SHOTCRETE REPAIRS (8-13-04)

1.0 SCOPE OF WORK

This work consists of completely removing deteriorated and disintegrated concrete from substructure bent caps, columns, and struts in reasonably close conformity with the lines, depth and details shown on the plans, described herein and as established by the Engineer. This work also includes cleaning reinforcing steel, removing all loose materials, removing and disposing of debris, and applying shotcrete.

The location and extent of repairs shown on the plans described herein are general in nature. The Engineer determines the exact extent of removal in the field based on an evaluation of the condition of the exposed surfaces.

Repair, to the Engineer's satisfaction, any portion of the structure that is damaged from construction operations. No extra payment is provided for these repairs.

Prior to beginning any repair work, provide a sufficiently sized temporary work platform at each repair location as required. Design steel members meeting the requirements of the American Institute of Steel Construction Manual. Design timber members in accordance with the "National Design Specification for Stress-Grade Lumber and Its Fastenings" of the National Forest Products Association. Submit the platform structure design for review and approval. Do not install the platform until the design is approved. Do not drill holes into the superstructure. When the platform is removed, remove all anchorages made in the substructure and repair the substructure at no additional cost to the Department.

2.0 SHOTCRETE

A. Qualification of Shotcrete Contractor

Shotcrete Contractors are not acceptable as a Prime Contractor or Subcontractor unless all of following requirements are met.

1. The Shotcrete Contractor furnishes proof that his or her company has a minimum of 5 years experience in shotcrete repair work on jobs of similar size and character.

2. The Shotcrete Contractor furnishes five references who were responsible for supervision of similar projects and testifies to the successful completion of these projects. Include name, address, and telephone number.

3. Prior to starting work, the Contractor's nozzlemen are required to pass a test demonstrating their competence. This test is conducted at the job site and approximates actual working conditions as near as possible. For test requirements, see ACI 506.3R, Chapters 2.5 and 3. Only workmanship demonstration is tested.

B. General

When shotcreting, meet all requirements of ACI 506.2, published by the American Concrete Institute, Detroit, Michigan, except as modified by the requirements of this Special Provision.

C. Material

Use materials conforming to the requirements of the applicable sections of the Standard Specifications and the following provisions:

1. Use Type II Cement.

2. Replace ten percent by weight of the cement with silica fume.

3. Do not use admixtures without approval.

4. Produce shotcrete cores with a compressive strength of 5000 psi (34.5 MPa) at 28 days. The provisions of ACI 506.2, Section 1.6.3.3, Paragraph 2, do not apply.

5. Submit the shotcrete mix design, including the source of the material, to the Engineer for acceptance before using it.

6. Use size 2S or 2MS fine aggregate unless otherwise approved.

D. Finish

Slightly build up and trim the shotcrete surface to the final surface by cutting with the leading edge of a sharp trowel. Use a rubber float to float any imperfections. Limit work on the finished surface to correcting imperfections caused by trowel cutting.

E. Testing

Each day shotcreting takes place, have each nozzleman shoot one 18" x 18" x 3" (460 mm x 460 mm x 75 mm) Test Panel. Shoot the panel in the same position as the repair work that is being done. The panel demonstrates whether the shotcrete is being properly applied and furnishes cores for testing compressive strength. Drill three 3" (76 mm) diameter cores from each test panel and also drill cores from the repair substructure units as directed by the Engineer. Do not take cores from repaired substructure units until the shotcrete has cured for 7 days. Drill a core that penetrates into the existing substructure concrete at least 2 inches (50 mm). These cores are inspected for delaminations and sand pockets and tested for bond strength and/or compressive strength. If a core taken from a repaired substructure unit indicates unsatisfactory application or performance of the shotcrete, take additional cores from the applicable substructure unit(s) for additional evaluation and testing as directed by the Engineer. No extra payment is provided for drilling extra cores. Patch all core holes in the repaired substructure units to the satisfaction of the Engineer. All material,

sample, and core testing is done by the Materials and Tests Unit of North Carolina Department of Transportation.

F. Mixture

Mix the shotcrete in the proportions of one part of portland cement to four parts of sand.

Measure this mixture by volume in the dry loose state. Check batching equipment daily or at the discretion of the Engineer.

G. Repair Method and Operations

Prior to starting the repair operation, delineate all surfaces and areas assumed to be deteriorated by visually examining and by sounding the concrete surface with a hammer or any other alternative approved method. The Engineer is the sole judge in determining the limits of deterioration.

Remove all deteriorated concrete to sound concrete with a 17 lb (7.7 kg) (maximum) pneumatic hammer with points that do not exceed the width of the shank or with hand picks or chisels as directed by the Engineer. Do not cut or remove the existing reinforcing steel. Do not remove more existing concrete than required to expose the surface of the sound concrete. Unless specifically directed by the Engineer, do not remove concrete deeper than 6 inches (150 mm) or deeper than 1 inch (25 mm) below the reinforcing steel.

If sound concrete is encountered before existing reinforcing steel is exposed, prepare and repair the surface without removing any more concrete. However, if the reinforcing steel is wholly or partially exposed, remove the deteriorated and/or sound concrete to a minimum clearance of 1 inch (25 mm) all around the reinforcing steel.

Sandblast all exposed concrete surfaces and existing reinforcing steel in repair areas to remove all debris, loose concrete, loose mortar, rust, scale, etc. Use a wire brush to clean all exposed reinforcing steel surfaces facing away from the sandblast nozzle to remove all dust and loose particles.

All material removed becomes the Contractor's. Use an approved method to dispose of the material.

Restore all repaired members, including chamfered edges, as close as practicable to their original "As Built" dimensions and configuration. Provide a minimum of 2" (50 mm) shotcrete cover over reinforcing steel exposed during repair. Finish the shotcrete by cutting the surface to final grade with the leading edge of a trowel.

Provide welded wire fabric at each repair area larger than 1 ft^2 (0.1 m^2) if the depth of the repair exceeds 2 inches (50 mm) from the "As Built" outside face. Provide a minimum 2" x 2" (50 mm x 50 mm) - 12 gage galvanized welded wire fabric. Rigidly secure the welded wire fabric to existing steel or to 3/16" (4.76 mm) minimum diameter

adequately spaced galvanized hook fasteners to prevent sagging. Encase the welded wire fabric in shotcrete to a minimum depth of 1½ inches (38 mm).

If preferred, use steel or synthetic fiber reinforcement as an alternate to welded wire fabric.

Work only with experienced personnel. Always work under the direction of an experienced superintendent. The superintendent is required to show a certified experience record indicating at least 5 years experience on work of similar type. No nozzleman is deemed experienced unless they have worked on several other jobs similar to that specified herein and have passed the required pre-qualification test listed in this Special Provision.

Before applying the shotcrete to the surface, thoroughly clean the surface of all dirt, grease, oil or foreign matter, and remove all loose or weakened material.

Wash the roughened existing concrete surface with fresh potable water and an air blast, or with a "stiff" hose stream of fresh water until all loosened materials and salt water spray are removed. Perform this operation 30 minutes to 1 hour prior to applying the shotcrete.

Maximum time allowed between removal of deteriorated concrete and shotcrete application is 5 days. If the time allowance is exceeded it will be necessary to prepare the surface again using the methods described above before shotcrete can be applied.

Apply shotcrete in layers. The properties of the applied shotcrete determine the proper thickness of each layer or lift.

If a work stoppage longer than 2 hours takes place on any shotcrete layer prior to the time it has been built up to required thickness, thoroughly wash the surface with a fresh water stream and air hose as outlined previously, prior to continuing with the remaining shotcrete course. Do not apply shotcrete to a dry surface.

Have the nozzleman hold the nozzle 3 – 4 feet (0.9 to 1.2 m) from the surface being covered in a position that ensures the stream of flowing material strikes at approximately right angles to the surface being covered without excessive impact. Have the nozzleman control the water content so it never exceeds 3½ gallons (13.25 liters) per sack of cement. Direct the nozzlemen to maintain the water at a practicable minimum, dependent on weather conditions, so that the mix properly adheres. Control water content so that it does not become high enough to cause the mix to sag or fall from vertical or inclined surfaces, or to separate in horizontal layers.

Use shooting strips or guide wires that do not entrap rebound sand to bring the finished work to approximate shape. Use guide wires to provide a positive means of checking the total thickness of the shotcrete applied. Remove the guide wires prior to the final finish coat.

Blow or rake off sand that rebounds and does not fall clear of the work, or which collects in pockets in the work, to avoid leaving sand pockets in the shotcrete. Do not reuse rebound material in the work.

Apply shotcrete only when the air temperature is at least 40°F (4°C) and rising, but less than 95°F (35°C). Do not apply shotcrete to frosted surfaces. Maintain shotcrete at a minimum temperature of 40°F (4°C) for 3 days.

H. Testing Shotcrete Surfaces

Immediately after bringing shotcrete surfaces to final thickness, thoroughly check them for sags, bridging, and other deficiencies. Approximately 3 days after completing the final shotcrete placement, thoroughly test it again with a hammer. At this time, the shotcrete should have sufficient strength for all sound sections to ring sharply. Remove and replace any unsound portions of the work found during this 3 day old inspection period, or at any other time prior to the final inspection of the work. No additional compensation is provided for removal and replacement of concrete during or after the 3 day old inspection.

I. Curing

Begin curing as soon as the finished shotcrete surface withstands the curing operation without damage in accordance with Section 3.7 of ACI 506.2.

3.0 METHOD OF MEASUREMENT

Substructure shotcrete repair work will be measured in cubic feet (cubic meters) of the shotcrete applied. Depth will be measured from a place at the original outside concrete face. The Contractor and Engineer will measure repair quantities after removal of unsound concrete and before application of shotcrete. Cores included in the item "Shotcrete Core Samples" are those taken from substructure units after shotcrete repairs. Cores taken from the required test panels are not included in "Shotcrete Core Samples".

4.0 BASIS OF PAYMENT

Concrete repair work will be paid for at the contract unit price bid per cubic foot (cubic meter) for "Shotcrete Repairs" which payment will be full compensation for removal, containment and disposal off-site of unsound concrete including the cost of materials, labor, tools, equipment and incidentals necessary to accomplish removal. Such payment will also include the cost of sandblasting, surface cleaning and preparation, cleaning of reinforcing steel, cost of temporary work platform, testing of the soundness of the exposed concrete surface, furnishing and installation of welded wire fabric or fibers, shotcrete material, application of shotcrete, curing of shotcrete and sampling of concrete, drilling of cores from the test panels, except the drilling of cores from the repaired substructure will be paid for as "Shotcrete Core Samples" at the unit price each.