SHOTCRETE CONCRETE REPAIR 8/28/25

**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 fullyexperienced 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.