend.

5.0 Field Quality Control.

5.1 Production test panels will not initially be required if a reference project for the nozzleman is provided as outlined in Paragraph 2.3 of this specification. The engineer may halt repair work if satisfactory results are not produced by the contractor and require production test panels.

5.2 If a comparable project demonstrating satisfactory results cannot be provided, the skills of the nozzleman shall be demonstrated and tested with at least one production test panel being furnished prior to performing repairs.

5.3 Production Test Panels (If Required).

5.3.1 Qualified personnel shall perform shotcreting and coring of the test panels with the engineer present. The contractor shall provide equipment, materials and personnel as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring.

5.3.2 Production test panels shall be made with the minimum full thickness and dimension of 18 x 18 inch and at least 3½ inch thick with 2-#4 bars placed in each direction. The #4 bars shall be centered in the 3½ inch dimension and evenly spaced in each direction with the bars touching at the 4 intersecting locations.

5.4 Test Panel Curing, Test Specimen Extraction and Testing (If Required).

5.4.1 Immediately after shooting, the test panels shall be field moist cured by covering and tightly wrapping with a sheet of material meeting the requirements of ASTM C 171 until delivered to the testing lab or test specimens are extracted. The test panels shall not be immersed in water. The test panels for the first 24 hours after shooting shall not be disturbed.

5.4.2 At the direction of the engineer at least two 3 inch diameter core samples shall be cut at two of the bar intersections to ensure consolidation around the bars. If voids are present the material and nozzleman are not approved for use. The contractor may continue with changes to the materials or nozzleman. The same process will be followed until no voids are present.

6.0 Shotcrete Facing Requirements.

6.1 Shotcrete Alignment Control. The final surface of the shotcrete shall maintain the existing concrete plane surface.

6.2 Surface Preparation. In addition to the manufacturer's recommendations, the surfaces to be shotcreted shall be cleaned of loose materials, mud, rebound, overspray or other foreign matter that could prevent or reduce shotcrete bond. Shotcrete shall not be placed on frozen surfaces.

6.3 Delivery and Application. In addition to the manufacturer's recommendations, a clean, dry, oil free supply of compressed air sufficient for maintaining adequate nozzle velocity shall be maintained at all times. The equipment shall be capable of delivering the premixed material accurately, uniformly and continuously through the delivery hose. Shotcrete application thickness, nozzle technique, air pressure and rate of shotcrete placement shall be controlled to prevent sagging or sloughing of freshly applied shotcrete.

6.3.1 The shotcrete shall be applied from the lower part of the area upwards to prevent accumulation of rebound. The nozzle shall be oriented at a distance and approximately perpendicular to the working face so that rebound will be minimal and compaction shall be maximized. Special attention shall be paid to encapsulating reinforcement. Care shall be taken while encasing reinforcing steel and mesh to keep the front face of the reinforcement clean during shooting operations, so that the shotcrete builds up from behind, to encase the reinforcement and prevent voids and sand pockets from forming. If a blow pipe was used to qualify, a blow pipe shall be required. The blow pipe is used to remove rebound and overspray immediately ahead of the nozzle. Rebound shall not be worked back into the construction. Rebound that does not fall clear

of the working area shall be removed. Hardened rebound and hardened overspray shall be removed prior to the application of additional shotcrete using abrasive blast cleaning, chipping hammers, high pressure water blasting or other suitable techniques.

6.3.2 When using multiple layer shotcrete construction, the surface of the receiving layer shall be prepared before application of a subsequent layer, by either:

- Brooming the stiffened layer with a stiff bristle broom to remove all loose material, rebound, overspray or glaze, prior to the shotcrete attaining initial set.

- If the shotcrete has set, surface preparation shall be delayed 24 hours, at which time the surface shall be prepared by sandblasting or high pressure water blasting to remove all loose material, rebound, hardened overspray, glaze or other material that may prevent adequate bond.

6.4 Defective Shotcrete. The engineer will have authority to accept or reject the shotcrete work. Shotcrete that is not in accordance with the project specifications may be rejected either during the shotcrete application process, or on the basis of tests. Shotcrete surface defects shall be repaired as soon as possible after placement. Shotcrete that exhibits segregation, honeycombing, laminations, voids or sand pockets shall be removed and replaced. In-place shotcrete determined not meeting the published technical information for the product used will be subject to remediation as approved by the engineer. Possible remediation options range from required latex over coating for excessive cracking up to removal and replacement at the contractor's expense

6.5 Construction Joints. Construction joints shall be tapered uniformly toward the excavation face over a minimum distance equal to the thickness of the shotcrete layer. Square joints will not be permitted except at the expansion joint. The surface of the joints shall be rough, clean and sound. A minimum reinforcement overlap at reinforcement splice joints shall be provided. The surface of a joint shall be clean and wet before adjacent shotcrete is applied.

6.6 Final Face Finish. Shotcrete finish shall be a wood float, rubber float, steel trowel or smooth screeded finish.

6.7 Additional Construction Requirements.

6.7.1 The work is to be performed is in the vicinity of a major waterway. Consequently, care shall be taken to avoid any rebound from entering the regulated waterway.

6.7.2 If the work to be performed is in the vicinity of an enclosed drainage system, care shall be taken to avoid any rebound from entering the drainage system.

6.8 Weather Limitations.

6.8.1 The shotcrete shall be protected if placed when the ambient temperature is below 40°F and falling or when likely to be subject to freezing temperatures before gaining sufficient strength. Cold weather protection shall be maintained until the compressive strength of the shotcrete is greater than 725 psi. Cold weather protection includes blankets, heating under tents or other means acceptable to the Engineer. The temperature of the shotcrete mix, when deposited, shall be not less than 50°F or more than 85°F. The air in contact with the shotcrete surfaces shall be maintained at temperatures above 32°F for a minimum of 7 days.

6.8.2 If the prevailing ambient temperature conditions (relative humidity, wind speed, air temperature and direct exposure to sunlight) are such that the shotcrete develops plastic shrinkage and/or early drying shrinkage cracking, shotcrete application shall be suspended. The contractor shall reschedule the work to a time when more favorite ambient conditions prevail or adopt corrective measures, such as installation of sunscreens, wind breaks or fogging devices to protect the work. Newly placed shotcrete exposed to rain that washes out cement or otherwise makes the shotcrete unacceptable shall be removed and replaced at the contractor's expense.

6.9 Curing. Permanent shotcrete shall be protected from loss of moisture for at least 1 day after placement. Shotcrete shall be cured by methods that keep the shotcrete surfaces adequately wet and protected during the specified curing period. Curing shall commence within one hour of shotcrete application. When the ambient temperature exceeds 80°F, the work shall be planned such that curing can commence immediately after finishing. Membrane curing shall be in accordance with the following requirements.

- **Membrane Curing.** Membrane curing is required on overhead surfaces that cannot be adequately wet cured. Curing compounds will not be permitted on any surface against which additional shotcrete or other cementitious finishing materials are to be bonded unless the surface is thoroughly sandblasted in a manner acceptable to the engineer. Membrane curing compounds shall be spray applied as quickly as practical after the initial shotcrete set at rate of coverage of not less than 7.1 square feet per gallon.

7.0 Safety Requirements. Nozzlemen and helpers shall be equipped with gloves, eye protection and adequate protective clothing during the application of shotcrete. Whip checks are required on air lines. The contractor shall be responsible for meeting all federal, state and local safety requirements.

8.0 Method of Measurement. Measurement of Substructure Repair (Unformed) and Slab Edge Repair shall be in accordance with Sec 704.

9.0 Basis of Payment. Payment for Substructure Repair (Unformed) and Slab Edge Repair shall be in accordance with Sec 704.

G. POLYESTER POLYMER CONCRETE WEARING SURFACE

1.0 Description. This work shall consist of constructing a wearing surface of polyester polymer concrete on a prepared surface in accordance with these specifications as shown on the plans or as directed by the engineer. Polyester polymer concrete shall be composed of the following three components – polyester resin binder, high molecular weight methacrylate (HMWM) resin and aggregate.

1.1 Hydro-demolition shall not be used with polyester polymer concrete.

2.0 Materials.

2.1 Primer. The prepared surface shall receive a wax-free low odor, high molecular weight methacrylate prime coat. The primer shall comply with the following requirements:

High Molecular Weight Methacrylate (HMWM) Resin		
Property	**Requirement**	**Test Method**
Viscosity *	0.025 Pa-s, maximum (Brookfield RVT with UL adapter, 50 RPM at 77°F)	ASTM D2196
Specific Gravity *	0.90, minimum (at 77°F)	ASTM D1475
Volatile Content *	30%, maximum	ASTM D2369
Flash Point *	180°F, minimum	ASTM D3278
Vapor Pressure *	1.0 mm Hg, maximum (at 77°F)	ASTM D323
Tack Free Time	400 minutes, maximum (at 77°F)	ASTM C679
PCC Saturated Surface-Dry Bond Strength	500 psi, minimum (24 hrs at 70 +/- 1°F)	California Test 551

*Tested prior to adding initiator

2.1.1 Mixing Requirements. The prime coat initiator shall consist of a metal drier and peroxide. If supplied separately from the resin, at no time shall the metal drier be mixed directly with the peroxide.

2.1.2 Storage. The containers shall be stored in a manner that will not allow leakage or spillage from one material to contact the containers or materials of the other.

2.2 Aggregates.

2.2.1 Polyester Concrete. The aggregates shall comply with Sec 1005, except as specified herein.

2.2.1.1 Crushed Particles. Aggregate retained on the No. 8 sieve shall have a maximum of 45 percent crushed particles as determined by AASHTO T 335.

2.2.1.2 Absorption. The aggregate absorption shall not exceed one percent as determined by AASHTO T 85.

2.2.1.3 Moisture Content. At the time of mixing with the resin, the moisture content of the aggregate, as determined by AASHTO T 255, shall not exceed one half of the aggregate absorption.

2.2.1.4 Temperature. The aggregate temperature shall be between 45°F and 100°F at the time of mixing.

2.2.1.5 Combined Gradation. Aggregate for polyester polymer concrete shall comply with the following requirements:

Combined Aggregate		
Sieve Size	**1/2" Max. Percent Passing**	**3/8" Max. Percent Passing**
½"	100	100
3/8"	83 – 100	100

Combined Aggregate		
Sieve Size	**1/2" Max. Percent Passing**	**3/8" Max. Percent Passing**
#4	65 – 82	62 – 85
#8	45 – 64	45 – 67
#16	27 – 48	29 – 50
#30	12 – 30	16 – 36
#50	6 – 17	5 – 20
#100	0 – 7	0 – 7
#200	0 - 3	0 – 3

2.2.1.6 Fine Aggregate. The fine aggregate shall consist of natural sand.

2.2.2 Finishing Sand. The sand for abrasive finish shall be commercial quality blast sand having at least 95 percent passing the No. 8 sieve and at least 95 percent retained on the No. 20 sieve when tested in accordance with AASHTO T 27. The absorption of the sand shall not exceed 1% when tested in accordance with AASHTO T 84.

2.3 Polyester Resin Binder. The resin shall be an unsaturated isophthalic-styrene co-polymer conforming to the following requirements:

Polyester Resin Binder		
Property	**Requirement**	**Test Method**
Viscosity *	0.075 to 0.200 Pa-s (RVT, No. 1 Spindle, 20 RPM at 77°F)	ASTM D2196
Specific Gravity *	1.05 to 1.10 (at 77°F)	ASTM D1475
Elongation	35%, minimum (Type I at 0.45"/min. Thickness = 1/4" +/- 0.04")	ASTM D638
	Sampling Condition: 18 hrs/77°F/50% + 5 hrs/158°F	ASTM D618
Tensile Strength	2,500 psi, minimum (Type I at 0.45"/min. Thickness = 1/4" +/- 0.04")	ASTM D638
	Sampling Condition: 18 hrs/77°F/50% + 5 hrs/158°F	ASTM D618
Styrene Content *	40 to 50% (by weight)	ASTM D2369
Silane Coupler	1.0%, minimum (by weight of polyester-styrene resin)	
PCC Saturated Surface-Dry Bond Strength	500 psi, minimum (24 hrs at 70 +/- 1°F)	California Test 551

*Tested prior to adding initiator

2.3.1 Silane Coupler. The silane coupler shall be an organsilane ester, gammamethacryloxpropyltrimethoxysilane.

2.3.2 Hardener. The promoter/hardeners shall be compatible with suitable methyl ethyl ketone peroxide (MEKP) and cumene hydroperoxide (CHP) initiators. MEKP initiators shall be used when

the surrounding concrete temperatures are above 60°F. A blend of initiators may be used as approved by the engineer when the surrounding concrete temperature is 50 – 60°F.

2.4 Delivery of Materials. All materials shall be delivered in their original containers bearing the manufacturer's label, specifying date of manufacturing, batch number, trade name, and quantity. Each shipment of polyester resin binder and HMWM resin shall be accompanied by a Material Safety Data Sheet (MSDS).

2.5 Storage of Materials. The material shall be stored to prevent damage by the elements and to ensure the preservation of their quality and fitness for the work. The storage space shall be kept clean and dry, and shall contain a high-low thermometer. The temperatures of the storage space shall not fall below nor rise above that recommended by the manufacturer. Every precaution shall be taken to avoid contact with flame.

2.5.1 Inspection. Stored materials shall be inspected prior to their use, and shall meet the requirements of this Specification at the time of use.

2.5.2 Failure. Any material which is rejected because of failure to meet the required tests or that has been damaged so as to cause rejection shall be immediately replaced at no additional expense to the Department.

2.5.3 Required Amount. Sufficient material to perform the entire polyester concrete application shall be in storage at the site prior to any field application, so that there shall be no delay in procuring the material for each day's application.

2.6 Training. The contractor shall arrange to have the material supplier furnish technical service related to application of material and health and safety training for personnel who are to handle the polyester polymer concrete and the HMWM resin prime coat.

2.7 Technical Support. The materials supplier shall have a representative onsite during placement of the polyester polymer concrete.

3.0 Mix Design. The contractor shall prepare and submit the polyester polymer concrete mix design and mixing procedures to the Construction and Materials Division for approval. The mix design shall include a recommended initiator percentage for the expected application temperature. The contractor shall not begin ordering materials for application of the polyester polymer concrete until the polyester polymer concrete mix design and mixing procedures are approved.

4.0 Construction.

4.1 Surface Preparation. The concrete surface shall be prepared by removing all material which may act as a bond breaker between the surface and the polyester polymer concrete.

4.1.1 Existing Bridge Decks. On existing concrete decks, the surface shall be uniformly scarified in accordance with Sec 216. If the existing deck is to be removed to a specified depth, then the surface shall be scarified to the removal depth specified in the drawings. The surface receiving the polyester polymer concrete is to be scarified to achieve a texture with an approximate amplitude of 1/4 inch. The scarifier shall not produce a polished or slick surface. Any epoxy patches or other existing repairs encountered shall be completely removed to sound, natural concrete. Sound concrete repairs may remain. Concrete deck repair is to be in accordance

with Sec 704 except as modified by Section 4.1.4 of this specification. Surfaces of concrete patches placed in the deck after scarifying shall be textured to an approximate depth of 1/4 inch before placing the overlay.

4.1.2 Existing Approach Slabs Containing Wearing Surface. On existing approach slabs with an existing wearing surface, the wearing surface shall be removed prior to scarifying the substrate and placing the polyester polymer concrete. The exposed concrete surface shall meet the requirements contained in Section 4.1.1 of this specification.

4.1.3 Concrete Deck Repair. Polyester polymer concrete may be substituted for Class B-2 concrete at locations of half-sole and full depth repairs. Polyester polymer concrete cannot be substituted for ultra-high performance concrete used to repair expansion device header slabs and must be placed after the slab has cured. Deck repairs using polyester polymer concrete shall be placed following the procedures recommended by the manufacturer. The maximum lift height recommended by the manufacturer is not to be exceeded. Monolithic repairs using supplementary wearing surface material are permitted when half the diameter or less of the top bar is exposed.

4.1.4 Removing Contaminates. The textured or scarified deck shall be sand blasted followed by an air blast. The sand blasting shall remove all dirt, oil and other foreign materials, as well as any unsound concrete or laitance from the surface and edges against which new polyester polymer concrete is to be placed. The compressor shall be equipped to prevent oil in the air supply. Any loose or foreign material detected on the concrete surface prior to placement of the polyester polymer concrete shall be removed by sand or air blasting. The concrete surface may require retexturing where penetration of foreign material is evident. No contamination of the retextured or scarified concrete surface shall be permitted. With approval from the engineer, the contractor may use automatic shot blasting units in lieu of sand blasting. The automatic shot blasting units shall be self-propelled and include a vacuum to recover spent abrasive. The abrasive shall be steel shot. Magnetic rollers shall be used to remove any spent shot remaining on the deck after vacuuming. Cleaned surfaces shall not be exposed to vehicular or pedestrian traffic other than that required by the overlay operation.

4.1.5 Steel Surfaces. All steel surfaces that will be in contact with the overlay shall be cleaned in accordance with SSPC-SP10, Near–White Blast Cleaning, except that wet blasting methods shall not be allowed.

5.0 Application of Prime Coat. One coat of HMWM prime coat shall be applied to the prepared concrete and steel surfaces immediately before placing the polyester polymer concrete. The prime coat shall be uniformly applied to completely cover the surface to receive the overlay. The area receiving the prime coat shall be dry and have had no exposure to any moisture within the past 24 hours. Prior to applying the prime coat, the surface shall be cleaned with compressed air to remove accumulated dust and any other loose material.

5.1 Surface Temperature. The concrete bridge deck surface shall be between 50°F and 100°F when applying the prime coat.

5.2 Relative Humidity. Polyester polymer concrete shall not be placed when the relative humidity is above 90 percent.

5.3 Curing. Polyester polymer concrete shall be placed immediately after the prime coat is applied to the bridge deck.

5.4 Prime Coat Contaminated. If the primed surface becomes contaminated, the contaminated area shall be cleaned by abrasive blasting and re-primed at no additional expense to the Department.

6.0 Placement of Polyester Polymer Concrete.

6.1 Placement Time. The polyester polymer concrete shall be placed on the prime coat within two hours of placing the prime coat.

6.2 Surface Temperature. The surface temperature of the area to receive polyester polymer concrete shall be the same as specified in Section 5.1 of this special provision.

6.3 Mixing Equipment. The concrete shall be volumetrically mixed at the bridge site by a continuous mixer in accordance with Sec 501.

6.3.1 Batching Information. The continuous mixer shall be equipped with a metering device that automatically measures and records the aggregate volumes and corresponding resin volumes. The volumes shall be recorded at no greater than five-minute intervals along with the time and date of each recording. A printout of the recordings shall be furnished to the engineer at the end of each shift. Readout gages shall be visible to the engineer at all times.

6.3.2 Mixture Consistency. The concrete discharged from the mixer shall be uniform in composition and consistency. Mixing capability shall be such that initial and final finishing operations can proceed at a steady pace.

6.4 Contamination. The contractor shall prevent any cleaning chemicals from reaching the polyester polymer concrete mix during the mixing operation.

6.5 Addition of Initiator. Polyester polymer concrete shall be placed prior to gelling and within 15 minutes following the addition of initiator, whichever occurs first. Polyester polymer concrete that is not placed within this time shall be discarded.

6.6 Amount of Polyester Resin. The polyester resin binder in the polyester polymer concrete shall be 12 percent +/- 1 percent by weight of the dry aggregate. The contractor shall determine the exact percentage as approved by the engineer.

6.7 Amount of Peroxide Initiator. The amount of peroxide initiator used shall result in a polyester polymer concrete set time between 30 and 120 minutes during placement. The initial set time will be determined by using an initial-setting time Gillmore needle in accordance with ASTM C266. Accelerators or inhibitors may be required as recommended by the polyester resin supplier and as approved by the engineer.

6.8 Finishing Equipment. Finishing equipment shall be capable of consolidating the polyester polymer concrete and striking off the polyester polymer concrete to the final grade, thickness and cross-sections as shown in the contract documents.

6.9 Overlay Thickness. The polyester polymer concrete overlay shall be placed to the thickness specified on the construction drawings.

7.0 Surface Texturing. The roadway surface, except within 12 inches of the inside face of the curb, shall be textured as soon as the condition of the polyester polymer concrete will permit. The

roadway finishing shall otherwise be in accordance with Sec 502. Hand-operated devices producing a satisfactory texture will be permitted. At the contractor's option, a finned float with a single row of fins may be used. The grooves produced by the finned float shall be approximately 1/8 inch wide at 5/8 to 3/4-inch centers and shall be approximately 1/8 inch deep. This operation shall be performed at such a time and in such a manner that the desired texture will be achieved while minimizing displacement of the layer aggregate particles.

8.0 Curing. Traffic and construction equipment shall not be permitted on the polyester polymer concrete overlay for at least two hours and until the polyester polymer overlay has reached a minimum compressive strength of 3,000 psi as verified by the rebound number determined in accordance with ASTM C805. Rebound number shall be correlated to cylinder compressive strength through development of a calibration curve specific to this project, and as directed by the manufacturer.

9.0 Testing. Bond testing shall be performed for each placement on each day. Testing will be conducted at three locations 48 hours after placement. Testing will be performed in accordance with ACI 506R. A passing test is the failure of the concrete substrate or bond strength above 250 psi.

10.0 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. Furnish Polyester Polymer Concrete Material will be measured by the actual volume of polyester concrete material complete-in-place measured in cubic yards. The volume shall include material used for the overlay and any other deck rehabilitation as directed by the engineer. Tickets provided to the engineer showing quantities of PPC produced shall be sufficient to calculate volume of material placed. Place Polyester Polymer Concrete Wearing Surface will be measured and paid for as the quantity of final surface finishing in square yards.

11.0 Basis of Payment. Payment for Furnish Polyester Polymer Concrete Material shall include all costs required to furnish the polyester concrete material including HMWM primer, freight to the project site, receiving, storage, and disposal of any unused overlay material. Payment by cubic yard will be based on 135 lbs. per cubic foot and recorded by calibrated mixer unit readouts.

- Payment for Place Polyester Polymer Concrete Overlay will be full compensation for all labor, equipment, and all incidentals necessary to prepare the concrete surface and complete and finish the overlay placement.

H. MILLING PRIOR TO WEARING SURFACE INSTALLATION

1.0 Description. The wearing surface rehabilitation for either alternate work shall require removal of existing concrete substrate and placement of a new wearing surface at the plan thickness and final grade shown on the contract drawings. Contractor shall determine appropriate means and methods to prepare the existing bridge deck to receive new wearing surface in accordance with the plans and Specifications.

2.0 Removals. To achieve the depth of removal shown on the plans, removals through mechanical milling, or similar, shall be performed in multiple passes. All removals shall be performed to prevent damage to the substrate and embedded rebar, while also providing an adequately prepared surface for application of the new wearing surface.

2.1 Contractor may elect to perform mock-ups or trial operations to demonstrate appropriate means and methods for removal using a single pass. The Resident Engineer may approve use of a single pass if the resulting removal depth and substrate profile are found to be sufficient and in accordance with the plans and Specifications.

3.0 Method of Measurement. There will be no additional measurement for multiple passes of milling required to achieve the depth of removals shown on the contract drawings.

4.0 Basis of Payment. There will be no additional payment for multiple passes of milling beyond the pay items included in the contract. There will be no additional payment for mock-ups or trial operations to demonstrate removal operations using a single pass.

I. BRIDGE INSPECTION ACCESS

1.0 Inspection. The contractor will provide access to MoDOT bridge inspection personnel and equipment to complete the biennial bridge inspection for each structure when requested. Inspection of the bridge when opened to two-way traffic is not planned.

2.0 Timing. MoDOT will coordinate with the contractor to identify a time when the inspections can be completed. The inspection will occur after the work on each structure is substantially complete and before the structure is open to traffic. Each inspection is anticipated to take one (1) day to complete.

3.0 Method of Measurement. There will be no measurement for this bridge inspection access.

4.0 Method of Payment. The contractor will not receive compensation for providing bridge inspection access to MoDOT.