Specifications for the Rehabilitation of Corrugated Metal Pipe using Shotcrete

I. Scope

A. The work covered by these specifications consists of furnishing all labor, equipment, appliances and materials, and performing all operations in connection with the rehabilitation of corrugated metal pipe with shotcrete, complete in drawings and subject to the terms and conditions of the contract.

B. Shotcreting shall conform to all requirements of "Guide to Shotcrete", published by the American Concrete Institute, Detroit, Michigan, except as modified by these specifications.

C. Reinforcement shall be incorporated in the shotcrete as required and shall be furnished and placed in accordance with the provisions of these specifications.

D. The purpose of this specification is to obtain a dense and durable concrete having the specified strength.

II. Composition

A. Shotcrete shall be composed of Portland cement, aggregate and water so proportioned as to produce a concrete suitable for pneumatic application.

III. Strength Requirements

A. Shotcrete shall be supplied by Ready Mix supplier. The shotcrete shall be extremely strong, dense and resistant to weathering and abrasion. Shotcrete shall have minimum 28-day strength of 4,000 psi.

IV. Materials

A. Portland Cement

1. Cement shall be Type I/II Portland Cement conforming to all of the requirements of the American Society for Testing Materials Standard Specifications, latest serial designation C-150.

B. Fine Aggregate

1. Fine aggregate shall be natural, siliceous sand consisting of hard, clean, strong, durable and uncoated particles, conforming to the requirements of American Society for Testing Materials Standard Specifications, Latest Serial Designation C-33 for Concrete Aggregates.

2. Fine aggregate shall not contain less than three percent or more than six percent of moisture.

3. Fine aggregate shall be evenly graded from fine to coarse and shall be within the following limits:

Passing No.	3/8 Sieve	100%
Passing No.	4 Sieve	95% to 100%
Passing No.	8 Sieve	80% to 100%
Passing No.	16 Sieve	50% to 85%
Passing No.	30 Sieve	25% to 60%
Passing No.	50 Sieve	10% to 30%
Passing No.	100 Sieve	2% to 10%

C. Water

1. Water used in mixing shall be fresh, clean, and free from injurious amounts of oil, acid, alkali, vegetable, sewage, and/or organic matter.

D. Reinforcement

1. Reinforcement bars shall conform to the latest requirements of ASTM Standard Specifications, Serial Designation A-615 for Deformed Billet Steel Bars for Concrete Reinforcement. Unless shown otherwise on the plans, all bars shall be Grade 40.

2. Steel mesh reinforcement shall be electrically welded, cold drawn, mild steel fabric conforming to the latest requirements of ASTM Standard Specifications, Serial Designation A-185 for Welded Steel Wire Fabric for Concrete Reinforcement. Mesh can be fabricated from cold-drawn steel wire conforming to the requirements of the latest ASTM Standard Specifications, Serial Designation A-82. Unless otherwise shown on the plans, mesh shall be 2 x 2 - W0.9 x W0.9 (2 x 2 - 12/12) galvanized welded wire fabric.

3. Polypropylene fibers shall be used as indicated on the drawings in lieu of wire mesh. Use only 100 percent virgin polypropylene fibers containing no

reprocessed olefin materials. Fiber manufacturer must document evidence of 5-year satisfactory performance history: ASTM C-1116 (Ref.: ASTM C-1018).

V. Sampling and Testing Cement and Aggregate

A. Where reputable cement and aggregate suppliers maintain regular recognized testing services, certified copies of such tests would be accepted by the Owner. However, in any case of doubt as to the accuracy and/or adequacy of such tests, the Owner may require that cement and aggregates be tested by a recognized commercial testing laboratory that has been selected by the Contractor and approved by the Owner. The testing laboratory shall also certify that the materials covered by the report comply in all respects with these specifications.

B. Shotcrete is supplied by local Ready Mix suppliers and pumped via contractor's equipment. The Shotcrete is typically an existing mix developed by the Ready Mix supplier based on standard raw materials (aggregate, sand, and cement).

C. Cylinders shall be taken during the pour from the Ready Mix truck shoot. Slump can also be tested for consistency. Cylinders, typically 4"x8", shall be cast and tested at 7 and 28 day intervals.

VI. Surface Preparation

A. All areas to receive pneumatic concrete shall be cleaned by flushing or scouring with water and compressed air jets to assure the removal of all loose particles.

B. To insure, the newly prepared surface shall be thoroughly moistened with water prior to application of shotcrete. In no instance shall shotcrete be applied in an area where free running water exists.

VII. Application

A. Shotcrete shall not be placed on a frozen surface or during freezing weather, unless means are used to elevate the area temperature, which is acceptable. Shotcrete shall not be placed when anticipated the temperature during the following 24 hours will drop below 32 degrees Fahrenheit, unless temperature is maintained.

B. Sequence of application may be from bottom to top or vice versa if rebound is properly removed.

C. Voids shall be filled first. "Shooting" shall be from an angle as near perpendicular to the surface as practicable, with the nozzle held approximately 3 feet from the work (except in confined space). If the flow of material at the nozzle is not uniform and slugs, sand spots, or wet sloughs result, the nozzleman shall direct the nozzle away from the work until the faulty conditions are corrected. Such defects shall be replaced as the work progresses.

D. Shotcreting shall be suspended if:

1. Air velocity separates the paste from the aggregate at the nozzle.

2. Temperature approaches freezing and the newly placed shotcrete cannot be protected.

E. Shotcrete can be applied in one or more layers to such total thickness as required restoring the area as detailed over the original lines of the adjoining surface, unless otherwise specified. All cavities, depressions, washouts and similar failures shall be rebuilt to original lines by use of shotcrete reinforced with wire mesh. Where the cavity exceeds four inches in depth, a layer of mesh shall be used for each four inches of depth of shotcrete. However, in no case shall wire mesh be placed behind existing reinforcement.

F. The time interval between successive layers in sloping vertical or overhanging work must be sufficient to allow initial, but not final, set to develop. At the time the initial set is developing, the surface shall be cleaned to remove the thin film of laitance in order to provide a perfect bond with succeeding applications.

VIII. Construction Joints

A. Construction joints or day's work joints shall be sloped off to a thin, clean, regular edge preferably at a 45-degree slope. Before placing the adjoining work, the slope portion of adjacent shotcrete shall be thoroughly cleaned as necessary, then moistened and scoured with an air jet.

IX. Surface Finish

A. Nozzleman shall bring the shotcrete to an even plane and to well-formed corners be working up to ground wires or other guides, using somewhat lower placing velocity than normal.

B. After the body coat has been placed, the surface shall be trued with a thin-edge screed to remove high areas and expose low areas. Low areas shall be properly filled with concrete to insure a true flat surface.

C. After the concrete surface has been brought to specified depth, the surface finish shall be either a 'broom' or 'float' finish - unless a special type finish is specified per the drawings.

X. Curing

A. Curing shall be in accordance with paragraph 8.7 ACI - 506-R, depending upon atmospheric condition.

B. Keep water off of shotcrete until shotcrete sets – typically 12 hours.

C. If water velocity is too great, extend introducing flow onto the shotcrete until final set is obtained.