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If a seal is present on this sheet, JSP's has been electronically sealed and dated.

JOB NO. J6I2090
St. Louis County, MO
Date Prepared: 5/3/2023

Addendum No. 001

Only the following items of the Job Special Provisions (Bridge) are authenticated by this seal: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R

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 structure(s) and the geotechnical report for the new structure(s) 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 a lane closure is for the absolute minimum amount of time required to complete the work. A lane shall not be closed until material is available for continuous construction and the contractor is prepared to diligently pursue the work until the closed lane is opened to traffic.

2.2 The contractor shall remove the substructure in accordance with Sec 216.10, except that the entire substructure footings shall also be removed at Intermediate Bents 2 & 3 of Bridge No. A1052.

2.2.1 For restrictions on traffic and working hours during demolition see Roadway Plans and Job Special Provisions

2.3 Bridge work by contractor forces, including erection, rehabilitation or demolition, shall not be allowed over traffic unless a bridge platform protection system is installed below the work area except for work performed above a deck that is intact. The protection system shall be capable of catching all falling objects such as tools, overhang brackets or materials. Lifting of objects that are heavier than the capacity of the bridge protection system shall not be permitted.

2.4 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.

2.5 The existing slab for the bridge(s) to be redecked was constructed as composite or non-composite as shown in the table below.

Bridge No.	**Type of deck**
A10514 & A10515	Composite

2.6 The bridge substructure for the widened portion of stage one construction on A10514 and A10515 shall be constructed as near to completion as feasible before removing the adjacent portions of existing superstructure.

2.7 Provisions shall be made to prevent any debris and material from falling onto the roadway. 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. Traffic under the bridge shall be maintained in accordance with the contract documents.

2.8 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.

2.9 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.

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

2.11 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.

2.12 The contractor shall schedule the substructure repairs as one of the first orders of work so that the fiber reinforced polymer wrap for shear strengthening can be installed as required by job special provision Fiber Reinforced Polymer (FRP) Wrap for Concrete Columns.

3.0 Method of Measurement. No measurement will be made.

4.0 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. DEFLECTION AND HAUNCHING

1.0 Description. The contractor shall determine dead load deflections and haunching based on field measurements and/or existing bridge plans for Bridge No. A1051 and these shall be adjusted based on the difference between the new and existing dead load weights.

2.0 Construction Requirements. In order to properly form the haunches for the new deck, the contractor shall survey top of deck elevations above each beam including centerline of roadway and along each beam line (top or bottom flange) prior to deck removal followed by surveying elevations of the beams (top or bottom flange) after deck removal.

3.0 Method of Measurement. No measurement will be made.

4.0 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.

C. 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.

D. FORM LINERS

1.0 Description. This work item shall consist of constructing the form liner aesthetic treatment on mechanically stabilized earth (MSE) wall systems as shown on the plans for MSE Walls No. A9013 and A9014 and described in this special provision.

2.0 Materials.

2.1 Shop Drawings. Contractor shall provide complete shop drawings of all aesthetic treatments.

2.2 Formwork. Formwork for aesthetic treatment of concrete facing panels for the MSE wall systems shall be a type that produces uniform results consistent in both, pattern and depth of relief with the project design aesthetics. The contractor shall be responsible to coordinate the aesthetic treatments of all components to meet the design aesthetic criteria described herein and as shown on plans. No mixing of pattern numbers or manufacturers will be permitted. The form liner pattern shall be one of the patterns listed on the plans or approved equal.

2.3 Form Ties. Wall form ties shall be placed in a uniform pattern. In surface areas receiving the aesthetic treatment form liner, all form ties shall be placed in the simulated stone surface. Form ties shall be fiberglass ties that shall hold the forms in the correct alignment. The color of the ties shall closely match the concrete wall color. Ties shall be ground flush with the surface of concrete prior to pressure washing.

2.4 Form Release Agent. Form release agents shall be the manufacturer's standard non-staining, non-petroleum based and compatible with surface sealer finish coating. Form release agents shall be applied to all surfaces of the form liner at the manufacturer's recommended rate.

2.5 Gaskets. Closed cell compressible neoprene of such thickness as is appropriate to assure leakage prevention shall be used to prevent joint leakage. One face shall be coated with an adhesive tape to assure proper positioning at the time of form closure. The neoprene shall be sufficiently compressible as to assure virtual "zero" separation of the forms as a result of the use of this product.

2.6 Aggregates.

2.6.1 Aggregate Source. The aggregate incorporated into the concrete mix of all aesthetic concrete MSE Wall components shall be from the same source. The aggregate incorporated into the concrete mix of all aesthetic concrete bridge components shall be from the same source as the balance of the bridge concrete work. The purpose for this provision is to ensure uniformity of materials and color once areas are pressure washed and aggregates become exposed. Single-source shall be interpreted as one contiguous rock quarry, gravel pit or dredging location. This provision in no way alters the specification requirements for aggregate quality specified in other sections of the project specifications.

2.6.2 Aggregate Gradation. Concrete mixes supplied for the construction of the aesthetic treatments shall be in accordance with the following requirements. The concrete aggregate for the aesthetic treatment mix shall be Gradation E in accordance with Sec 1005 for any areas where aesthetic treatment is formed monolithically with the structure. This requirement for

aggregate size is necessary to permit concrete mixture to flow freely and fill completely into reveals and form liner proposed in the aesthetic treatment. Gradation E aggregate shall meet the aggregate source requirements.

2.7 Joint Materials. Bond breaker material shall be polyethylene tape, coated paper, metal foil or similar type materials. The backup material shall be compressible, non-shrink, non-reactive with the sealant and non-absorptive material type such as extruded butyl or polychloroprene foam rubber. The joint sealant shall be an elastomeric, multi-component sealant, in accordance with Federal Specification TT-S-227, Type II. The sealant color shall match the pressure washed concrete surface color.

3.0 Construction Requirements.

3.1 Reveals and Texture. All reveals and texture shall be continuous from element to element through construction joints and around corners. Techniques shall be utilized to ensure true continuous texture between separate elements. Sand blasting will not be permitted for cleaning concrete surface, as sand blasting will reduce the special surface texture specified. Pressure washing with water is the preferred method of removing laitance. Pressure washing cleaning shall provide a minimum pressure of 3000 psi at a rate of 3 to 4 gallons per minute (11.4 to 15.1 L/min) using a fan nozzle held perpendicular to the surface at a distance of 2 to 3 feet. The completed surface shall be free of blemishes, discolorations, surface voids and conspicuous form marks to the satisfaction of the engineer.

3.2 Sample Test Panels. Sample test panels shall be constructed to demonstrate the contractor's workmanship for all form liner textures and patterns as shown on the plans. The sample test panels may also be used for demonstration special surface finish if approved by the engineer. The architectural surface treatment of the finished work shall achieve the same final effect as demonstrated on the approved sample test panels. The materials used in construction of the sample test panels shall be in accordance with all standards as listed in this specification and the plans. The concrete mix shall be consistent with the project specifications and criteria. The minimum size of the sample test panels shall be 6 x 6 feet x 8 inches. The form liner finish shall be demonstrated in a vertical strip covering one-half to three-quarters of the sample test panel(s).

3.3 Patches. Holes and defects in concrete surface shall be filled within 48 hours of when the forms are removed. The same patching materials and techniques shall be used that were approved on sample test panels. The patches shall be made with a stiff mortar made with the same material sources as the concrete. The mortar mix proportions shall be adjusted so the dry patch matches the dry adjacent concrete. White cement shall be added to the mortar mix if necessary to lighten the mortar mix.

3.4 Joints. Joints shall be sealed when the sealant, air and concrete temperatures are above 40°F. Joints shall be primed and filled flush with joint sealant in accordance with the manufacturer's recommendation. All construction control and expansion joints shall occur within the vertical joints as shown in the elevation views on the plans. All vertical expansion joints shall be filled with preformed fiber expansion joint filler covered with bond break tape and sealed with elastomeric, multi-component sealant.

4.0 Method of Measurement. No measurement of form liners on MSE wall systems shall be made.

5.0 Basis of Payment.

5.1 Form Liners on MSE Wall Systems. Payment for the above described work, including all material, additional concrete, equipment, labor and any other incidental work necessary to complete this item, will be considered completely covered by the contract unit price for "MSE Wall Systems".

E. AESTHETIC CONCRETE STAIN

1.0 Description. This work shall consist applying aesthetic concrete stain to the MSE wall Panels for MSE Walls No. A9013 and A9014 as shown on the contract plans.

2.0 Materials

2.1 Color. The color of the stain shall be opaque gray, matching Sherwin Williams exterior satin latex paint, color "7066 Gray Matters". The concrete stain manufacturer shall submit a sample to the engineer for approval and provide documentation stating that the color of the stain will not be altered or deteriorated.

3.0 Construction Requirements

3.1 Cleaning. All areas to be stained shall have cured for at least 30 days prior to application of the stain. Prior to application of the stain, surfaces shall be cleaned of latency, dirt, dust, grease or other foreign material and in accordance with the manufacturer's recommendations. Concrete surface shall be free of blemishes, discoloration, surface voids and unnatural form marks.

3.**2 Application.** The method of application shall be in accordance with the manufacturer's recommendations and as approved by the Engineer.

4.0 Method of Measurement. No measurement will be made.

5.0 Basis of Payment. Payment for all work associated with the concrete stain, including all material, material property verifications, equipment, labor and any other incidental work necessary to complete this item, will be considered completely covered by the lump sum price for "Aesthetic Concrete Stain".

F. EPOXY PRESSURE INJECTING

1.0 Description. Surface cracks in the substructure shall be pressure injected with epoxy. The engineer will designate the cracks to be repaired.

2.0 Material.

2.1 Epoxy. The epoxy material shall consist of a two-component system in accordance with the requirements of ASTM C 881, Type IV, Grade 1, except that the viscosity shall be a maximum of 4.5 poise (0.45 Pa·s). The Class designation of the epoxy shall be determined according to the temperature that exists on the job.

2.2 Certification. The contractor shall furnish manufacturer's certification that the material supplied is in accordance with these specifications. The certification shall include or have

attached typical test results for all specified properties required by ASTM C 881 for the injecting resin. The engineer reserves the right to sample and test any or all material supplied.

3.0 Construction Requirements. The surface to receive the epoxy grout shall be cleaned of laitance, grease and foreign matter by sandblasting. The cracks shall be cleaned of debris by using oil-free and water-free compressed air or vacuum. After the cracks are cleaned, the epoxy shall be injected in accordance with manufacturer's recommendations. The temporary surface seal and placement and method of attachment of injection ports shall be in accordance with the epoxy manufacturer's recommendations.

4.0 Method of Measurement. The extent of epoxy pressure injecting may vary from the estimated quantity but the contract unit price shall prevail regardless of the variation. The epoxy pressure injecting will be measured to the nearest linear foot (0.5 m).

5.0 Basis of Payment. Accepted quantity of epoxy pressure injecting will be paid for at the contract unit price. 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 unit price for "Epoxy Pressure Injecting".

G. FIBER REINFORCED POLYMER (FRP) WRAP FOR CONCRETE COLUMNS

1.0 Description. This work shall consist of designing, furnishing, and placing carbon fiber reinforced polymer (FRP) composite wrap to provide increased column ductility during a seismic event at the locations as shown on bridge plans for Bridge No. A10514, A10515 and as directed by the engineer.

2.0 Materials. The storage and handling of materials for the FRP composite work shall be in accordance with the manufacturer's written recommendations in factory sealed containers with the FRP manufacturer's labels. Labels shall be intact and legible with date of manufacture and shelf life.

2.1 Material Properties.

2.1.1 The contractor shall provide a unidirectional, high-strength fiber fabric fully saturated with compatible epoxy resin per manufacturer's recommendations. FRP provided shall meet or exceed ASTM D3039 test procedure requirements (tensile modulus, stress and strain) as determined from independent laboratory testing.

2.1.2 The contractor shall provide a flexible, waterproofing, non-vapor barrier protective top coating compatible with the FRP manufacturer's recommendations to protect the FRP from ultraviolet radiation and heavy abrasion with a design life of 50 years. This protective top coating shall closely match the gray color appearance of the existing concrete color.

2.2 Product Data. Manufacturer's product data including physical and chemical characteristics, material specifications for each component, limitations on use of the system, construction or application specifications, maintenance instructions and general manufacturer's recommendations regarding each system shall be provided. Product data on the proposed primer, putty, resin, saturant, and carbon or glass fiber shall be included. Testing information on the combination of the proposed carbon or glass fiber reinforcement and epoxy when used together as a system shall be provided. The contractor shall provide certifications by the producers of the materials that all materials supplied are in accordance with all the requirements

and standards of the appropriate ASTM and other agencies. Manufacturer's Material Safety Data Sheets (MSDS) for all materials to be used shall be provided.

2.3 Contractor Submittals. The contractor shall submit the following documentations and obtain approval 30 days before work commences.

2.3.1 Contractor Qualifications. The contractor shall provide a manufacturer's certification of technical training, FRP system selected, project supervisor, and documentation showing the contractor has been certified or approved by the manufacturer of the FRP system. A contractor specializing in the supply and installation of FRP repair systems with minimum of 5 years of documented experience or 25 documented similar field applications with acceptable reference letters from respective owners in performing FRP composite retrofits shall perform the work. A trained project supervisor shall remain at the work site at all times to instruct the work crew in the FRP application procedures.

2.3.2 Shop Drawings. Shop drawings shall be submitted signed and sealed by a Missouri Professional Engineer in accordance with Sec 107 for Authentication of Certain Documents. Shop drawings shall include the detail of types, locations, dimensions, number of layers and splice details and orientation of all FRP materials and coatings to be installed.

3.0 Construction Requirements.

3.1 FRP Wrapping. Following completion of Substructure Repair (Formed) on the columns indicated in the plans, the contractor shall prepare the concrete for application of a CFRP fiber wrap with a minimum total thickness of 0.06". The number of layers required is dependent on the thickness of the CFRP system chosen by the contractor. The contractor shall follow manufacturer instructions for application of the CFRP fiber wrap to the columns to the limits shown in the plans. The purpose of this CFRP fiber wrap is to provide a confining stress to the column concrete for increased section ductility during a seismic event. The CFRP fiber wrap is a passive system that is engaged only when the concrete dilates. No strengthening of the column is necessary or required from this CFRP fiber wrap.

3.2 Concrete Moisture Requirement. The surfaces of the concrete to receive the FRP composite shall be reasonably dry based on the following test. A 3 x 3 foot polyethylene sheet shall be taped to the existing concrete surface and at any substructure repair area. If moisture collects on the underside of the polyethylene sheet before the epoxy would cure, the concrete shall be allowed to dry longer. The concrete surface shall pass this test before the FRP can be applied.

3.3 Surface Preparation. Spalled and loose concrete shall be removed and concrete surfaces restored to their original dimensions using substructure repair in accordance with Sec 704. The new concrete in the substructure repair areas shall cure for a minimum of 28 days before the FRP is applied. Concrete surfaces of existing or patched concrete to receive an application of FRP material shall be prepared by abrasive blasting or grinding to remove existing laitance and expose aggregate to a minimum ICRI-CSP3 concrete surface profile. All FRP contact surfaces shall have all laitance, dust, dirt, oil, curing compound, existing coatings and any other foreign matter removed that could interfere with the bond between the FRP system and the concrete. Localized out-of-plane variations, including form lines, shall not exceed the smaller of 1/32 inch or the tolerances recommended by the FRP manufacturer's recommendation. Sharp and chamfered corners shall be rounded off to a minimum radius of 1/2 inch by grinding or forming with the system's thickened epoxy. Variations in the radius along the vertical edge shall not exceed 1/2 inch for each foot of length.

3.4 Installation of FRP. The concrete and atmospheric temperatures shall be between 40°F and rising and 90°F and falling during installation of the FRP. Tension adhesion testing shall be conducted using ASTM D7234 with the strengths reaching 200 psi. Any failure shall exhibit failure of the concrete substrate before failure of the adhesive. Tension adhesion testing shall cease when strengths reach 200 psi. Any failure of the concrete substrate and/or FRP adhesion shall be repaired at the contractor's expense and as directed by the engineer. Two adhesion tests shall be performed for each bent having FRP being applied. The FRP shall be installed in accordance with the manufacturer's written recommendations and as required by the job special provisions.

4.0 Method of Measurement. Fiber reinforced polymer wrap will be measured to the nearest square foot based on the member surface area as detailed on the contract plans. No additional compensation will be given for the use of multiple layers of material to achieve design strength. Final measurements will not be made except for authorized changes during construction or where significant errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

5.0 Basis of Payment. The contractor is responsible for visiting the site and appropriately familiarizing themselves with the work to bid the repair items outlined in this provision. 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 unit price for Fiber Reinforced Polymer Wrap.

H. SHOTCRETE CONCRETE REPAIR

1.0 Description. Substructure repair (formed) shall be in accordance with Sec 704 and as shown on the contract plans. Shotcrete, in accordance with this Special Provision, may be used at the Contractor's option for formed substructure repairs.

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 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 Section 5.1 of this Job Special Provision 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 Shotcrete Materials.

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

a) BASF MasterEmaco S 211SP
b) Euclid Chemical Eucoshot F
c) King Shotcrete MS-D1
d) CTS Cement Low-P

3.2 No material testing is anticipated. Acceptance will be based on the prequalified materials listed in this Special Provision, approval of the nozzleman prior to material placement, and visual inspection. If questions arise based from 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 formed substructure repair, a copy of the following information shall be submitted in writing to the Engineer for review:

(a) Written documentation of the nozzlemen's qualifications including proof of ACI or EFNARC certification;

(b) Proposed methods of shotcrete placement and of controlling and maintaining facing alignment including equipment models;

(c) Shotcrete mix; and

(d) 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

(e) 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 formed substructure 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 Section 2.3 of this Job Special Provision. 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.

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 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:

(a) 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.

(b) 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 If the work to be performed is in the vicinity of a jurisdictional water of the US, 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 sun screens, 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. Curing shall be in accordance with the following requirements.

> **(a) 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) shall be in accordance with Sec 704.

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

I. BARRIER REPAIR (FORMED)

1.0 Description. This work will consist of all items necessary to repair Type A and Type B Barrier as shown in the plans on Bridge No. A46574 and A46575. Alternatively, the contractor shall have the option to perform this work by Shotcrete Concrete Repair by adhering to all requirements set forth by Section J of these Job Special Provisions.

2.0 Materials. Concrete for Type A and Type B Barrier repairs shall be Class B-1 and shall be in accordance with Sec 501. Coarse aggregate shall be Gradation E in accordance with Sec 1005.

3.0 Construction Requirements. Construction requirements for removing unsound concrete preparing the repair area and placement of new concrete shall be in accordance with Sec 704.

4.0 Method of Measurement. Barrier Repair (Formed) shall be measured to the nearest linear foot.

5.0 Basis of Payment. Payment for the above described work, including all material, equipment, labor and any other incidental work necessary, shall be considered completely covered by the contract unit price for “Barrier Repair (Formed)”.

J. DRAINAGE SYSTEM

1.0 Description.

1.1 This work shall consist of furnishing, fabricating and installing the drainage items necessary to complete the entire drainage system as shown on the contract plans.

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, provided that 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. 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 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 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 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 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 Size 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.

3.4 When the drainage system continues between superstructure units and/or between the superstructure and substructure units, the drainage system shall have allowance for the expected differential expansion and contraction movements 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 to complete this item will be considered completely covered by the contract lump sum price for Drainage System (On Structure).

K. 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.

L. TEMPORARY MSE WALL

1.0 Description. This work shall consist of furnishing materials and placement of temporary wire face retaining walls constructed in accordance with these specifications and in reasonably close conformity with the lines, grades, design and dimensions shown on the plans or otherwise established. Dimensions and elevations shown on the plans shall be considered approximate and used for estimating purposes only.

1.1 The temporary wire faced MSE walls are located on the plans for phasing of the permanent MSE Wall. The Contractor may locate the temporary wire face MSE wall differently than that shown on the plans with the approval of the Engineer. No additional payment shall be made for change in wall location or subsequent changes in labor or materials for the relocation.

1.2 The Contractor is solely responsible for determining the dimensions of the temporary wall and ensuring that the temporary wall is compatible with the construction of the MSE walls and bridges.

2.0 Design Requirements: The design by the wall system supplier shall consider the internal stability of the reinforced soil mass and shall be in accordance with acceptable engineering practice and these specifications. The design life of the structure shall be 3 years unless otherwise specified by the owner.

2.1 Three **(**3) sets of design drawings and calculations signed and sealed by a professional engineer registered to practice engineering in Missouri submitted to the engineer for approval.

2.2 The structure's design height, H, shall be from the bottom of the wire facing to the top of the wall where the ground surface intercepts the wall facing.

2.3 The soil reinforcement length shall be the same length from top to bottom of wall. The minimum soil reinforcement length shall be as required to achieve a minimum width of structure B, measured from the front face of wall to the end of the soil reinforcements, greater than or equal to 70 percent of the design height, H. The minimum reinforcement length shall be 8.0 ft.

2.4 A bilinear failure surface shall be assumed in design passing through the base of wall behind the facing to a point 0.3H behind and 0.5H above the base of wall and shall be assumed vertical above this point to the ground surface.

1 REVISED **2.5** The soil parameters assumed for the design shall be those shown on the plans for the permanent MSE Wall ~~or as specified by the Engineer~~.

2.6 The following are factors of safety for internal stability:

- Reinforcement yield: FS = 1.5
- Reinforcement pullout in soil: FS = 1.5 against 0.5 inch deformation.
- pullout resistance determined at 0.5 inch deformation.
- Connection of reinforcements to facing units: The maximum allowable reinforcement tension shall not exceed one-half of the ultimate breaking load of the connection.

2.7 The allowable reinforcement tensile stress shall not exceed 55 percent of the yield strength of the steel (i.e. FS = 1.5 against yield).

2.8 The lateral earth pressure to be resisted by the reinforcements at each reinforcement layer shall be calculated using the appropriate coefficient of earth pressure, K, times the vertical stress at each reinforcement layer. The vertical soil stress at each reinforcement layer shall consider the local equilibrium of all the forces acting above the layer under investigation, and shall be computed using the Meyerhof bearing pressure equation. The coefficient of earth pressure, K, shall vary from an at-rest earth pressure coefficient, K_0, at the ground surface and shall decrease linearly to an active earth pressure coefficient, K_a, at depth of 20 feet. The coefficients of earth pressure shall be based on level top conditions and shall be independent of surcharge slope.

1 ADDED **2.9** The global stability and settlement for temporary MSE walls has been checked by the Engineer within the footprint of the proposed ground improvements. For temporary MSE walls located outside the footprint of the proposed ground improvements, global stability and settlement shall be the responsibility of the Contractor.

3.0 Materials. The contractor shall make his own arrangements to purchase the materials covered by this section of the specifications.

3.1 Select granular backfill as specified in Sec 1010.

3.2 Soil reinforcement and attachment devices as specified in Sec 1052.

3.3 Wire facing and HA ladders (where applicable) shall be shop fabricated of cold drawn steel wire conforming to the minimum requirements of AASHTO M-32 (ASTM A-82) and welded into the finished configuration in accordance with AASHTO M-55 (ASTM A-185). The tie plate for ladder reinforcing shall conform to the physical and mechanical properties of (ASTM A-570, Grade 50 steel).

3.4 Inspection of the foundation conditions, the materials of construction, and the construction procedures is the responsibility of the owner or the owner's representative. Inspection is not the responsibility of the wall system supplier.

4.0 Construction Requirements.

4.1 Wall Erection. The wall system components shall be constructed in accordance with the wall system supplier's recommendations and construction manual. The wall shall be constructed vertical or as near vertical as the wall system will allow. The overall vertical tolerance of the wall and the horizontal alignment tolerance shall not exceed 3 inches per 10 feet.

4.2 Backfill Placement.

4.2.1 Backfill placement shall closely follow erection of each course of wire facing units. Backfill shall be placed in such a manner as to avoid any damage or disturbance to the wall materials or misalignment of the facing. Any wall materials which become damaged or disturbed during backfill placement shall be either removed and replaced at the contractor's expense or corrected as directed by the engineer. Any misalignment or distortion of the wall elements due to placement of backfill outside the limits of this specification shall be corrected as directed by the engineer.

4.2.2 Reinforced backfill shall be compacted to 95 percent of the maximum density as determined by AASHTO T-99 (ASTM D-698, Method C). Reinforced backfill material shall have a placement moisture content less than or equal to the optimum moisture content. Backfill material

with a placement moisture content in excess of the optimum moisture content shall be removed and reworked until the moisture content is uniform and acceptable throughout the entire lift. The optimum moisture content shall be determined in accordance with AASHTO T-99 (ASTM D-698, Method C). The maximum lift thickness after compaction shall not exceed 10 inches, regardless of the vertical spacing between layers of soil reinforcements. The contractor shall decrease this lift thickness, if necessary, to obtain the specified density.

4.2.3 Prior to placement of the soil reinforcements, the reinforced backfill elevation, after compaction, shall be 2 inches above the connection elevation from a point approximately 24 inches behind the facing to the free end of the soil reinforcements, unless otherwise shown on the plans.

4.2.4 Compaction within 3 feet of the facing shall be achieved by at least three (3) passes of a lightweight mechanical tamper, roller or vibratory system. No soil density tests need be taken within this area. Care shall be exercised in the compaction process to avoid misalignment of the facing. Heavy compaction equipment shall not be used to compact backfill within 3 feet of the wall face. At the end of each day's operation, the contractor shall slope the last level of backfill away from the wall facing to direct runoff of rainwater away from the wall face. In addition, the contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

5.0 Method of Measurement. No measurement shall be made.

6.0 Basis of Payment. Payment for the above described work, including all material, equipment, labor and any other incidental work necessary to complete this item, will be included in the contract lump sum price for "Temporary MSE Wall" for each MSE Wall where a temporary wall is required.

6.1 The estimated area (square foot) of the temporary wire faced MSE Wall required is shown on the MSE Wall plans and is based on the lines, grades, design, dimensions and subsurface conditions used to develop the contract drawings. The actual limits of the temporary wire faced MSE may vary from those shown on the plans, either decreased or increased, depending on the conditions encountered during the work. All variations shall be approved by the Engineer.

M. DYNAMIC PILE TESTING

1.0 General.

1.1 Scope of Work. Scope of work shall include furnishing all labor, equipment and analysis associated with dynamic testing of driven piles as specified in this special provision.

1.2 Performance and Design Requirements. Performance and design conditions for dynamic testing of driven piles shall be in accordance with section 4.0 of this special provision.

1.3 Approved Manufacturers. For the following hardware and software components, only the listed manufacturer is recognized as providing the level of quality required. If the contractor wants to propose a non-listed manufacturer that is considered to provide an equivalent level of quality, this manufacturer shall be identified and supporting documentation provided. Acceptance of the manufacturer as a substitute will be at the discretion of the engineer.

Component	Product	Manufacturer
Pile Driving Modeling - Wave Equation Software	GRLWEAP	Pile Dynamics, Inc.

Component	Product	Manufacturer
Pile Driving Monitoring - Hardware & Software	Pile Driving Analyzer - Model PAK	Pile Dynamics, Inc.
Pile Driving Analysis – Signal Matching Software	CAPWAP	Pile Dynamics, Inc.

1.4 Test Requirements. Dynamic pile testing shall be conducted in accordance with the standard test method indicated below.

Standard Test Method	Designation	Conducted By
High-Strain Dynamic Testing of Piles	ASTM D 4945	Contractor

1.5 Qualifications. The contractor shall perform dynamic pile testing utilizing the services of an independent dynamic pile testing consultant and qualified personnel. An engineer with a minimum of three years of dynamic pile testing and analysis experience or who has achieved Basic or better certification under the High-Strain Dynamic Pile Testing Examination and Certification process of the Pile Driving Contractors Association and Foundation QA shall perform pile driving monitoring. An engineer with a minimum of five years of dynamic pile testing and analysis experience or who has achieved Advanced or better certification under the High-Strain Dynamic Pile Testing Examination and Certification process of the Pile Driving Contractors Association and Foundation QA shall perform pile driving modeling and pile driving analyses.

2.0 Execution.

2.1 Pile Driving Modeling. The contractor shall perform preconstruction wave equation analyses and prepare a summary report of the results. The wave equation analyses shall be used to assess the ability of all proposed pile driving systems to install piles to the required capacity and the desired penetration depth within allowable driving stresses. The report shall include a drivability graph relating pile capacity, blow count and driving stresses to depth. The report shall include a bearing graph relating the pile capacity to the pile driving resistance. The bearing graph shall indicate blow count versus capacity and stroke. The report shall also contain a constant capacity analysis or inspectors chart to assist the engineer in determining the required driving resistance at other field observed strokes. The contractor shall perform wave equation analyses in accordance with section 4.0 of this special provision. Acceptability of the wave equation report and the adequacy of analyses will be determined by the engineer.

2.1.1 Approval by the engineer of the proposed pile driving system will be based upon the wave equation analyses indicating that the proposed system can develop the specified pile capacity at a pile driving rate of 2 to 10 blows per inch at the end of driving, and within allowable driving stresses per *AASHTO LRFD Bridge Construction Specifications*, Section 4.4.1. The contractor shall provide preliminary pile driving criteria based on wave equation analyses and any anticipated capacity changes after driving, set-up or relaxation, subject to revision based upon dynamic pile testing field measurements.

2.1.2 If any changes or modifications are made to the approved pile driving system, additional wave equation analyses in accordance with section 2.1 of this special provision shall be required.

2.2 High-Strain Dynamic Pile Testing.

2.2.1 The contractor shall perform dynamic pile testing at the locations and frequency required in accordance with section 4.0 of this special provision.

2.2.2 Dynamic pile testing involves monitoring the response of a pile subjected to heavy impact applied by the pile hammer at the pile head. The testing shall provide information on the driving stresses, pile capacity, structural integrity and hammer efficiency.

2.2.3 The contractor shall engage an independent dynamic pile testing consultant and qualified personnel in accordance with section 1.5 of this special provision. Prior to testing, the engineer will review and approve the proposed independent dynamic pile testing consultant, the experience and qualifications of assigned personnel, details of the method of testing, a list of equipment, and the method of analysis of test results. The contractor shall provide all available details of the subsurface conditions, pile dimensions and properties, and pile driving systems to the independent dynamic pile testing consultant.

2.2.4 All field testing and measurements shall be made in the presence of the engineer.

2.3 Field Testing.

2.3.1 Equipment. Dynamic pile testing field measurements shall be carried out using approved equipment, software and recording equipment. The data collected at the end of initial driving and the beginning of restrike shall be analyzed using approved signal matching techniques and software.

2.3.2 Monitoring During Driving. During pile driving, piles shall be instrumented and monitored with testing equipment satisfying the requirements of section 1.3 of this special provision.

2.3.2.1 The contractor shall install two sets of strain transducers and accelerometers near the top of each pile to be tested and shall use a compatible measuring and recording system to record the data during driving.

2.3.2.2 The equipment required to be attached to the pile shall be appropriately positioned and fixed to the approval of the engineer.

2.3.2.3 The hammer and all site equipment used shall be capable of delivering an impact force sufficient to mobilize the specified pile capacity indicated in section 4.0 of this special provision without damaging the pile.

2.3.2.4 The testing equipment shall monitor pile stresses during driving to prevent pile damage and ensure pile integrity and capacity. If the testing equipment indicates overstressing or damage to the pile, the contractor shall immediately discontinue driving and notify the engineer.

2.3.2.5 If the testing equipment determines that pile stresses during driving exceed acceptable levels, a new pile driving system, modifications to existing system or new pile installation procedures shall be proposed by the contractor. Approval by the engineer of any proposed changes to the pile driving system or pile installation procedures will be based upon the results of additional wave equation analyses in accordance with section 2.1.2 of this special provision.

2.3.3 Preparation of the Pile Head. The preparation of the pile head for the application of dynamic test load shall involve, where appropriate, trimming the head, cleaning, and building up the pile using materials that shall, at the time of testing, safely withstand the impact stresses. The impact surface shall be flat and at right angles to the pile axis.

2.3.4 Dynamic Measurement and Analysis. Monitoring of pile driving shall begin when pile driving begins. The data shall be recorded and processed immediately in the field by the pile driving monitoring equipment and software. Unless monitoring indicates that additional driving will damage the pile, pile driving and monitoring shall continue until both the specified pile tip elevation and the specified pile capacity are reached. For each pile tested, pile driving analysis using signal matching techniques shall be performed for a selected blow at the end of driving to determine the relative capacities from end bearing and skin friction along the pile.

2.3.4.1 Restrike tests shall be performed at the frequency indicated in section 4.0 of this special provision. The time interval between end of initial driving and beginning of restrike shall be in accordance with section 4.0 of this special provision. During restrike, the pile shall be instrumented and monitored similar to during initial driving. For each restrike test, pile driving analysis using signal matching techniques shall be performed for a selected blow from the beginning of restrike to determine the relative capacities from end bearing and skin friction along the pile.

2.3.4.2 The restrike test shall be performed with a warmed-up hammer and shall consist of striking the pile for 20 blows or until the pile penetrates an additional 3 inches whichever occurs first unless testing equipment indicates overstressing or damage to the pile. If such overstressing or damage to the pile is indicated, the contractor shall immediately discontinue driving and notify the engineer. In the event initial restrike testing indicates a pile capacity below the specified capacity additional driving may be required as directed by the engineer.

2.3.4.3 The engineer may request use of pile driving monitoring equipment and software on additional piles if inconclusive results are obtained or unusual driving conditions are encountered.

2.3.4.4 Pile bearing capacity and integrity shall be evaluated based on the standard procedure used in practice.

2.3.4.5 Tabular records of the dynamic pile testing field measurements obtained at the end of initial driving and at the beginning of restrike shall be immediately provided to the engineer by the contractor.

2.3.5 Results.

2.3.5.1 Preliminary Reports. The contractor shall prepare a preliminary report for each pile tested for review by the engineer. Each report shall contain tabular as well as graphical presentation of the dynamic test results versus depth. Each report shall also indicate the pile driving criteria for the additional piles to be installed at the substructure unit of the pile tested. Each preliminary report shall include the following:

(a) The maximum force applied to the pile head.

(b) The maximum pile head velocity.

(c) The maximum energy imparted to the pile.

(d) The assumed soil damping factor and wave speed.
(e) Static capacity estimate.

(f) The maximum compressive and tensile forces in the pile.

(g) Pile integrity.

(h) Blows per inch.

(i) Stroke.

(j) Summary results of pile driving analysis from selected blow analyzed using signal matching techniques and software.

2.3.5.2 Summary Report. The contractor shall prepare a summary report of all piles tested for review by the engineer. The report shall include the results of hammer performance, pile driving stresses, and pile capacity during initial driving and restrike for all piles tested. The report shall also include the following:

(a) Date of testing and date of pile installation.

(b) Pile identification number and location.

(c) All information given in preliminary reports as follows:

(1) Length of pile below commencing surface.

(2) Total length of pile, including projection above commencing surface at time of test.

(3) Length of pile from instrumentation position to tip.

(d) Hammer type, drop and other relevant details.

(e) Blow selected for signal matching analysis.

(f) Maximum compressive and tensile stresses, stroke, and capacity versus penetration depth.

(g) Temporary compression.

(h) Pile integrity and location of damage, if any.

(i) Force/velocity versus time trace.

(j) Force/velocity match curve.

(k) Resistance distribution along the pile.

(l) Detailed graphical and tabular results from blow analyzed using signal matching techniques and software.

3.0 Schedule of Contract Submittals.

Item Number	Submittal Item	Type	Calendar Days	Event/Date	Liquidated Damages Apply
1	Proposed independent dynamic pile testing consultant, and a listing of assigned personnel and their experience and qualifications.	DOCS	45 Before	Start of pile driving monitoring	No
2	Details of the components, method of testing, pile driving equipment and materials to be used, and the results of wave equations analyses.	DOCS	15 Before	Start of pile driving monitoring	No
3	Two copies of each Preliminary Report as defined in section 2.3.5.1 of this special provision	DOCS	3 After	Completion of each field test	No
4	Four copies of the Summary Report as defined in section 2.3.5.2 of this special provision	DOCS	7 After	Completion of all field tests	No

4.0 High-Strain Dynamic Pile Testing Specification.

Item	Requirement
Wave Equation Analysis	Minimum of one and sufficient additional analyses as needed to define performance for all combinations of piles, driving systems and subsurface conditions anticipated.
Dynamic Testing Pile Capacity	Nominal Axial Pile Compressive Resistance or 2.25 times the Design Bearing shown on the plans or as required by engineer
End of Initial Driving Test Frequency	As shown in the contract plans
Restrike Test Frequency	As shown in the contract plans
Time Interval between End of Initial Driving and Restrike	Minimum of 7 days or as required by the engineer
Pile Driving Analyses using Signal Matching Techniques	For each End of Initial Driving Test and each Restrike Test

5.0 Method of Measurement. Dynamic pile testing and dynamic pile restrike testing will be measured per each.

6.0 Basis of Payment. Payment for the above described work, including all material, equipment, tools, labor and any other incidental work necessary to complete this item, will be considered completely covered by the contract unit price for Dynamic Pile Testing and Dynamic Pile Restrike Testing.

N. PIPE PILE SPACERS

1.0 Description. In lieu of using pipe pile spacers, the contractor will have the option to use pile jackets. This job special provision contains general requirements for furnishing and placing pile jackets on piles.

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

2.1 Pile Jackets.

2.1.1 The pile jacket material shall meet or exceed the following physical requirements:

Pile Jackets		
Property	**Specification**	**Requirement**
Specific Gravity	ASTM D 1505	0.906 g/cc
Tensile @ Yield	ASTM D 638	4,000 psi
Flexural Modulus	ASTM D 790	195,000 psi
Elongation @ Break	ASTM D 638	> 500%
Heat Deflection Temperature @ 66 psi	ASTM D 648	190°F
Impact Strength, Notched Izod @ 73°F	ASTM D 256	No Break ft-lb/in
Rockwell Hardness	ASTM D 785	75 R scale

3.0 Construction Requirements.

3.1 For pile jacket option, the contractor shall drive piles before construction of the mechanically stabilized earth (MSE) wall. Pile jackets shall be installed on each pile and placed in the zone between the bottom of the levelling pad and the bottom of beam cap. The pile jacket shall be installed and backfill and soil reinforcements shall be placed around the pile jacket per the pile jacket manufacturer's installation requirements and recommendations. The contractor shall adequately support the piling to ensure that proper pile alignment is maintained during wall construction. The contractor's plan for bracing the pile shall be submitted to the engineer for review. The contractor shall avoid any damage to pile jacket during MSE wall construction. For damaged pile jacket sections, the contractor shall follow manufacturer's recommendations for the proper methods of in-place repair.

4.0 Method of Measurement. The pipe pile spacer or pile jacket will be measured per each.

5.0 Basis of Payment. Payment for furnishing and installing pipe pile spacers or pile jackets complete in place including all equipment, labor, and any other incidental work necessary to complete this item will be considered completely covered by the contract unit price for Pipe Pile Spacers.

O. 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 to 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 @

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	C882/C928 [2]	24hrs.& min. 1500 psi @ 7 days	n/a	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.

P. 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 (semi annual), 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.

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 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 water storage (+0.15)	n/a

		In air storage (-0.15)	In air storage (-0.15)	
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

3.1.1 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 to the manufacturer's recommendations.

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.

Q. 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 was-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	**½" 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 = ¼" +/- 0.04")	ASTM D638
	Sampling Condition:	ASTM D618

Polyester Resin Binder		
Property	**Requirement**	**Test Method**
	18 hrs/77°F/50% + 5 hrs/158°F	
Tensile Strength	2,500 psi, minimum (Type I at 0.45"/min. Thickness = ¼" +/- 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 with an existing wearing surface, the wearing surface shall be removed prior to placing the polyester polymer concrete. If the existing deck is to be removed to a specified depth, then the surface shall be removed to the removal depth specified in the drawings. Any 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 4.1.2 of this specification.

4.1.2 Concrete Deck Repair. Polyester polymer concrete or rapid set concrete patching material may be substituted for Class B-2 concrete at locations of half-sole repairs. 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. Deck repairs using rapid set concrete patching material shall be placed following the procedures as shown in Section S of these Job Special Provisions. Monolithic repairs are permitted when half the diameter or less of the top bar is exposed.

4.1.3 Removing Contaminates. The textured 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 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.

4.1.4 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. Furnishing 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. Deductions will be made for:

- Material wasted.
- Excess material used when removal depth during existing wearing surface removal exceeds the specified removal depth.

10.1 Placing 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 Furnishing 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.

11.1 Payment for Placing 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.

R. SPECIAL CHANGE ORDER AND VALUE ENGINEERING CONSIDERATION

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) for Bridge No. A46574 and A46575.

Pay Item Number	Pay Item Description	Innovation
5029907	Furnishing Polyester Polymer Concrete Material	Wearing Surface & Maintenance
5059905	Placing Polyester Polymer Concrete Material	Wearing Surface & Maintenance

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 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 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 such item(s) from the contract ensuring that 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 MoDOT project manager.