TABLE OF CONTENTS

A. Construction Requirements
B. Dewatering
C. Removal of Existing Bearings
D. Rapid Set Concrete Patching Material – Horizontal Repairs
E. Rapid Set Concrete Patching Material – Vertical and Overhead Repairs
F. Deflection and Haunching
G. FRP Wrap for Concrete Beams
H. Shotcrete Concrete Repair
I. Powerwash and Remove Loose Concrete
J. Cleaning and Epoxy Coating
K. Steel Fiber Reinforced Concrete
L. Cleaning, Lubricating and Coating Existing Bearings
M. Epoxy Pressure Injecting
N. Surface Sealing Concrete

STATE OF MISSOURI ALEX BENZ NUMBER PE-2018003121 PROFESSIONAL ENGINEER Alex C. Benz 09/25/202612:48:33 PM Alex Benz - Civil MO PE-2018003121	**MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION** 105 W. CAPITOL AVE. JEFFERSON CITY, MO 65101 Phone (888) 275-6636
	EFK Moen 1355 N Highway Dr., Suite 200 St. Louis, MO 63026 Certificate of Authority # 001578 Consultant Phone # 314-394-3100
	If a seal is present on this sheet, JSP's has been electronically sealed and dated.
	JOB NO. J6I3572 St. Louis County, MO Date Prepared: 9/25/2026
Only the following items of the Job Special Provisions (Bridge) are authenticated by this seal: A-K	

STATE OF MISSOURI SHARON A.W. HOFFMANN NUMBER E-2001018753 REGISTERED PROFESSIONAL ENGINEER Sharon Hoffmann Digitally signed by Sharon Hoffmann DN: C=US, E=sharon.hoffmann@jacobs.com, O=Jacobs, CN=Sharon Hoffmann Date: 2026.09.25 13:15:40-05'00'	**MISSOURI HIGHWAYS AND TRANSPORTATION COMMISSION** 105 W. CAPITOL AVE. JEFFERSON CITY, MO 65101 Phone (888) 275-6636
	Jacobs Engineering Group 1001 Highlands Plaza Drive, Suite 400 St. Louis, MO 63110 Certificate of Authority # 00704 Consultant Phone # 314-335-4000
	If a seal is present on this sheet, JSP's has been electronically sealed and dated.
	JOB NO. J6I3572 St. Louis County, MO Date Prepared: 9/25/2026
Only the following items of the Job Special Provisions (Bridge) are authenticated by this seal: L-N	

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(s) for the existing 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 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.

2.3 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.

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

Bridge No.	Type of deck
A28074	Composite
A28093	Composite
A3176	Composite

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

2.6 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.

2.7 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.

2.8 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.

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

2.10 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.

2.11 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 Beams.

3.0 Coating Information.

3.1 Straps Removal. Exposed portions of straps for stay-in-place forms shall be removed prior to surface preparation. Straps need not be removed in areas that are not being painted. Flame cutting will not be permitted. The contractor shall exercise care not to damage the existing structure during removal. 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.

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

3.3 Existing Bridge Information. The informational plans may be used by bidders in determining the amount of steel to be cleaned and recoated or overcoated with the full understanding that the State accepts no responsibility for accuracy of the estimated tons of existing steel shown in the table below. The bidder's acceptance and use of the estimate shown below shall be no cause for claim for any final adjustment in the contract unit price for the work involved in repainting. Each bidder is expected to carefully examine the structure(s), investigate the condition of existing paint and prepare an estimate of quantities involved before submitting a bid. Surface preparation and application of field coatings to the structural steel shall be based on the contract plan quantities. No final measurements will be made.

Bridge No.	Estimated Tons			Existing Paint System	Lead Based?
	Coating System		Total		
	System G Recoat	System G Overcoat			
A28074	191	0	191	S over B	Yes
A28093	230	0	230	S over B	Yes
A3176	212	0	212	B	Yes

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

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

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

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

4.0 Method of Measurement. No measurement will be made.

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

B. DEWATERING

1.0 Description. This provision covers dewatering the site as necessary to provide a suitable condition for rehabilitation of the box culvert as approved by the engineer. This work will only be performed at the discretion of the engineer and will be underrun if not required by the engineer. If the engineer determines it necessary to provide dewatering, the work shall be performed in accordance with Sec 206 and this job special provision.

2.0 Construction Requirements. Dewatering shall provide a dry work area suitable to rehabilitate the box culvert within specifications, as approved by the engineer. Typical dewatering methods consist of, but are not limited to, construction of cofferdams, seal courses, over excavation, well point systems, dewatering and drainage diversion. Any dewatering method utilized shall conform to all environmental laws and regulations.

3.0 Method of Measurement. No measurement will be made.

4.0 Basis of Payment. Payment for dewatering will be made regardless of which dewatering means is utilized. No payment will be made if the work area is not maintained in a dewatered state as approved by the engineer. The lump sum payment for dewatering will be considered full compensation, and no time extensions will be made regardless of which means and methods are utilized by the contractor.

C. REMOVAL OF EXISTING BEARINGS

1.0 Description.

1.1 With the deck removed, this work shall consist of but is not limited to raising and supporting existing girders and/or beams at the locations specified on the plans, removing and disposing of

the existing bearings and anchor bolts and performing all other required preparations prior to installing new bearings and anchor bolts as shown on plans.

1.2 The responsibility for the design and construction of falsework required to support the girders and/or beams during bearing removal and new bearing installation shall rest solely with the contractor. The design shall ensure that the falsework can support all applicable dead loads and any construction loads. The design shall also provide an adequate factor of safety when selecting the temporary support members. The falsework design and working plans including detailed computations shall be signed, sealed and stamped by a registered professional engineer in the State of Missouri in accordance with Authentication of Certain Documents in Sec 107.

1.3 Existing girders and/or beams shall be subject to minimal construction loading by performing this work with the existing deck removed.

1.4 Existing bearing top plates shall be removed and girder and/or beam surfaces cleaned and coated before placement of new bearings. The removal of the existing bearing top plate and cleaning shall be completed in such a manner as to not cause any damage to the existing bottom flange. Method of removal shall be as approved by the engineer.

2.0 Construction Requirements and Materials.

2.1 Raising and Supporting the Superstructure.

2.1.1 Before beginning operations, the contractor shall submit to the engineer for review the method and sequence of operation proposed to be used in performing this work. With the deck removed, the contractor shall exercise caution when supporting the structural steel and shall raise the girders and/or beams the minimum extent necessary to perform this work with a maximum raise of 1/4 inch. Raising the girders and/or beams at the location of reset bearings shall be performed in a manner to prevent any damage to the adjoining steel. The lifting operation shall be performed only when authorized, but such authorization shall not relieve the contractor of responsibility for the safety of the operation or for damage to the structure. Any damage caused by the contractor's operations shall be repaired at the contractor's expense as approved by the engineer.

2.1.2 Temporary timber supports (bearing stiffeners) shall be placed between the girder and/or beam flanges at each jacking location to prevent flange rotation. Permanent steel stiffening angles shall be designed and attached to the beam web when the beam web thickness is not adequate to support the jacking load.

2.1.3 Raising the girders and/or beams shall be performed simultaneously and shall be performed in a manner to prevent any damage to the adjoining steel.

2.1.4 Existing end diaphragms at bent may require loosening or be completely removed in order to install new anchor bolts and bearings as authorized by the engineer.

2.1.5 Bolts of existing end diaphragms that must be loosened or removed shall be replaced with like size galvanized high strength bolts with washer under head and nut.

2.2 Bearing Removal.

2.2.1 After the structural members are supported, the contractor shall remove the existing bearings.

2.2.2 The contractor shall remove the existing anchor bolts to one inch below the concrete surface or to the extent needed for installation of the new anchor bolts as required by the plans and as authorized by the engineer. The resultant holes shall be filled with a qualified special mortar in accordance with Sec 704.

2.3 Cleaning and Painting. Faying surfaces where existing end diaphragms will be reconnected and inside of drilled holes and the bottom surface of existing flange which will become faying surfaces of new connections shall be cleaned and painted with one coat of gray epoxy-mastic primer (non-aluminum).

3.0 Method of Measurement. Final measurement for removal of the existing bearings and preparation for the installation of the new bearings will be made per each.

4.0 Basis of Payment. Payment for furnishing and placing all temporary falsework (including stiffeners), materials, removals, disposal of all falsework, labor, tools, equipment and all incidentals necessary to complete this item will be considered completely covered by the contract unit price for Removal of Existing Bearings.

D. RAPID SET CONCRETE PATCHING MATERIAL – HORIZONTAL REPAIRS

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

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

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

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

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

2.4 Qualification and Project Acceptance.

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

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

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

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

(a) Brand name of the product.

(b) Certification that the material meets this specification.

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

(d) Specific mixing, handling and curing instructions.

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

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

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

(a) New Products Evaluation Form

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

(c) Documentation prepared by MoDOT covering two years of field performance on MoDOT's system. MoDOT will need to approve the location of the test site. Documentation will contain the placement date, field observations (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.

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.

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 air storage (-0.15)	In water storage (+0.15) In air storage (-0.15)	n/a
Color		gray	gray	gray

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

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

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

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

4.0 Construction Requirements.

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

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

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

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

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

E. 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:

(e) 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.

(f) 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.

3.1.2 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
Bond Strength by Slant Shear	ASTM C882/C928 [2]	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days	n/a	min. 1000 psi @ 24hrs.& min. 1500 psi @ 7 days
Linear Coefficient of Thermal Expansion [1] (for bagged mortar only, without extension aggregate)	ASTM C531	n/a	n/a	4 – 8 X 10-6 in/in/deg F
Resistance to Rapid Freezing & Thawing	AASHTO T161 or ASTM C666	80% min. using Procedure B[3] (300 Cycles)	80% min. using Procedure B[3] (300 Cycles)	n/a
Compressive Strength	AASHTO T22 or ASTM C39	1500 psi @ 3 hr & 3000 psi @ 24 hr	1500 psi @ 3 hr & 3000 psi @ 24 hr	n/a
Rapid Chloride Permeability	AASHTO T277 or ASTM C1202	1000 coulombs @ 28 days	1000 coulombs @ 28 days	1000 coulombs @ 28 days
Length Change	AASHTO T 160 or ASTM C157	In water Storage (+0.15) In air storage (-0.15)	In water storage (+0.15) In air storage (-0.15)	n/a
Color		gray	gray	gray

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

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

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

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

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

4.0 Construction Requirements.

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

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

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

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

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

F. DEFLECTION AND HAUNCHING

1.0 Description. The contractor shall determine haunching based on field measurements, existing bridge plans and/or adjusted dead load deflections based on the difference between the new and existing dead load weights. A spreadsheet showing adjusted girder or beam deflections due to the weight of the new deck and barriers is included in the contract in the bridge electronic deliverables zip file.

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 girder or beam including centerline of roadway and along each girder or beam line (top or bottom flange) prior to deck removal followed by surveying elevations of the girders or 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.

G. FRP WRAP FOR CONCRETE BEAMS

1.0 Description. This work shall consist of designing, furnishing, and placing carbon or glass fiber reinforced polymer (FRP) composite wrap to shear strengthen the concrete beam at the locations shown on bridge plans 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.

2.3.3 Calculations.

2.3.3.1 Concrete Beam Shear Strengthening. Signed and sealed calculations with the shop drawings shall be submitted indicating that the proposed system provides the additional design forces required at the locations indicated on the plans. The fiber reinforced polymer wrapping shall be designed in accordance with NCHRP Report 678, Design of FRP System for Strengthening Concrete Girders in Shear.

3.0 Construction Requirements.

3.1 FRP Wrapping. FRP shear reinforcement shall be by complete wrapping except where objects interfere. In those places, U-wrap shall be used. FRP wrapping along the portion of the member length to be strengthened may be applied continuously or as discrete strips. The maximum gap between discrete strips shall be limited to d/4, where d equals distance from extreme compression fiber to centroid of the main moment tension reinforcement. Fibers in the FRP in its final position on the concrete component shall be oriented in the direction that maximizes the effectiveness of the FRP reinforcement. Anchorage shall be required for U-wrap, and overlap shall be required for complete wrap as per the manufacturer's recommendation. Additional horizontal strips of FRP shall not be used as anchorage for FRP shear reinforcement**.** The FRP shear strengthening may be installed during the process of forming the deck but shall be installed and cured before the deck is poured.

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. 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 and unformed), superstructure repair (unformed) and slab edge repair shall be in accordance with Sec 704 and as shown on the contract plans. Shotcrete, in accordance with this job special provision, shall be used for slab edge repair and may be used at the contractor's option for formed and unformed substructure and superstructure 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 then conveying the mixture through the hose pneumatically while 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 that 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 performed 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 one 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 the engineer to confirm satisfactory results.

3.0 Shotcrete Materials.

3.1 Shotcrete materials shall consist of one of the premixed and packaged materials in the qualified product listing shown on MoDOT's web site.

3.2 No material testing is anticipated. Acceptance will be based on the prequalified materials listed on the MoDOT web site, approval of the nozzleman prior to material placement, and visual inspection. If questions arise based on visual examination, placement methods, curing methods or other potentially undesirable influences, the engineer reserves the right to test any material properties listed on the published product data sheet for the material selected. Testing shall be performed 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 and unformed 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 shall not be permitted to begin formed or unformed 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 inches and at least 3 1/2 inches thick with 2-#4 bars placed in each direction. The #4 bars shall be centered in the 3 1/2 inch dimension and evenly spaced in each direction with the bars touching at the four 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 will not be 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 to not meet 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 overcoating 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 U.S., 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 favorable 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 one 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), Substructure Repair (Unformed), Superstructure Repair (Unformed) and Slab Edge Repair shall be in accordance with Sec 704.

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

I. POWERWASH AND REMOVE LOOSE CONCRETE

1.0 Description. This work shall consist of powerwashing and removing the top of the bottom slab to the depth shown on the plans and as directed by the engineer.

2.0 Construction Requirements. The concrete shall be uniformly removed to the depth as shown on the plans. Excessive removal of the slab shall require immediate correction. The removal process shall produce a very rough texture that is acceptable to the engineer as a bondable surface for the new concrete wearing surface. The removal process shall not produce a polished or slick surface. Any epoxy patches encountered shall be completely removed to sound, natural concrete.

3.0 Method of Measurement. Final measurement will be to the nearest square foot based on measurement longitudinally along the length of the culvert and transversely from the face of the culvert walls.

4.0 Basis of Payment. Payment for Powerwash and Remove Loose Concrete includes all material, equipment, labor and other incidentals necessary to complete this work.

J. CLEAING AND EPOXY COATING

1.0 Description. All loose and delaminated concrete shall be removed, and a protective epoxy coating shall be applied to the concrete in the area as shown in the bridge plans and per this job special provision.

2.0 Construction Requirements. Cleaning shall include removal of all loose and delaminated concrete with hand tools to the satisfaction of the engineer. Hand tools may include chipping chisels, wire brushes, dust brushes, etc. After cleaning, an epoxy coating meeting the requirements of Sec 1059.20 shall be applied in accordance with Sec 711.3.2 and the manufacturer's recommendations.

3.0 Method of Measurement. No measurement will be made for cleaning and epoxy coating except for authorized changes during construction or where appreciable errors are found in the plan quantity. When required, measurement will be made to the nearest square foot.

4.0 Basis of Payment. Payment for Cleaning and Epoxy Coating includes all material, equipment, labor and any other incidentals necessary to complete this work.

K. STEEL FIBER REINFORCED CONCRETE

1.0 Description. Steel Fiber Reinforced Concrete (SFRC) is a specially designed concrete that is highly flowable and requires limited mechanical vibration for consolidation. All material, proportioning, mixing and transporting of concrete shall be in accordance with Sec 501, except as specified herein.

2.0 Materials. All material shall be in accordance with Division 1000, Material Details, except as noted herein.

2.1 Aggregate. Fine and coarse aggregate shall be in accordance with Sec 1005, except that the requirements for gradation will not apply.

2.1.1 Gradation. The contractor shall submit the target gradation and allowable gradation range of each fraction of each aggregate source used in the mix design. During production, the contractor shall be within the allowable gradation range for each aggregate that was submitted.

2.1.2 Maximum Coarse Aggregate Size. Requirement for coarse aggregate passing ½ -inch sieve shall be 100 percent.

2.1.3 Fine Aggregate Content. Fine aggregate content shall be 50 to 55 percent by volume of total aggregate content.

2.2 Admixture. All chemical admixtures shall be in accordance with Sec 1054, except as noted herein.

2.2.1 High Range Water Reducer. A polycarboxylate based high range water reducer (HRWR) shall be in accordance with ASTM C 494, Type F or G. The high range water reducer should enable fluidity retention for at least 1 hour.

2.2.2 Viscosity-Modifying Admixture. The viscosity-modifying admixture (VMA) shall be evaluated according to the test methods and mix design proportions referenced in ASTM C 494. The admixture is required to ensure high stability of the SFRC.

2.2.3 Air Entraining Admixture. An air entraining admixture (AEA) is required to ensure proper frost durability of the concrete and comply with AASHTO M 154.

2.2.4 Combination. The SFRC system shall consist of either a polycarboxylate based high range water-reducing admixture or a polycarboxylate based high range water reducer combined with a separate viscosity-modifying admixture.

2.3 Macro and Micro Steel Fibers. A combination of macro and micro steel fibers incorporated at ratio of 80% to 20% will be used with SFRC. Two types of steel fibers shall be incorporated. Both shall be made from low carbon steel with lengths 1.18 inches (30 mm) and 0.5 inches (13 mm) and shall meet the physical property requirements prescribed in ASTM A820. The long fibers (Macro) shall have an aspect ratio of 80, while the short ones (Micro) shall have an aspect ratio of 65. The long fibers will be hooked at both ends, and the short fibers shall be straight. The fibers shall be free from rust, oil and other deleterious materials. Steel fibers shall be transported, stored and incorporated into the concrete mixture in accordance with the manufacturer's recommendations.

2.3.1 On-site Assistance. The contractor shall provide initial on-site technical assistance from the supplier of the steel fiber reinforcement. Further technical assistance shall be available at the request of the Engineer.

2.3.2 Dosage. The steel fiber dosage rate shall be 67 pounds per cubic yard of concrete (54 and 13 pounds per cubic yard for the long and short fibers, respectively). The material shall have a maximum fiber content of 1% by volume. The contractor shall provide signed and sealed calculations, by a registered engineer in the state of Missouri, which verifies the proposed steel fiber dosage rate.

3.0 Concrete Mix Design. At least 120 days prior to using SFRC, the contractor shall submit a mix design for approval to Construction and Materials. The SFRC mix shall be designed by absolute volume methods or an optimized mix design method such as Shilstone or other recognized optimization method.

3.1 Required Information. The mix design shall contain the following information:

(a) Source, type and specific gravity of Portland cement

(b) Source, type (class, grade, etc.) and specific gravity of supplementary materials (fly ash)

(c) Source, name, type and amount of admixtures, including expansive agent

(d) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregate

(e) Specific gravity and absorption of each fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including raw data

(f) Source, name, type and amount of steel fibers

(g) Unit weight of each fraction in accordance with AASHTO T 19

(h) The design air content and target slump flow (also referred to as slump spread)

(i) Batch weights of Portland cement and supplemental cementitious materials

(j) Batch weights of coarse, intermediate and fine aggregates

(k) Batch weight of water

(l) Compressive strength at 1 day, 3 days, 28 days, and 56 days

3.2 Supplementary Cementitious Materials. The SFRC mixture shall use Class C fly ash between 15 to 30% by mass of total cementitious materials (Portland cement and fly ash).

3.3 Expansive agent (EA). A Calcium Oxide (CaO) based expansive agent (G-Type) shall be incorporated at a dosage of 5% by mass of the total binder mass.

3.3 Water Amount. The maximum water-to-cementitious ratio (w/cm) shall be 0.42. Water included in the chemical admixtures shall be considered as part of the total water.

3.4 Minimum Cementitious Materials Amount. The total amount of cementitious materials (Portand cement and fly ash) shall not be below 615 pounds per cubic yard.

3.5 Slump Flow. The slump flow (or slump spread) test shall be performed in accordance with ASTM C 1611. The slump flow shall meet the following requirements:

Slump Flow (inches)	
Minimum	**Maximum**
20	23

The loss of slump flow after one hour of concrete subjected to agitation shall not exceed 3 inches. The T40 time (time to reach 40 cm or 16 inches spread) shall be 1.5 $\pm$ 0.5 seconds.

3.6 Passing Ability. The passing ability of SFRC shall be evaluated using the modified J-Ring test method. The modified J-Ring test consists of a ring with eight equally spaced bars instead of the 16 bars used in the standard test (ASTM C 1621). . The difference between the slump flow spread and the modified J-Ring spread shall be limited to 1 inch over a test period of one hour for concrete sample subjected to agitation.

3.8 Segregation Resistance. Resistance to segregation shall be performed in accordance with ASTM C 1611. The test value shall be zero (no signs of bleeding or segregation).

3.9 Air Content. The targeted air content should be 7% ± 1%.

3.10 Compressive Strength. Compressive strength shall be performed in accordance with AASHTO T 22. Concrete shall have a 28-day minimum compressive strength as shown on the final bridge plans.

4.0 Batching Sequence Plan. The contractor shall submit a Batching Sequence Plan outlining how the SFRC mix will be batched and mixed. The Batching Sequence Plan shall be submitted to the Engineer for approval.

5.0 Trial Batch. A trial batch shall be done at least 90 days prior to SFRC being used to ensure the mix is in accordance with this special provision. The SFRC mix design shall not be used until all the specified criteria have been met. The trial batch shall be at least 3 cubic yards. MoDOT Field Materials Engineer shall be present during the trial batch. The SFRC mixture shall be tested for air content, slump flow, T40, visual stability index, passing ability, compressive and flexural strengths. The retention of fresh properties will be evaluated for a period of 90 minutes.

6.0 Production. SFRC mix shall not be used until the concrete mix, the Batching Sequence Plan, and the Trial Batch have been approved. The SFRC mix shall not vary from the mix design submitted for approval. Any changes in material sources, aggregate gradations, or material content shall require a new SFRC mix be resubmitted for approval. Changes to the water content and chemical admixture dosages will be allowed by MoDOT Field Materials Engineer to handle changes in environmental conditions.

6.1 Forms. SFRC mixes generate higher fluid pressures than conventional concrete mixes. Forms shall be mortar-tight and capable of supporting the additional pressure.

6.2 Reinforcement. Reinforcement and other critical components shall be tightly secured in the form to prevent these items from shifting during concrete placement.

7.0 Quality Control. Because the quality of freshly mixed SFRC may fluctuate at the beginning of daily production, the contractor shall conduct air test, slump flow, visual stability index, and passing ability for every truck until consistent and compliant results are obtained. Subsequently, all testing shall be conducted in accordance with MoDOT specifications.

7.1 Slump Flow Requirement. During production, the target slump flow shall be 21.5 inches and shall be within ± 1.5 inch of the target slump at the location of casting.

8.0 Placement Plan.

8.1 At least eight weeks prior to the first placement of the reinforced concrete slab on the project, a pre-placement conference shall be held with the Contractor, the steel fiber supplier, the Engineer and other parties involved with the reinforced concrete slab on the project. The Contractor shall present the plan for furnishing, placing, sampling and testing of the reinforced concrete slab in accordance with the requirements of this Special Provision.

8.2 Placement of reinforced concrete for the link slabs shall not be allowed until the Engineer approves the Contractor's plan,. Mixing, pumping, placing and finishing techniques should ensure uniform fiber distribution throughout the mixture without fiber balling or segregation. After approval, the placement plan shall not be changed unless approved in writing by the Engineer.

9.0 Construction Requirements.

9.1 Pumping. Pumping shall generally be in accordance with Sec 703. Unless otherwise approved by the Engineer, the following practices shall be observed:

(a) Avoid rapid reduction in line size from the pump to the lines.

(b) Operating pressure inside the line should be kept as low as functionally possible.

(c) Use 5 inch (minimum) diameter clean, steel lines.

9.2 The curing and sealing of the concrete on the existing bridge slab shall be in accordance with Sec 703.3.6.

9.3 SFRC requires limited vibration to ensure proper filling of the formwork. Over vibrating of SFRC can lead to segregation.

9.4 SFRC needs proper surface finishing in accordance with MoDOT requirements. Surface of SFRC should be roughly leveled to the specified dimensions, and the final finishing applied as necessary before the concrete hardens.

10.0 Basis of Payment. Payment for the above described work, including all material, equipment and labor necessary to complete this work, will be completely covered by the contract unit bid price for Steel Fiber Reinforced Concrete.

L. CLEANING, LUBRICATING AND COATING EXISTING BEARINGS

1.0 Description. This work shall consist of raising and supporting the existing girders as required to inspect, clean, lubricate and coat existing bearings as specified on the plans and as directed by the engineer.

2.0 Construction Requirements.

2.1 Raising and Supporting the Superstructure. Before commencing operations, the contractor shall submit to the engineer for review the method and sequence of operation proposed to be used in performing this work. The contractor shall exercise caution when supporting the structural steel and shall raise the girders the minimum extent necessary to perform this work. Raising the girders at the bents and piers shall be done simultaneously to prevent any damage to the adjoining steel and concrete deck. The lifting operation shall be done only when authorized, but such authorization shall not relieve the contractor of responsibility for the safety of the operation or for damage to the structure. Any damage caused by the contractor's operations shall be repaired at the contractor's expense as approved by the engineer.

2.2 Bearing Inspection and Repair. After the structural members are supported, each bearing shall be inspected for deterioration. Any or all portions of the deteriorated bearings shall be replaced as determined by the engineer. When required to remove a bearing, removal of the bearing shall cause no damage to the existing anchor bolts in the concrete beam. Prior to removal or disassembly, all bearings shall be match marked for reassembly at ends of each piece by stamping an identification number in the metal with a steel stencil. All existing bearing material determined to be replaced shall be disposed of by the contractor in accordance with Sec 202.

2.3 Cleaning, Lubricating and Coating. Bearings shall be cleaned in accordance with Sec 1081. After cleaning and just prior to resetting the bearings, contact surfaces between the bearing pin and cradle shall be given a heavy coat of a graphite grease with a minimum of twenty percent graphite. After bearings are reset, the bearings shall receive a final cleaning and a prime coat. The final coat shall be applied when the existing structural steel is coated. Coating of bearings shall be as indicated for coating existing steel as specified in the contract documents.

3.0 Method of Measurement. Measurement for cleaning, lubricating and coating existing bearings will be made per each.

4.0 Basis of Payment. When required, payment for furnishing any new bearing material will be in accordance with Sec 109. 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 “Cleaning, Lubricating and Coating Bearing”.

M. 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”.

N. SURFACE SEALING CONCRETE

1.0 Description. This provision allows surface sealing concrete to be applied as last order of work.

2.0 Construction Requirements. The surface of the new concrete shall be surface sealed in accordance with Sec 703.3.8 except that lanes may be opened to traffic after the concrete has properly cured in accordance with Sec 703 and the sealant applied as a last order of work. Any lanes open to traffic prior to surface sealing shall have foreign materials removed. Surfaces that are sealed after each stage of construction shall have all vertical construction joints between stages protected from the surface sealant. If asphalt roadway surface is adjacent to the new concrete, the asphalt surface shall be protected from spillage of the sealant.

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.