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SECTION 03307

CONCRETE FOR MINOR STRUCTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 308	(1992) Standard Practice for Curing Concrete
ACI 318/318R	(1992) Building Code Requirements for Reinforced Concrete
ACI 318M/318RM	(1992) Building Code Requirements for Reinforced Concrete (Metric)
ACI 347R	(1994) Formwork for Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 185	(1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
ASTM A 615/A 615M	(1995a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31	(1991) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1993) Concrete Aggregate
ASTM C 39	(1993) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94	(1994) Ready-Mixed Concrete
ASTM C 143	(1990a) Slump of Hydraulic Cement Concrete
ASTM C 150	(1995) Portland Cement
ASTM C 171	(1992) Sheet Materials for Curing Concrete
ASTM C 172	(1990) Sampling Freshly Mixed Concrete
ASTM C 231	(1991b) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1994) Air-Entraining Admixtures for Concrete

ASTM C 309	(1994) Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 494	(1992) Chemical Admixtures for Concrete
ASTM C 595	(1994a) Blended Hydraulic Cements
ASTM C 595M	(1995) Blended Hydraulic Cements (Metric)
ASTM C 618	(1994a) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 685	(1994) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 920	(1994) Elastomeric Joint Sealants
ASTM D 75	(1987; R 1992) Sampling Aggregates
ASTM D 98	(1993) Calcium Chloride
ASTM D 1752	(1984; R 1992) Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM E 96	(1995) Water Vapor Transmission of Materials

CORPS OF ENGINEERS (COE)

COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 572	(1974) Corps of Engineers Specifications for Polyvinylchloride Waterstop
COE CRD-C 506	(1972) Sealing Compound: Elastomeric Type, Multi-Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures)

1.2 UNIT PRICES

1.2.1 Concrete

1.2.1.1 Payment

All costs associated with manufacturing, furnishing, delivering, placing, finishing, and curing of concrete for the various items of the schedule, which price shall include the cost of all formwork. Payment for concrete for which payment is made as a lump sum is not to be included in this unit price payment item. Payment for grout, preformed expansion joints, field-molded sealants, waterstops, reinforcing steel bars or wire reinforcement is to be included in this unit price payment item.

1.2.1.2 Measurement

Concrete will be measured for payment on the basis of the actual volume of concrete within the pay lines of the structures as indicated. Measurement of concrete placed against the sides of any excavation without the use of intervening forms will be made only within the pay lines of the structure. No deductions will be made for rounded or beveled edge, for space occupied by meal work, for electrical conduits or timber, or for voids or embedded items that are either less than 0.14 cubic meter 5 cubic feet in volume or 0.1 square meter 1 square foot in cross section.

1.2.1.3 Unit of Measure

Unit of measure: cubic meter. yard.

1.3 DESIGN AND PERFORMANCE REQUIREMENTS

The Government will maintain the option to sample and test joint sealer, joint filler material, waterstop, aggregates and concrete to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary to assist the Government in procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D 75. Concrete will be sampled in accordance with ASTM C 172. Slump and air content will be determined in accordance with ASTM C 143 and ASTM C 231, respectively, when cylinders are molded. Compression test specimens will be made, cured, and transported in accordance with ASTM C 31. Compression test specimens will be tested in accordance with ASTM C 39. Samples for strength tests will be taken not less than once each shift in which concrete is produced from each class of concrete required. A minimum of three specimens will be made from each sample; two will be tested at 28 days (90 days if pozzolan is used) for acceptance, and one will be tested at 7 days for information.

1.3.1 Strength

Acceptance test results will be the average strengths of two specimens tested at 28 days (90 days if pozzolan is used). The strength of the concrete will be considered satisfactory so long as the average of three consecutive acceptance test results equal or exceed the specified compressive strength, f'c, and no individual acceptance test result falls below f'c by more than 3.4 MPa. 500 psi.

1.3.2 Construction Tolerances

A Class "C" finish shall apply to all surfaces except those specified to receive a Class "D" finish. A Class "D" finish shall apply to all surfaces which will be permanently concealed after construction. The surface requirements for the classes of finish required shall be as specified in ACI 347R.

1.3.3 Concrete Mixture Proportions

Concrete mixture proportions shall be the responsibility of the Contractor.

Mixture proportions shall include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic yard of concrete. All materials included in the mixture proportions shall be of the same type and from the same source as will be used on the project. Specified compressive strength f'c shall be 20.7 MPa 3,000 psi at 28 days (90 days if pozzolan is used). The maximum

nominal size coarse aggregate shall be 19 mm 3/4 inch inches, in accordance with ACI 318M/318RM. ACI 318/318R. The air content shall be between 4.5 and 7.5 percent. The slump shall be between 50 and 125 mm. 2 and 5 inches. The maximum water cement ratio shall be 0.50.

1.4 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-01 Data

Air-Entraining Admixture; FIO. Accelerating Admixture; FIO.
Water-Reducing or Retarding Admixture; FIO. Curing Materials; FIO.
Reinforcing Steel; FIO. Expansion Joint Filler Strips, Premolded; FIO.
Joint Sealants - Field Molded Sealants; FIO. Waterstops; FIO.

Manufacturer's literature is available from suppliers which demonstrates compliance with applicable specifications for the above materials.

Batching and Mixing Equipment; FIO.

Batching and mixing equipment will be accepted on the basis of manufacturer's data which demonstrates compliance with the applicable specifications.

Conveying and Placing Concrete; FIO.

The methods and equipment for transporting, handling, depositing, and consolidating the concrete shall be submitted prior to the first concrete placement.

SD-08 Statements

Formwork; FIO.

Formwork design shall be submitted prior to the first concrete placement.

SD-09 Reports

Aggregates; FIO.

Aggregates will be accepted on the basis of certificates of compliance and test reports that show the material(s) meets the quality and grading requirements of the specifications under which it is furnished.

Concrete Mixture Proportions; FIO.

Ten days prior to placement of concrete, the contractor shall submit the mixture proportions that will produce concrete of the quality required. Applicable test reports shall be submitted to verify that the concrete mixture proportions selected will produce concrete of the quality specified.

SD-13 Certificates

Cementitious Materials; FIO.

Certificates of compliance attesting that the concrete materials meet the requirements of the specifications shall be submitted in accordance with the Special Clause "CERTIFICATES OF COMPLIANCE". Cementitious material will be accepted on the basis of a manufacturer's certificate of compliance, accompanied by mill test reports that the material(s) meet the requirements of the specification under which it is furnished.

Aggregates; FIO.

Aggregates will be accepted on the basis of certificates of compliance and tests reports that show the material(s) meet the quality and grading requirements of the specifications under which it is furnished.

1.5 REGULATORY REQUIREMENTS

The state statutory and regulatory requirements listed in the Task Order form a part of this specification to the extent referenced.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

Cementitious materials shall conform to the appropriate specifications listed:

2.1.1.1 Portland Cement

ASTM C 150, Type I, IA, II, IIA, III, IIIA or V, low alkali as required by the Task Order.

2.1.1.2 Pozzolan

Pozzolan shall conform to ASTM C 618, Class C or F, including requirements of Tables 1A and 2A.

2.1.2 Aggregates

Aggregates shall meet the quality and grading requirements of ASTM C 33 Class Designations 4M or better.

2.1.3 Admixtures

Admixtures to be used, when required or approved, shall comply with the appropriate specification listed. Chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing shall be retested at the expense of the contractor at the request of the Contracting Officer and shall be rejected if test results are not satisfactory.

2.1.3.1 Air-Entraining Admixture

Air-entraining admixture shall meet the requirements of ASTM C 260.

2.1.3.2 Water-Reducing or Retarding Admixture

Water-reducing or retarding admixture shall meet the requirements of ASTM C 494, Type A, B, or D.

2.1.4 Water

Water for mixing and curing shall be fresh, clean, potable, and free from injurious amounts of oil, acid, salt, or alkali, except that unpotable water may be used if it meets the requirements of COE CRD-C 400.

2.1.5 Reinforcing Steel

Reinforcing steel bar shall conform to the requirements of ASTM A 615/A 615M, Grade 60. Welded steel wire fabric shall conform to the requirements of ASTM A 185. Details of reinforcement not shown shall be in accordance with ACI 318M/318RM, ACI 318/318R, Chapters 7 and 12.

2.1.6 Expansion Joint Filler Strips, Premolded

Expansion joint filler strips, premolded shall be sponge rubber conforming to ASTM D 1752, Type I.

2.1.7 Joint Sealants - Field Molded Sealants

Joint sealants - field molded sealants shall conform to COE CRD-C 506, Type II for vertical joints and Type I for horizontal joints, Class A. Bond-breaker material shall be polyethylene tape, coated paper, metal foil, or similar type materials. The backup material shall be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, the joint shall be cleaned of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

2.1.8 Waterstops

Waterstops shall conform to COE CRD-C 572.

2.1.9 Formwork

The design and engineering of the formwork as well as its construction, shall be the responsibility of the Contractor.

2.1.10 Form Coatings

Forms for exposed surfaces shall be coated with a nonstaining form oil, which shall be applied shortly before concrete is placed.

2.1.11 Vapor Barrier

Vapor barrier shall be polyethylene sheeting with a minimum thickness of 0.15 mm 6 mils or other equivalent material having a vapor permeance rating not exceeding 30 nanograms per pascal second square meter 0.5 perms as determined in accordance with ASTM E 96.

2.1.12 Curing Materials

Curing materials shall conform to the following requirements.

2.1.12.1 Impervious Sheet Materials

Impervious sheet materials, ASTM C 171, type optional, except polyethylene

film, if used, shall be white opaque.

2.1.12.2 Membrane-Forming Curing Compound

ASTM C 309, Type 1-D or 2, Class A or B as required by the Task Order.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 General

Construction joints shall be prepared to expose coarse aggregate, and the surface shall be clean, damp, and free of laitance. Ramps and walkways, as necessary, shall be constructed to allow safe and expeditious access for concrete and workmen. Snow, ice, standing or flowing water, loose particles, debris, and foreign matter shall have been removed. Earth foundations shall be satisfactorily compacted. Spare vibrators shall be available. The entire preparation shall be accepted by the Government prior to placing.

3.1.2 Embedded Items

Reinforcement shall be secured in place; joints, anchors, and other embedded items shall have been positioned. Internal ties shall be arranged so that when the forms are removed all metal will be not less than 50 mm 2 inches from concrete surfaces permanently exposed to view or exposed to water on the finished structures. Embedded items shall be free of oil and other foreign matters such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. All equipment needed to place, consolidate, protect, and cure the concrete shall be at the placement site and in good operating condition.

3.1.3 Formwork Installation

Forms shall be properly aligned, adequately supported, and mortar-tight. The form surfaces shall be smooth and free from irregularities, dents, sags, or holes when used for permanently exposed faces. All exposed joints and edges shall be chamfered, unless otherwise indicated.

3.1.4 Vapor Barrier Installation

Vapor barriers shall be applied over gravel fill. Edges shall be lapped not less than 150 mm. 6 inches. All joints shall be sealed with pressure-sensitive adhesive not less than 50 mm 2 inches wide. The vapor barrier shall be protected at all times to prevent injury or displacement prior to and during concrete placement.

3.1.5 Production of Concrete

3.1.5.1 Ready-Mixed Concrete

Ready-mixed concrete shall conform to ASTM C 94 except as otherwise specified.

3.1.5.2 Concrete Made by Volumetric Batching and Continuous Mixing

Concrete made by volumetric batching and continuous mixing shall conform to

ASTM C 685.

3.1.5.3 Batching and Mixing Equipment

The contractor shall have the option of using an on-site batching and mixing facility. The facility shall provide sufficient batching and mixing equipment capacity to prevent cold joints. The method of measuring materials, batching operation, and mixer shall be submitted for review. On-site plant shall conform to the requirements of either ASTM C 94 or ASTM C 685.

3.1.6 Waterstops

Waterstops shall be installed and spliced as directed by the manufacturer.

3.2 CONVEYING AND PLACING CONCRETE

Conveying and placing concrete shall conform to the following requirements.

3.2.1 General

Concrete placement shall not be permitted when weather conditions prevent proper placement and consolidation without approval. When concrete is mixed and/or transported by a truck mixer, the concrete shall be delivered to the site of the work and discharge shall be completed within 1-1/2 hours or 45 minutes when the placing temperature is 30 degrees C 85 degrees F or greater unless a retarding admixture is used. Concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods which prevent segregation or loss of ingredients. Concrete shall be in place and consolidated within 15 minutes after discharge from the mixer. Concrete shall be deposited as close as possible to its final position in the forms and be so regulated that it may be effectively consolidated in horizontal layers 450 mm 18 inches or less in thickness with a minimum of lateral movement. The placement shall be carried on at such a rate that the formation of cold joints will be prevented.

3.2.2 Consolidation

Each layer of concrete shall be consolidated by rodding, spading, or internal vibrating equipment. External vibrating equipment may be used when authorized. Internal vibration shall be systematically accomplished by inserting the vibrator through the fresh concrete in the layer below at a uniform spacing over the entire area of placement. The distance between insertions shall be approximately 1.5 times the radius of action of the vibrator and overlay the adjacent, just-vibrated area by approximately 100 mm. a few inches. The vibrator shall penetrate rapidly to the bottom of the layer and at least 150 mm 6 inches into the layer below, if such a layer exists. It shall be held stationary until the concrete is consolidated and then withdrawn slowly at the rate of about 75 mm 3 inches per second.

3.2.3 Cold-Weather Requirements

No concrete placement shall be made when the ambient temperature is below 2 degrees C 35 degrees F or if the ambient temperature is below 5 degrees C 40 degrees F and falling. Suitable covering and other means as approved shall be provided for maintaining the concrete at a temperature of at least 10 degrees C 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Salt,

chemicals, or other foreign materials shall not be mixed with the concrete to prevent freezing. Any concrete damaged by freezing shall be removed and replaced at the expense of the contractor.

3.2.4 Hot-Weather Requirements

When the rate of evaporation of surface moisture, as determined by use of Figure 1 of ACI 308, is expected to exceed 1 kilogram per square meter 0.2 pound per square foot per hour, provisions for windbreaks, shading, fog spraying, or covering with a light-colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as finishing operations will allow.

3.3 FORM REMOVAL

Forms shall not be removed before the expiration of 24 hours after concrete placement except where otherwise specifically authorized. Supporting forms and shoring shall not be removed until the concrete has cured for at least 5 days. When conditions on the work are such as to justify the requirement, forms will be required to remain in place for longer periods.

3.4 FINISHING

3.4.1 General

No finishing or repair will be done when either the concrete or the ambient temperature is below 10 degrees C. 50 degrees F.

3.4.2 Finishing Formed Surfaces

All fins and loose materials shall be removed, and surface defects including tie holes shall be filled. All honeycomb areas and other defects shall be repaired. All unsound concrete shall be removed from areas to be repaired. Surface defects greater than 13 mm 1/2 inch in diameter and holes left by removal of tie rods in all surfaces not to receive additional concrete shall be reamed or chipped and filled with dry-pack mortar. The prepared area shall be brush-coated with an approved epoxy resin or latex bonding compound or with a neat cement grout after dampening and filled with mortar or concrete. The cement used in mortar or concrete for repairs to all surfaces permanently exposed to view shall be a blend of portland cement and white cement so that the final color when cured will be the same as adjacent concrete.

3.4.3 Finishing Unformed Surfaces

All unformed surfaces that are not to be covered by additional concrete or backfill shall be float finished to elevations shown, unless otherwise specified. Surfaces to receive additional concrete or backfill shall be brought to the elevations shown and left as a true and regular surface. Exterior surfaces shall be sloped for drainage unless otherwise shown. Joints shall be carefully made with a jointing tool. Unformed surfaces shall be finished to a tolerance of 10 mm 3/8 inch for a float finish and 8 mm 5/16 inch for a trowel finish as determined by a 3 m 10 foot straightedge placed on surfaces shown on the plans to be level or having a constant slope. Finishing shall not be performed while there is excess moisture or bleeding water on the surface. No water or cement shall be added to the surface during finishing.

3.4.3.1 Float Finish

Surfaces to be float finished shall be screeded and darbied or bullfloated to eliminate the ridges and to fill in the voids left by the screed. In addition, the darby or bullfloat shall fill all surface voids and only slightly embed the coarse aggregate below the surface of the fresh concrete. When the water sheen disappears and the concrete will support a person's weight without deep imprint, floating should be completed. Floating should embed large aggregates just beneath the surface, remove slight imperfections, humps, and voids to produce a plane surface, compact the concrete, and consolidate mortar at the surface.

3.4.3.2 Trowel Finish

A trowel finish shall be applied to as required by the Task Order. Trowelling shall be done immediately following floating to provide a smooth, even, dense finish free from blemishes including trowel marks. Finished surfaces shall be protected from damage during the construction period.

3.4.3.3 Broom Finish

A broom finish shall be applied as required by the Task Order. The concrete shall be screeded and floated to required finish plane with no coarse aggregate visible. After surface moisture disappears, the surface shall be broomed or brushed with a broom or fiber bristle brush in a direction transverse to that of the main traffic or as directed.

3.4.3.4 Expansion and Contraction Joints

Expansion and contraction joints shall be made in accordance with the details shown or as otherwise specified. Provide 13 mm 1/2 inch thick transverse expansion joints where new work abuts an existing concrete. Expansion joints shall be provided at a maximum spacing of 10 m 30 feet on center in sidewalks and at a maximum spacing of 10 meters 30 feet in slabs, unless otherwise indicated. Contraction joints shall be provided at a maximum spacing of 2 linear meters 6 linear feet in sidewalks and at a maximum spacing of 2 meters 6 feet in slabs, unless otherwise indicated. Contraction joints shall be cut at a minimum of 25 mm 1 inch(es) deep with a jointing tool after the surface has been finished.

3.5 CURING AND PROTECTION

Beginning immediately after placement and continuing for at least 7 days, all concrete shall be cured and protected from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage, and exposure to rain or flowing water. All materials and equipment needed for adequate curing and protection shall be available and at the site of the placement prior to the start of concrete placement. Preservation of moisture for concrete surfaces not in contact with forms shall be accomplished by one of the following methods:

- a. Continuous sprinkling or ponding.
- b. Application of absorptive mats or fabrics kept continuously wet.
- c. Application of sand kept continuously wet.
- d. Application of impervious sheet material conforming to ASTM C 171.

e. Application of membrane-forming curing compound conforming to ASTM C 309, Type 1-D, on surfaces permanently exposed to view and Type 2 on other surfaces shall be accomplished in accordance with manufacturer's instructions.

The preservation of moisture for concrete surfaces placed against wooden forms shall be accomplished by keeping the forms continuously wet for 7 days. If forms are removed prior to end of the required curing period, other curing methods shall be used for the balance of the curing period. During the period of protection removal, the temperature of the air in contact with the concrete shall not be allowed to drop more than 15 degrees C 25 degrees F within a 24 hour period.

3.6 TESTS AND INSPECTIONS

3.6.1 General

The individuals who sample and test concrete as required in this specification shall have demonstrated a knowledge and ability to perform the necessary test procedures equivalent to the ACI minimum guidelines for certification of Concrete Field Testing Technicians, Grade I.

3.6.2 Inspection Details and Frequency of Testing

3.6.2.1 Preparations for Placing

Foundation or construction joints, forms, and embedded items shall be inspected in sufficient time prior to each concrete placement by the Contractor to certify that it is ready to receive concrete.

3.6.2.2 Air Content

Air content shall be checked at least once during each shift that concrete is placed for each class of concrete required. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 231.

3.6.2.3 Slump

Slump shall be checked once during each shift that concrete is produced for each class of concrete required. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 143.

3.6.2.4 Consolidation and Protection

The Contractor shall ensure that the concrete is properly consolidated, finished, protected, and cured.

3.6.3 Action Required

3.6.3.1 Placing

The placing foreman shall not permit placing to begin until he has verified that an adequate number of acceptable vibrators, which are in working order and have competent operators, are available. Placing shall not be continued if any pile is inadequately consolidated.

3.6.3.2 Air Content

Whenever a test result is outside the specification limits, the concrete

shall not be delivered to the forms and an adjustment shall be made to the dosage of the air-entrainment admixture.

3.6.3.3 Slump

Whenever a test result is outside the specification limits, the concrete shall not be delivered to the forms and an adjustment should be made in the batch weights of water and fine aggregate. The adjustments are to be made so that the water-cement ratio does not exceed that specified in the submitted concrete mixture proportion.

3.6.4 Reports

The results of all tests and inspections conducted at the project site shall be reported informally at the end of each shift and in writing weekly and shall be delivered within 3 days after the end of each weekly reporting period. See Section 01451 CONTRACTOR QUALITY CONTROL.

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DIVISION 03 - CONCRETE

SECTION 03340

ROOF DECKING, CAST-IN-PLACE LOW DENSITY CONCRETE

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SECTION 03340

ROOF DECKING, CAST-IN-PLACE LOW DENSITY CONCRETE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI-01 (1986; Addenda 1989) Cold-Formed Steel Design Manual

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 82 (1995a) Steel Wire, Plain, for Concrete Reinforcement

ASTM A 185 (1994) Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

ASTM A 653 (1996) Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

ASTM C 150 (1996) Portland Cement

ASTM C 260 (1995) Air-Entraining Admixtures for Concrete

ASTM C 332 (1987; R 1991) Lightweight Aggregates for Insulating Concrete

ASTM C 495 (1991a) Compressive Strength of Lightweight Insulating Concrete

ASTM C 513 (1989) Obtaining and Testing Specimens of Hardened Lightweight Insulating Concrete for Compressive Strength

ASTM C 578 (1995) Rigid, Cellular Polystyrene Thermal Insulation

ASTM C 595 (1995a) Blended Hydraulic Cements

ASTM C 796 (1987a; R 1993) Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam

ASTM C 869 (1991) Foaming Agents Used in Making Preformed Foam for Cellular Concrete

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING
ENGINEERS (ASHRAE)

ASHRAE-03 (1993) Handbook, Fundamentals I-P Edition

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4 (1993) Standard Symbols for Welding,
Brazing and Nondestructive Examination

1.2 DESIGN REQUIREMENTS

Services of a firm experienced in the installation of cast-in-place low density roof systems shall be provided. A representative of the firm shall supervise the mixing, transporting, placing, finishing, and testing the low density concrete.

1.2.1 Concrete

The strength qualities of the low density concrete proposed for use shall be established by manufacturer's submitted data prior to the beginning of construction operations. The preparation of the design mix and testing shall be performed by an approved testing laboratory capable of performing such services or, if approved, by the manufacturer of the low density concrete. Trial design batches shall be prepared with the same materials proposed for use in the work. Test cylinders shall be made and tested in accordance with ASTM C 495 for perlite and vermiculite concrete and ASTM C 796 for cellular concrete. Low density concrete shall be proportioned for a minimum oven-dry unit weight of 400 kg/cubic meter (25 pcf) 25 pcf and the minimum average compressive strengths at 28 days of 862 kPa (125 psi). 125 psi.

1.2.2 Required U-Value

The actual average installed thickness of concrete, forms, and insulation, if used, shall be sufficient to provide a coefficient of heat transmission, or U-value, based on winter conditions, through the affected construction, as required by the Task Order, when determined in accordance with recognized methods set forth in the ASHRAE-03. The U-value shall be determined from inside air to outside air.

1.2.3 Steel Forms

Design of steel forms shall conform to AISI-01. Units shall be designed for attachment to the structural supports by welding or by a special system of clips as recommended by the manufacturer. The deflection of the steel forms under the design live load indicated shall not exceed 1/240 of the clear span.

1.3 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Roof Decking System; GA.

Drawings indicating shop and erection details for form systems proposed to be used. Drawings shall show cuts, vent holes, cut-outs for other trades, connections, and welds. Welds shall be indicated in accordance with AWS A2.4.

SD-09 Reports

Mix Design; GA.

Certified copies of mix design report for low density concrete indicating mixture proportions, average compressive strength in MPa, psi, and wet unit weight at point of placement for the type proposed for the project. Allowances shall be made for any unit weight changes resulting from handling and placing methods.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Admixtures

Air-entraining admixtures shall conform to ASTM C 260. Admixtures containing chloride ions shall not be used.

2.1.2 Aggregate

Light weight aggregate shall be free of asbestos and shall conform to ASTM C 332, Group I.

2.1.3 Foaming Agent

Foaming agents for making cellular concrete shall conform to ASTM C 869.

2.1.4 Cementitious Material

Portland cement shall conform to ASTM C 150, Type I; or ASTM C 595, Type IS.

2.1.5 Wire Reinforcement

Reinforcement shall consist of either wire mesh or welded wire fabric. Mesh shall be 50 mm (2 inch) 2 inch hexagonal, woven from 19 gauge 19 gauge steel wire and reinforced with 16 gauge 16 gauge longitudinal steel wire spaced on 76 mm (3 inch) 3 inch maximum centers. Wires forming common sides of mesh spaces that are adjacent to longitudinal wires shall be woven around longitudinal wires. Wire shall be galvanized conforming to ASTM A 82.

Welded wire fabric shall conform to ASTM A 185, galvanized, 12 gauge 12 gauge longitudinal wires spaced on 100 mm (4 inch) 4 inch maximum centers with 14 gauge 14 gauge transverse wires spaced on 200 mm (8 inch) 8 inch maximum centers.

2.1.6 Steel Forms

Forms shall be galvanized corrugated steel conforming to ASTM A 653, Grade A or E, with coating Class G 90. Forms shall be provided with side lap venting clips, formed in side lap vents, or vent slots in the corrugation. Vent area shall be at least 700 square mm per square m (0.10 square inch per square foot) 0.10 square inch per square foot of roof deck area.

2.1.7 Rigid Insulation

Insulation shall conform to ASTM C 578, Type as recommended by the manufacturer.

2.1.8 Expansion Joint Materials

Expansion joint material shall be compressible up to at least 50 percent under 172 kPa (25 psi) 25 psi of pressure. Material shall be weather resistant and compatible with the roofing system used.

2.2 MIXING PROCEDURE

Concrete ingredients shall be mechanically mixed to produce low density concrete of uniform consistency and a wet unit weight at point of placement required to obtain the compressive strength specified. Mixing and transporting operation shall be in accordance with the low density concrete material manufacturer's recommendation.

PART 3 EXECUTION

3.1 FORMWORK

Forms shall be attached to structural members by plug welding or special clips furnished by the manufacturer. Welding or the use of clips shall be in conformance with recommendations of the manufacturer. Sheets shall be placed with edge-corrugation lips pointing upward and shall be lapped not less than one full corrugation. End laps shall be located over permanent supports and shall be a minimum of 50 mm. 2 inches. Venting shall be as recommended by the manufacturer. Prior to placing low density concrete, areas of coating that have been damaged by welding or other operations shall have welding flux, spatter, and slag removed, shall be cleaned of loose rust and other foreign matter by wire brushing, and then coated with zinc-rich paint.

3.2 WIRE REINFORCEMENT

Wire reinforcement shall be unrolled and placed so that the long dimension is perpendicular with the corrugation in the steel forms. Location of reinforcement shall be approximately in the center of the lower one-third of the slab in which it is placed; however, minimum cover for reinforcement shall be 20 mm. 3/4 inch.

3.3 LOW DENSITY CONCRETE CONVEYING AND PLACEMENT

Conveying of low density concrete from the mixer to place of deposit shall be by methods that will prevent segregation and loss of material. Equipment for conveying concrete shall be of such size and design to ensure uniform, continuous placement of concrete. Low density concrete shall be deposited and screeded in a continuous operation until the placing of a panel or section is completed. Rodding, tamping, vibrating, or steel troweling shall not be used. Temporary runways shall be used during placement. The actual thickness of the roof system shall be that required to obtain the U-value specified; however, the minimum thickness of the top-most layer of low-density concrete shall not be less than 50 mm.2 inches. Rigid insulation, if used to obtain the required U-value, shall be encapsulated in low density concrete as recommended by the manufacturer.

3.4 EXPANSION JOINTS

Expansion joints shall be located as indicated. In addition, where perlite aggregate is used 25,40 mm 1,1-1/2 inch expansion joints shall be installed at junctions of roof and vertical surfaces as required by the Task Order. Joints shall extend the full depth of the roof system.

3.5 COLD WEATHER PLACEMENT

Reinforcement, forms, fillers, and other materials that will come in contact with the low density mixture shall be free of frost, snow, or ice.

Low density concrete shall not be placed at temperatures below 4 degrees C 40 degrees F or when temperatures are predicted to fall below 4 degrees C 40 degrees F during placement, unless precautions recommended by the manufacturer are employed and such placement is approved.

3.6 CURING

Low density concrete shall be cured in accordance with the manufacturer's recommendation. Curing operations shall commence at initial set of the concrete. After curing, surfaces shall be allowed to dry sufficiently to permit subsequent application of roofing system.

3.7 FIELD-CONTROL TESTS

Field-control tests shall be performed by an approved commercial testing laboratory and shall consist of wet-density at time of placement and compressive strength tests. If the compressive tests fail to meet the specified value, the portion of the roof decking represented by the cylinders shall be tested for structural integrity in accordance with ASTM C 513. If the specimens tested fail to meet the compressive-strength requirements, the portion of roof decking represented by the specimens shall be removed and replaced.

3.7.1 Wet-Density Tests

Wet-density tests shall be made as required, but shall be not less than twice during each day's pour. Samples for wet-density tests shall be taken at the point of placement. A variation in excess of 5 percent under the laboratory-established design wet density after discharge at point of placement shall require a modification of mix proportions or changes in mixing procedure, or both.

3.7.2 Compressive Strength Tests

The preparation of cylinders and testing shall be in accordance with ASTM C 495, or ASTM C 796 as applicable except that samples shall be obtained at the point of placement. Samples shall be taken at least once a day and for each 60 cubic meters 75 cubic yards of low density concrete placed. The area of roof decking represented by the sample shall be properly identified. One sample shall be sufficient to make at least four cylinders.

3.8 CLEANING AND PROTECTION

Upon completion of the roof deck, the roof surfaces shall be swept clean of debris and left ready to receive the roofing. The finished deck shall be protected from damage by weather and construction operations prior to installation of roofing.

-- End of Section --

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SECTION 03900

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SECTION 03900

RESTORATION OF CONCRETE IN HISTORIC STRUCTURES

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

ACI INTERNATIONAL (ACI)

ACI 201.1R	(1992) Guide for Making a Condition Survey of Concrete in Service
ACI 211.1	(1991) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 211.2	(1991) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 224.1R	(1993) Causes, Evaluation, and Repair of Cracks in Concrete Structures
ACI 301	(1996) Standard Specification for Structural Concrete
ACI 304R	(1989) Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 315	(1994) ACI Detailing Manual: Section Details and Detailing of Concrete Reinforcement
ACI 318/318R	(1995) Building Code Requirements for Structural Concrete and Commentary
ACI 347R	(1994) Guide to Formwork for Concrete
ACI 364.1R	(1994) Guide for Evaluation of Concrete Structures Prior to Rehabilitation
ACI 437R	(1991) Strength Evaluation of Existing Concrete Buildings
ACI Compilation 10	(1990) Repair and Rehabilitation of Concrete Structures
ACI Compilation 20	(1992) Repair and Rehabilitation II

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 182 (1991) Burlap Cloth made from Jute or Kenaf

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M (1996) Carbon Structural Steel

ASTM C 31/C 31M (1996) Making and Curing Concrete Test Specimens in the Field

ASTM C 33 (1993) Concrete Aggregates

ASTM C 39 (1996) Compressive Strength of Cylindrical Concrete Specimens

ASTM C 42 (1994) Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C 78 (1994) Flexural Strength of Concrete (Using Simple Beam With Third-Point Loading)

ASTM C 109/C 109M (1995) Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens)

ASTM C 114 (1997) Chemical Analysis of Hydraulic Cement

ASTM C 136 (1996a) Sieve Analysis of Fine and Coarse Aggregates

ASTM C 143 (1990a) Slump of Hydraulic Cement Concrete

ASTM C 150 (1996) Portland Cement

ASTM C 171 (1997) Sheet Materials for Curing Concrete

ASTM C 192/C 192M (1995) Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 231 (1997) Air Content of Freshly Mixed Concrete by the Pressure Method

ASTM C 260 (1995) Air-Entraining Admixtures for Concrete

ASTM C 295 (1990) Petrographic Examination of Aggregates for Concrete

ASTM C 457 (1990) Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete

ASTM C 494 (1992) Chemical Admixtures for Concrete

ASTM C 597 (1983; R 1991) Pulse Velocity Through

Concrete

ASTM C 618	(1997) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 642	(1997) Density, Absorption, and Voids in Hardened Concrete
ASTM C 803/C 803M	(1996) Penetration Resistance of Hardened Concrete
ASTM C 805	(1994) Rebound Number of Hardened Concrete
ASTM C 823	(1995) Examination and Sampling of Hardened Concrete in Construction
ASTM C 856	(1995) Petrographic Examination of Hardened Concrete
ASTM C 881	(1990) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 979	(1982; R 1993) Pigments for Integrally Colored Concrete
ASTM C 989	(1995) Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM C 1017	(1992) Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C 1084	(1992) Portland Cement Content of Hardened Hydraulic-Cement Concrete
ASTM C 1107	(1997) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1218/C 1218M	(1997) Water-Soluble Chloride in Mortar and Concrete
ASTM D 75	(1987; R 1992) Sampling Aggregates

CORPS OF ENGINEERS (COE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
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1.2 GENERAL REQUIREMENTS

The Contractor shall be responsible for equipment, materials, testing, labor and other items and services required to accomplish the work. Equipment and techniques proposed for use in the work shall not be used until they have been demonstrated and approved. Materials and equipment which have not been approved for use in the work shall not be stored or brought on to Government property. The Contractor shall provide equipment, materials, and labor to demonstrate materials, equipment, and techniques proposed for use in the work. The demonstrations shall be performed at the site, at a time and location as directed. The demonstration shall include

surface cleaning, excavation, surface patching (including finishing, texturing, and curing materials and methods), curing, safety procedures, surface finish and appearance. The Contractor's quality control shall conform to Section 01451 CONTRACTOR QUALITY CONTROL. All sampling and testing shall be the Contractor's responsibility, and shall be performed by an approved independent commercial testing laboratory, except as otherwise specified.

1.2.1 Concrete Mixture

The concrete mixture shall match that of the existing concrete to be repaired unless otherwise directed and shall be designed in accordance with ACI 211.1 or ACI 211.2 as required by the Task Order. The mixture proportions shall include consideration of the finishes required.

1.2.2 Formwork Design

Formwork design shall conform to ACI 301 and ACI 347R.

1.3 UNIT PRICES

1.3.1 Measurement of Concrete

The quantity of concrete to be paid for will be the number of cubic meters cubic feet placed in the completed and accepted renovated areas.

1.3.2 Payment for Concrete

The quantity of concrete, measured as specified, will be paid for at the contract unit price. The unit price for concrete will include full compensation for furnishing labor; materials; tools and equipment; and for performing work involved in repair of the areas as specified.

1.4 SUBMITTALS

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-04 Drawings

Architectural Concrete; GA.

Detail drawings conforming to ACI 315 and ACI 318/318R. Detail drawings shall show location of architectural concrete elements in the work, building elevations, formwork fabrication details, reinforcements, embedments, dimensions, concrete strength, interface with adjacent materials, and special placing instructions, in sufficient detail to cover fabrication, placement, stripping, and finishing.

SD-08 Statements

Proportions of Mixture; GA.

The results of trial mixture along with a statement giving the maximum nominal coarse aggregate size, aggregate grading, and the proportions of all ingredients that will be used in the manufacture of each strength of concrete, at least 14 days prior to commencing concrete placing operations.

Aggregate quantities (by mass) shall be based on the saturated surface-dry condition. The statement shall include a complete petrographic analysis of the aggregates proposed for use in the concrete. The statement shall be accompanied by test results from an independent commercial testing laboratory, attesting that the proportions selected will produce concrete of the qualities indicated. No substitutions shall be made in the materials used in the work without additional tests to show that the quality of the concrete is satisfactory.

Qualifications; GA.

A statement certified by the contractor attesting that the experience and qualification of the workers (journeymen) comply with the specifications.

SD-09 Reports

Sampling and Laboratory Testing of Materials; FIO.

Certified copies of laboratory test reports on analysis of existing concrete composition and new concrete mixtures, including all test data, for aggregate, admixtures, and curing compound. These tests shall be made by an approved commercial laboratory or by a laboratory maintained by the manufacturers of the materials.

SD-13 Certificates

Materials; FIO.

Certificates of compliance attesting that the materials meet specification requirements.

SD-14 Samples

Materials; GA.

A minimum of 3 sample specimens for each proposed mixture at least 14 days prior to any placements, in order to demonstrate range of variation of each mixture. Samples of cured concrete and mortar patching specimens for each mixture shall be submitted for comparison with the cleaned structure. Samples of concrete and mortar shall be approximately 305 by 305 mm 12 by 12 inches in plan dimension and 25 to 38 mm 1 to 1-1/2 inches thick. The samples shall clearly indicate the mixture represented by the specimen, and shall have been produced, placed, finished, textured, and cured in the same manner as proposed for use in the work. The samples shall be checked for matches in color and shade, finish, texture, and surface defects. The samples shall be compared to that part of the structure on which the mixture is proposed to be used. The samples shall be compared to the thoroughly cleaned structure. The samples and structure surfaces shall be clean and completely dry during the comparison. Following the comparison to dry surfaces, the sample and structure shall be dampened with clean, potable water and the surfaces shall be compared for acceptability to the Contracting Officer.

1.5 QUALIFICATIONS

The Contractor shall provide qualified workers trained and experienced in restoration of concrete in historic structures for at least 5 consecutive years. A list of similar jobs shall be provided identifying when, where, and for whom the work was done.

1.6 EQUIPMENT

Equipment that is dependable and adequate to accomplish the specified work shall be assembled at the work site in sufficient time before the start of the work to permit thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required. The equipment shall be maintained in acceptable working condition during the life of the project.

1.6.1 Cleaning

Equipment used in cleaning shall not cause staining, erosion, marring, or other damage or changes in the appearance of the surfaces to be cleaned.

1.6.1.1 Sandblasting

Sandblasting equipment shall not be used in cleaning concrete and other building surfaces; and shall be subject to approval for each other specific applications. Sandblasting equipment permitted for use in cleaning reinforcement and other embedded metal items shall include an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening shall not exceed 6.3 mm. 1/4 inch. The air compressor shall be portable and shall be capable of furnishing not less than 4.2 cubic meters 150 cubic feet per minute and maintaining a line pressure of not less than 0.620 MPa 90 psi at the nozzle while in use. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the reinforcement and other items to be cleaned, and will maintain the nozzle approximately 25 mm 1 inch above the surface. The height, angle of inclination and the size of the nozzle shall be adjusted as necessary to provide satisfactory results. The Contractor shall provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

1.6.1.2 Water Blasting

Water blasting equipment shall include a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water re-supply equipment. The equipment shall not be operated at a pressure which will cause etching or other damage to the concrete surface, except for the surfaces of the interior of the excavation, where operation at higher pressures may be used, subject to specific approval. The equipment shall be operated at a discharge capacity of 0.38 MPa 55 psi maximum and 9.5 to 11.4 Lpm 2.5 to 3 gpm for general surface cleaning operations of the structure, and between 3.5 and 7 MPa 500 and 1000 psi and 9.5 to 11.4 Lpm 2.5 to 3 gpm for cleaning of drill holes and surfaces of excavations. The water tank and auxiliary re-supply equipment shall be of sufficient capacity to permit continuous operations. The Contractor shall provide protective covers and barriers as required to prevent over-spray onto adjacent surfaces.

1.6.2 Excavation

The equipment used to excavate concrete shall be handheld manual or power type with a low-impact energy output and shall have gad points. The use of chisel points is prohibited. Surface grinders for use in preparing concrete and metal surfaces shall be small, hand-held equipment with a slow

to moderate operating RPM, using stone grinding wheels. Saw cutting equipment shall use circular diamond blades. The blade shall be at least 3.2 mm 1/8 inch thick, with blade diameter selected as appropriate for the application. Excavation equipment shall be subject to approval.

1.6.3 Drilling

Equipment used to drill holes in concrete for patch anchors and other applications shall be standard handheld masonry drills, commonly used for drilling small holes in concrete and masonry. The drill shall be a small, powered, handheld type, using rotary drilling mode only. Impact and rotary impact type drills are prohibited.

1.6.4 Finishing and Texturing

Hand tools used for placing, finishing and texturing concrete and mortar shall be commercially available and commonly used in concrete construction and repair. Equipment used for finishing and texturing concrete and mortar surfaces shall be a type commonly used in the concrete construction and repair industry for that application. Surface grinders, impact tools, and other equipment shall conform to the requirements specified herein, except as specifically required by the type of finish and texture, and subject to approval.

1.6.5 Compressed Air Supplies

Compressed air shall provide clean, oil and moisture free compressed air at the surface to be cleaned. The compressed air line shall have at least two in-line air filters to remove oil and moisture from the air supply. The compressed air supply shall be tested during each shift for the presence of oil and moisture.

1.6.6 Mixing, Transporting, and Placing

Equipment used for mixing, transporting, placing, and confining concrete and mortar placements shall be suitable for the intended purpose and be capable of satisfactorily mixing material, and supporting placement operations in an uninterrupted manner. Equipment shall be maintained in a clean, good operable condition at all times. Equipment used in the work shall be subject to approval. Defects, and deficiencies in operation or capacity shall be resolved prior to use in the work. Equipment used for batching, mixing, conveying, and placing of materials shall be clean, free of old materials and contaminants, and shall conform to the material manufacturer's recommendations.

1.6.7 Associated Equipment

Associated equipment such as mixer timing equipment, valves, pressure gauges, pressure hoses, other hardware, and tools shall be provided as required to ensure a continuous supply of material and operation control. Mechanical or radio communication systems shall be used between elements of mortar production and placement operation which are more than 30 m 100 feet apart.

1.7 SAMPLING AND LABORATORY TESTING OF MATERIALS

Sampling and testing shall be performed by an approved independent commercial testing laboratory, or by the Contractor subject to approval. Should the Contractor elect to establish testing facilities, no work

requiring testing shall be permitted until the Contractor's facilities have been inspected and approved. All sampling and testing shall be the Contractor's responsibility.

1.7.1 Existing Concrete Testing

Representative samples of existing concrete shall be taken from areas of the structure to be repaired at indicated locations. The samples shall be taken in accordance with ASTM C 42 and ASTM C 823 and tested in accordance with ASTM C 39, ASTM C 42, ASTM C 295, ASTM C 457, ASTM C 856, ASTM C 1218/C 1218M, ASTM C 642, ASTM C 114 and ASTM C 1084 as required by the Task Order. Aggregates in the existing concrete shall be evaluated in accordance with ASTM C 136 and ASTM C 295. The air content of the existing concrete shall be determined in accordance with ASTM C 457 and ASTM C 642.

1.7.2 Acceptance of Cement

Cement for repair concrete and mortars shall be tested as prescribed in the referenced specification under which it is furnished. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specification. The mill test reports and certification of compliance shall clearly reference the applicable ASTM documents and present the test result data. Cement shall conform to the specified requirements, and where the cement consists of a blend of cement and pozzolan, the pozzolan shall conform to the specified requirements for pozzolan, and the blend of cement and pozzolan shall conform to ASTM C 1107 and all other specified requirements.

1.7.3 Aggregate

Aggregate samples for repair concrete and mortars for laboratory testing shall be taken in conformance with ASTM D 75 and tested in accordance with ASTM C 33, ASTM C 136, and ASTM C 295.

1.7.4 Epoxy-Resin Grout

Epoxy-resin grout shall be tested for conformance with ASTM C 881.

1.8 SAMPLE PANELS

Sample panels of each mixture proposed for use in the work shall be submitted for approval. No concrete or mortar shall be used in the work until the samples and the represented mixture has been approved. Materials proposed for use in producing concrete and mortar shall not be brought on to Government property until the samples and mixtures have been approved. Samples for each side of the structure shall be evaluated both close up and at a distance under both wet and dry conditions. Each patch location and each side of the structure may require a separate or different mixture.

1.9 SPECIFIC REQUIREMENTS

1.9.1 Compressive Strength

Each class or mixture of concrete and mortar proposed for use in the work shall have a 28-day compressive strength matching the compressive strength of the adjacent existing concrete in the structure as determined by ASTM C 39 for concrete and ASTM C 109/C 109M for mortar. The compressive strength of the existing concrete shall be determined from testing of samples for each portion of the work in accordance with ASTM C 42. Test specimens of

existing concrete shall be taken from a sound and intact representative portion of the structure, at locations indicated.

1.9.2 Air Entrainment

Each class or mixture of concrete and mortar proposed for use in the work shall have a total air content matching the total air content of the adjacent concrete. Air content of the proposed mixture shall be determined in accordance with ASTM C 231. When air-entrained concrete is required for resistance to freezing and thawing, the concrete shall contain an air-entraining admixture conforming to ASTM C 260 and having an air content as indicated in ACI 301, (Table 3.4.1).

1.9.3 Admixtures

Concrete may contain admixtures, such as pigments, water reducers, high-range water reducers, or set retarders to provide special properties to the concrete. Use of admixtures shall be subject to approval.

1.9.4 Cementitious Content

Each class or mixture of concrete and mortar proposed for use in the work shall have a cement content matching the cement content of the adjacent existing concrete in order to provide uniform strength, weathering characteristics, and appearance of repaired surfaces in relation to existing surfaces.

1.9.5 Slump

Slump shall be determined in accordance with ASTM C 143, and shall be within the following limits:

<u>Structural Element</u>	<u>Slump in mm*</u>	<u>Minimum</u>	<u>Maximum</u>
Walls, columns, and beams		50	100
Foundation walls, substructure walls, footings, pavement, and slabs		25	75
Any structural concrete approved for placement by pumping		None	150

<u>Structural Element</u>	<u>Slump in Inches*</u>	<u>Minimum</u>	<u>Maximum</u>
Walls, columns, and beams		2	4
Foundation walls, substructure walls, footings, pavement, and slabs		1	3
Any structural concrete approved for placement by pumping		None	6

*These slump requirements do not apply when admixtures conforming to ASTM C 1017 are approved to produce flowing concrete.

1.9.6 Technical Service for Specialized Concrete

The service of a technical representative shall be obtained to oversee proportioning, batching, mixing, placing, consolidating, and finishing of concrete and mortar, until field controls indicate specialized concrete of specified quality is furnished.

1.10 PROPORTIONS OF MIXTURE

Trial batches shall contain materials proposed to be used in the project. Trial mixtures having proportions, consistencies and air content suitable for the work shall be made based on methodology described in ACI 211.1, using at least three different water/cement (w/c) ratios. Trial mixtures shall be proportioned to produce concrete matching the qualities specified.

In the case where ground granulated iron blast-furnace slag conforming to ASTM C 989 is used, the mass of the slag will be substituted in the equations for the term P which is used to denote the mass of pozzolan. Trial mixtures shall be designed for maximum permitted slump and air content. The concrete and mortar patching mixtures shall be designed using the lowest practical w/c ratio. The temperature, slump, and air content of the concrete and mortar mixtures in each trial batch shall be reported. For each w/c ratio at least three test specimens for each test age shall be made and cured in accordance with ASTM C 192/C 192M and ASTM C 109/C 109M. They shall be tested at 7 and 28 days in accordance with ASTM C 39 for concrete and ASTM C 109/C 109M for mortar. From these test results a curve shall be plotted showing the relationship between w/c ratio and strength. For each strength of concrete the maximum allowable w/c ratio shall be that shown by these curves to produce an average strength as specified in paragraph Average Strength. Materials, physical and chemical properties, and composition of concrete and mortar patch mixtures shall match the existing concrete to be repaired, except that patching mixtures shall have the lowest total chlorides content practical and shall conform to ACI recommendation for maximum permitted total chloride content.

1.10.1 Average Strength

In meeting the strength requirements specified, the selected mixture shall produce an average compressive strength exceeding the specified strength by the amount indicated below. Where a concrete production facility has test records, a standard deviation shall be established. Test records from which a standard deviation is calculated shall represent materials, quality control procedures, and conditions similar to those expected; shall represent concrete produced to meet a specified strength or strengths within 3.5 MPa 500 psi of that specified for proposed work; and shall consist of at least 30 consecutive tests. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days or at other test age designated for determination of the specified strength.

1.10.2 Test Records Exceeding 29

Required average compressive strength used as the basis for selection of concrete proportions shall be the larger of the specified strength plus the standard deviation multiplied by 1.34 or the specified strength plus the standard deviation multiplied by 2.33 minus 3.5 MPa. 500 psi.

1.10.3 Test Records Less Than 29

Where a concrete production facility does not have test records meeting the above requirements but does have a record based on 15 to 29 consecutive tests, a standard deviation may be established as the product of the

calculated standard deviation and a modification factor from the following Table:

<u>No. of tests (1)</u>	<u>Modification factor for standard deviation</u>
less than 15	See Note
15	1.16
20	1.08
25	1.03
30 or more	1.00

(1) Interpolate for intermediate numbers of tests.

Note: When a concrete production facility does not have field strength test records for calculation of standard deviation or the number of tests is less than 15, the required average strength shall be specified strength plus 3.5 MPa. 500 psi.

1.11 STORAGE OF MATERIALS

Cement and pozzolan shall be stored in weathertight buildings, bins, or silos which will exclude moisture and contaminants. Cement shall be furnished in suitable bags used for packaging cements. Labeling of packages shall clearly define contents, manufacturer, batch identification, etc. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of aggregates. Reinforcing bars and accessories shall be stored in such a manner as to avoid contamination and deterioration. Admixtures which have been in storage at the project site for longer than six months or which have been subjected to freezing shall not be used unless retested and proven to meet the specified requirements. Epoxy shall be stored in accordance with the manufacturer's recommendations.

1.12 WEATHER LIMITATIONS

Concrete, mortar, and epoxy adhesives shall not be placed when weather conditions detrimentally affect the quality of the finished product. No concrete or mortar shall be placed when the air temperature is below 5 degrees C 40 degrees F in the shade. When air temperature is likely to exceed 35 degrees C, 90 degrees F, concrete and mortar shall have a temperature not exceeding 35 degrees C 90 degrees F when deposited, and the surface of the placed concrete shall be kept damp with a water fog until the approved curing medium is applied. Materials proposed for use in the work shall not be produced and placed during periods of rain or other precipitation. Material placements shall be stopped and all in-place material shall be protected from exposure during periods of rain or other precipitation.

PART 2 PRODUCTS

2.1 MATERIALS

Materials, physical and chemical properties, and composition of new concrete shall match that of existing concrete to be repaired, unless samples and testing determine that existing mixtures and materials are faulty or non-performing.

2.1.1 Admixtures

Air entraining admixtures shall conform to ASTM C 260, water-reducing or -retarding admixtures shall conform to ASTM C 494, and pigments for integrally colored concrete shall conform to ASTM C 979 and ASTM C 1017. Admixtures shall not contain added chlorides.

2.1.2 Aggregates

Aggregates shall match existing aggregates as determined by samples and testing and shall otherwise conform to ASTM C 33.

2.1.3 Bonding Agents

Bonding agents for use in bonding concrete and mortar patching materials to concrete and steel are specifically prohibited for use in the work.

2.1.4 Cementitious Materials

Cementitious materials shall each be of one type and from one source when used in concrete which will have surfaces exposed in the finished structure. Cementitious materials shall conform to one of the following:

2.1.4.1 Cement

Cement composition shall match that of cement used in existing concrete to be repaired as determined by samples and testing and shall conform to the basic requirements of ASTM C 150, Type I or II, low alkali as required by the Task Order. Cement shall have non-shrink (shrinkage compensating) properties and shall conform to ASTM C 1107, Class B or C, expansive cement type.

2.1.4.2 Pozzolan

Pozzolan shall conform to ASTM C 618, Class F, including limit on available alkalis, "Table 2 - Supplementary Optional Chemical Requirements," and uniformity requirements, "Table 4 - Supplementary Optional Physical Requirements."

2.1.5 Epoxy Anchor Adhesives

An epoxy-resin grout shall be used to bond steel anchors to concrete, and shall be a 100 percent solids, moisture insensitive, low creep, structural adhesive. The epoxy shall conform to ASTM C 881, type IV; grade and class selected to conform to the manufacturer's recommendations for the application. The epoxy adhesive shall be conditioned, proportioned, mixed, and applied in accordance with the manufacturer's recommendations, except as otherwise specified herein or indicated on the drawings.

2.1.6 Reinforcing Steel

Reinforcing steel shall conform to ASTM A 36/A 36M, sizes as indicated, unless otherwise directed.

2.1.7 Tie Wire

Tie wire shall be soft Monel Metal or 18-8 stainless steel.

2.1.8 Metal attachments

Anchors for spall repairs shall be threaded stainless steel, size as indicated. Other plates, angles, anchors, and embedments shall conform to ASTM A 36/A 36M, and shall be prime painted with inorganic zinc primer.

2.1.9 Formwork

Formwork for special effects shall be as indicated or directed, and shall be subject to specific approval.

2.1.10 Form-Release Agents

Form-release agents shall be the manufacturer's standard, nonstaining, nonpetroleum based, compatible with surface finish and subsequent surface treatments.

2.1.11 Cleaning Solution

The cleaning solution shall consist of a 1:1 to 1:1.5 (water: liquid chlorine bleach) mixture of clean potable water and liquid chlorine bleach. Rinse water shall be clean potable water.

2.1.12 Water

Water used in cleaning concrete surfaces, used in producing concrete and mortars, and used for curing concrete shall be potable.

2.1.13 Curing Materials

2.1.13.1 Burlap

AASHTO M 182.

2.1.13.2 Impervious Sheets

ASTM C 171, type optional, except that polyethylene film, if used, shall be white opaque.

2.1.13.3 Membrane-Forming Compounds

COE CRD-C 300, non-pigmented, containing a fugitive dye.

2.1.14 Joint Sealing

Joint sealing shall be as specified in Section 07900 JOINT SEALING.

2.1.15 Epoxy-Resin Grout

Epoxy-resin grout shall be a two-component material, 100 percent solids by weight, formulated to meet the requirements of ASTM C 881, Type I or II. Type I material shall be used when materials or atmospheric temperatures are 20 degrees C 70 degrees F or above. Type II material shall be used when materials or atmospheric temperatures are below 20 degrees C. 70 degrees F. Epoxy-resin grout shall have the ability to structurally rebond cracks, delaminations, and hollow plane conditions in concrete; shall be insensitive to the presence of water; and shall have the capability to penetrate cracks down to 0.12 mm 5 mils in width. Materials shall have been used in similar conditions for a period of at least five years.

2.1.16 Epoxy Injection Ports

Injection ports for epoxy-resin grout shall be designed for the intended use as detailed in this section and shall be made according to the recommendation of the epoxy manufacturer.

PART 3 EXECUTION

3.1 EVALUATION AND ANALYSIS

Evaluation and analysis shall conform to the requirements specified herein, and the requirements specified in Section 01451 CONTRACTOR QUALITY CONTROL.

3.1.1 Existing Concrete

Concrete renovation shall be undertaken only after a complete evaluation and analysis of the areas to be repaired is completed. This shall include sampling and testing of the existing concrete to determine its composition and qualities. A condition survey of the area to be repaired shall conform to ACI 201.1R and ACI 364.1R. Strength evaluation shall be per ACI 437R. Cracks shall be evaluated per ACI 224.1R. Examination and sampling procedures shall conform to ASTM C 823.

3.1.2 Evaluation and Acceptance of New Concrete

3.1.2.1 Frequency of Testing

Samples for strength, slump, air content, and shrinkage tests of each concrete mixture placed each day shall be taken not less than once a day, and at least once for each 0.33 cubic meters 10 cubic feet of concrete; nor less than once for each 50 square meters 500 square feet of surface area for slabs or walls. Samples for strength, slump, air content, and shrinkage tests of each mortar mixture placed each day shall be taken not less than once a day, and at least for each 0.25 cubic meters 9 cubic feet of mortar. If this sampling frequency results in less than 3 strength tests for a given class of concrete or individual mixture design, tests shall be made from at least 3 randomly selected trucks (or batches) or from each truck (or batch) if fewer than 3 truck loads (or batches) are used. Field cured specimens for determining form-removal time or when a structure may be put in service shall be made in numbers directed to check the adequacy of curing and protection of concrete in the structure. The specimens shall be removed from the molds at the age of 24 hours and shall be cured and protected, insofar as practicable, in the same manner as that given to the portion of the structure the samples represent.

3.1.2.2 Testing Procedures

Strength test specimens for acceptance tests shall be molded and cured in accordance with ASTM C 31/C 31M. Strength test specimens and testing for mortar shall conform to ASTM C 109/C 109M. Cylinders shall be tested in accordance with ASTM C 39 and beams shall be tested in accordance with ASTM C 78. A strength test shall be the average of the strengths of two specimens made from the same sample of concrete and tested at 28 days or at another specified test age. Tests for total air content and slump shall be made on fresh samples of the concrete and mortar. Tests shall be performed on site, on samples taken at the location of placement. Slump shall be determined in accordance with ASTM C 143. Air content shall be determined in accordance with ASTM C 231. Testing for shrinkage shall be determined in accordance with ASTM C 1107.

3.1.2.3 Evaluation of Results

Concrete and mortar shall have a compressive strength at 28 days as determined by ASTM C 39 and ASTM C 109/C 109M respectively, which matches the present compressive strength of concrete in the structure within a tolerance of from -0 MPa to +3.5 MPa. from -0 psi to +500 psi. Concrete and mortar strengths will be considered satisfactory if the averages of all sets of three consecutive strength test results equal or exceed the specified strength and no individual strength test result falls below the required strength. For flexural strength concrete, the strength level of the concrete will be considered satisfactory if the averages of all sets of five consecutive strength test results equal or exceed the required flexural strength, and not more than 20 percent of the strength test results fall below the required strength by more than 0.35 MPa. 50 psi. The required minimum strength shall be the strength determined from testing of samples taken from the structure.

3.1.2.4 Investigation of Low-Strength Test Results

When any strength test of standard-cured test specimen falls below the specified strength requirement by more than 3.5 MPa, 500 psi, or if tests of field-cured specimens indicate deficiencies in protection and curing, steps shall be taken to ensure that load-carrying capacity of the structure is not jeopardized. Nondestructive testing in accordance with ASTM C 597, ASTM C 803/C 803M, or ASTM C 805 may be permitted by the Contracting Officer to determine the relative strengths at various locations in the structure as an aid in evaluating concrete strength in place or for selecting areas to be cored. Such tests, unless properly calibrated and correlated with other test data, shall not be used as a basis for acceptance or rejection. When strength of concrete in place is considered potentially deficient, cores shall be obtained and tested in accordance with ASTM C 42. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location of cores shall be determined by the Contracting Officer to least impair the strength of the structure. If the concrete in the structure is dry under service conditions, the cores shall be air-dried (temperature 16 to 27 degrees C, 60 to 80 degrees F, relative humidity less than 60 percent) for seven days before testing and shall be tested dry. If the concrete in the structure is more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42. Concrete in the area represented by the core testing will be considered adequate if the average strength of the cores is equal to or at least 85 percent of the specified strength requirement and if no single core is less than 75 percent of the specified strength requirement. If the core tests are inconclusive or impractical to obtain, or if structural analysis does not confirm the safety of the structure, load tests may be directed by the Contracting Officer in accordance with the requirements of ACI 318/318R. Concrete work evaluated by structural analysis or by results of a load test and found deficient shall be corrected in a manner satisfactory to the Contracting Officer. All investigations, testing, load tests, and correction of deficiencies shall be performed, and approved by the Contracting Officer, at the expense of the Contractor.

3.2 PREPARATION OF CONCRETE SURFACES

3.2.1 Initial Surface Cleaning

The cleaning materials, equipment, and methods shall not result in staining, erosion, marring, or other damage to the surfaces of the structure. The materials, equipment, and methods proposed for use in cleaning shall be demonstrated in a 1 by 1 m 3 by 3 foot square test section. The location of the test section, and the completed test section shall be subject to approval. The cleaning process shall be adjusted as required and the test section rerun until an acceptable process is obtained. Following an initial inspection and evaluation of the structure and surfaces, the structure shall be given an initial surface cleaning. The initial surface cleaning shall be completed prior to start of excavation, and sampling and testing for mixtures. The initial cleaning shall provide for the complete cleaning of all exterior concrete surfaces of the structures. The initial cleaning shall thoroughly clean the concrete surface to remove all traces of moss, dirt, and other contaminants. The cleaning shall provide a clean concrete surface to allow determination of the concrete's color and shades, finish and texture, and other properties. The "initial cleaning" shall consist of initial surface washing, followed by treatment with the cleaning solution, and then followed by a final water rinse. The initial surface washing shall consist of washing the surface with clean, low pressure water (pressure of less than 0.38 MPa 55 psi and 9.5 to 11.4 Lpm 2.5 to 3 gpm discharge) and manual surface scrubbing using handheld natural or plastic bristle brushes, followed by a clean water rinse. Following completion of the initial surface washing of the entire structure (or side of structure) the concrete shall be dried prior to application of the cleaning solution. The concrete surfaces of the structure shall be coated with the cleaning solution at an application rate of 3.8 L 1 gal of solution per 1 to 3 square meters 10 to 30 square feet of treated surface using low pressure spraying equipment. The application rate of the solution shall be adjusted as directed to ensure that the entire surface has been thoroughly wetted with the solution. A manual surface scrubbing with handheld natural or plastic bristle brushes shall be used on heavily soiled areas. Following treatment with the cleaning solution the treated surfaces shall be rinsed with clean, low-pressure water. Water and all liquid materials used in the work shall be contained at the building perimeter and collected and disposed of in an approved manner.

3.2.2 Areas to be Removed

Unsound, weak, or damaged concrete shall be removed. Loose particles, laitance, spalling, cracked, or debonded concrete and foreign materials shall be removed with hand tools unless otherwise noted. Surfaces of the structure, and surfaces adjacent to the excavation shall be protected from damage which may result from excavation, cleaning, and patching operations.

3.2.3 Exposed Reinforcement

Concrete shall be removed from around exposed or deteriorated reinforcing steel. Steel shall stand free of concrete at least 25 mm 1 inch minimum to provide mechanical bond with patch material.

3.2.4 Excavation in Concrete

Deteriorated areas indicated to be repaired shall be excavated to sound concrete. The use of concrete and masonry saws for outlining the excavation shall not be used. The excavation shall be accomplished by use of manual methods and low-energy, handheld equipment. The sides of the excavation shall be approximately perpendicular to the exposed surface, dovetailed back 15 degrees from perpendicular to the exposed surface at the

bottom in order to key in the patch. The bottom (or back) of the excavation shall be approximately parallel with the exposed surface of the patch. The surfaces of the excavation shall be finished to remove excessive variations and roughness and shall be shaped to provide a patch with uniform dimensions. Feathering at edges shall not be permitted. The excavation shall be accomplished to minimize the appearance of bond lines between the patch and the adjacent concrete and other abutting surfaces. Surfaces of the structure and surfaces adjacent to the excavation shall be protected from damage which may result from excavation operations.

3.2.5 Cleaning of Excavations

The surfaces of the excavation shall be cleaned by water blasting and manual scrubbing methods. Sandblasting shall not be used to clean concrete surfaces. The surfaces of excavations shall be cleaned of dust, dirt, laitance, corrosion, or other contamination. Cracks and voids shall be flushed out with clean water and allowed to dry. Concrete surfaces to be in contact with the freshly placed concrete shall be maintained in a continuously damp condition for at least 24 hours prior to concrete placement. Immediately before placement, areas to be patched shall be cleaned and rinsed, followed by blowing dry with filtered, dry, compressed air to remove excess water, and to provide a surface in a saturated, surface-dry, damp condition. Surfaces of the structure and surfaces adjacent to the excavation shall be protected from damage which may result from cleaning operations.

3.2.6 Previously Repaired Cracks

Old caulking or grout shall be removed from previously repaired cracks where it is failing. Loose particles shall be removed from cracks. Cracks shall be cleaned, rinsed with water followed by blowing with filtered, dry, compressed air.

3.3 REINFORCING STEEL

3.3.1 Cleaning

Exposed reinforcing steel shall be mechanically cleaned to bare metal. Exposed steel in areas to be patched shall be painted with two coats of zinc-rich primer paint.

3.3.2 Repairing

The Contracting Officer shall be notified of any steel members which have significant loss in cross-sectional area due to corrosion, cutting, or other damage. Damaged portions shall be mechanically cut away. Reinforcing steel to match existing shall be installed where existing reinforcing is badly corroded or damaged. Lap splices shall be as required by code. If necessary, bars shall be fastened with tie wires.

3.4 FORMWORK ERECTION

Formwork shall be erected in accordance with the detail drawings to ensure that the finished concrete members conform accurately to the indicated dimensions, lines, elevations, and finishes. Deflection shall not exceed 1/360th of each component span or distance between adjacent supports. Deflections and tolerance shall not be cumulative. Form liners shall be installed as necessary to provide the required finish. Forms shall be coated with form release agents before reinforcement is placed.

3.5 CONCRETE REPAIR

3.5.1 General Requisites

Repairs shall be accomplished in accordance with ACI Compilation 10, ACI Compilation 20, ACI 301, and ACI 304R. Cracks shall be repaired, if required, per ACI 224.1R. Detailing shall be per ACI 315. Repaired surfaces shall match adjacent existing surfaces in all respects. Formwork as necessary to reconstruct concrete to match adjacent surfaces shall be provided. Voids shall be filled flush with adjacent surfaces. Products shall be used in accordance with the manufacturer's instructions.

3.5.2 Spalls

Spalls less than 25 mm 1 inch deep, where indicated to be repaired, shall be drypacked with an approved patching mortar. Spalls greater than 25 mm 1 inch deep shall be excavated and patched with concrete.

3.5.3 Patch Anchors

Surface areas to be patched which do not have reinforcement or other metal embedments which will be placed in the patching concrete and mortar shall be provided with patch anchors. Patch anchors shall be provided to ensure that the patch is tied to the existing concrete structure. Patch anchors shall be provided within the excavation at a frequency of at least one patch anchor per 0.10 square meter square foot of patch plan surface area; specific locations for patch anchors shall be as indicated. Small handheld, low-speed rotary masonry drills shall be used to produce holes in the existing concrete, within the limits of the excavations for the patch anchor installation.

3.5.3.1 Holes

Holes shall be drilled into the existing concrete substrate material of the excavation using rotary (non-hammer) drills. Holes shall have a diameter 3.2 mm 1/8 inch larger than the anchor diameter. The holes shall be drilled to a depth of 100 mm, 4 inch, except as otherwise indicated or directed. Drill holes shall be produced to ensure that the holes do not penetrate completely through the concrete, and will provide at least 25 mm 1 inch of cover around the drill hole. Holes shall be cleaned by water blasting to remove drill dust and other debris and then blown dry with filtered, dry, compressed air. Drill holes shall be conditioned in accordance with the epoxy adhesive manufacturer's recommendations.

3.5.3.2 Anchor Installation

Anchors shall be cleaned to remove all contaminants which may hinder epoxy bond. Epoxy adhesive shall be pressure injected into the back of the drilled holes. The epoxy shall fill the holes so that when the anchors are inserted, the epoxy completely fills the holes and excess epoxy is not exuded from the holes. Anchors shall be inserted immediately into the holes. The anchors shall be set back from the exterior face at least 25 mm. 1 inch. Anchors shall be installed without breaking or chipping the exposed concrete surface.

3.5.3.3 Cleanup

Excess epoxy and spills shall be removed from the surface of the

excavation. The surface of the excavation shall be left in a clean and uncontaminated condition. Spills on adjacent surfaces shall also be removed and surfaces repaired as required.

3.5.4 Mixing Epoxy-Resin Grout Components

Epoxy-resin grout components shall be mixed in the proportions recommended by the manufacturer. The components shall be conditioned from 20 to 30 degrees C 70 to 85 degrees F for 48 hours prior to mixing. The two epoxy components shall be mixed with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. The polysulfide curing agent component shall be added gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. The rate of stirring shall be such that the entrained air is at a minimum.

3.5.4.1 Tools and Equipment

Tools and equipment used further in the work shall be thoroughly cleaned before the epoxy-resin grout sets.

3.5.4.2 Health and Safety Precautions

Full-face shields shall be provided for all mixing, blending, and placing operations as required. Protective coveralls and neoprene-coated gloves shall be provided for all workers engaged in the operations. Protective creams of a suitable nature for the operation shall be supplied. Adequate fire protection shall be maintained at all mixing and placing operations. Smoking or the use of spark- or flame-producing devices shall be prohibited within 15 m 50 feet of mixing and placing operations. The mixing, placing, or storage of epoxy-resin grout or solvent shall be prohibited within 15 m 50 feet of any vehicle, equipment, aircraft, or machinery that could be damaged from fire or could ignite vapors from the material.

3.5.4.3 Epoxy Pressure-Injection of Cracks

Cracks shall be pressure-injected using a two component epoxy system with an in-line mixing and metering capability. System shall be capable of injection pressures up to a maximum of 1 MPa 150 psi to ensure complete penetration of the crack. An adequate surface seal shall be applied to the crack or joint to prevent the escape of epoxy. Entry points shall be established along the crack. The crack shall be filled with a 100 percent solid epoxy adhesive. The adhesive shall be injected into the crack at the first entry point with sufficient pressure to advance the epoxy to the next adjacent port. The original port shall be sealed and injection moved to the port at which the epoxy appears. The process shall continue until each joint and crack has been injected for its entire length. Epoxy shall be allowed to cure in accordance with manufacturer's instructions. Sealing materials shall then be removed and surface finished to match adjacent existing surface.

3.5.5 Application of Concrete and Patching Mortar

Concrete and mortar shall be placed to rebuild spalled or damaged areas to match the original surface finish, level, texture, and color. Concrete shall be cured as specified herein. The finished appearance of the patch shall match the adjacent existing surface.

3.6 CURING AND PROTECTION

Concrete and mortar patching shall be cured by an approved method for at least 7 days. Immediately after placement, concrete shall be protected from premature drying, extremes in temperatures, rapid temperature change, mechanical injury and injury from rain and flowing water. Air and forms in contact with concrete and mortar shall be maintained at a temperature above 10 degrees C 50 degrees F for the first 3 days and at a temperature above 0 degrees C 32 degrees F for the remainder of the specified curing period. Materials and equipment needed for adequate curing and protection shall be available and at the placement site prior to placing concrete and mortar. No fire or excessive heat shall be permitted near or in direct contact with the concrete and mortar at any time. Curing shall be accomplished by any of the following methods, or combination thereof, as approved:

3.6.1. Moist Curing

Concrete and mortar to be moist-cured shall be maintained continuously wet for the entire curing period. If water or curing materials stain or discolor concrete and mortar surfaces which are to be permanently exposed, the concrete and mortar surfaces shall be cleaned. When wooden forms are left in place during curing, they shall be kept wet at all times. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces, using suitable materials. Horizontal surfaces shall be cured by ponding, by covering with a 50 mm 2 inch minimum thickness of continuously saturated sand, or by covering with waterproof paper, polyethylene sheet, polyethylene coated burlap, or saturated burlap.

3.6.2 Membrane Curing

Membrane curing shall not be used on surfaces that are to receive any subsequent treatment depending on adhesion or bonding to the concrete; except that a styrene acrylate or chlorinated rubber compound meeting COE CRD-C 300 requirements may be used for surfaces which are to be painted or are to receive bituminous roofing or waterproofing, or for floors that are to receive adhesive applications of resilient flooring. The curing compound selected shall be compatible with any subsequent paint, roofing, waterproofing, or flooring specified. Curing compound shall be applied to formed surfaces immediately after the forms are removed and prior to any patching or other surface treatment except the cleaning of loose sand, mortar, and debris from the surface. Surfaces shall be thoroughly moistened with water and the curing compound shall be applied to slab surfaces as soon as the bleeding water has disappeared, with the tops of joints being temporarily sealed to prevent entry of the compound and to prevent moisture loss during the curing period. Compound shall be applied in a one-coat continuous operation by mechanical spraying equipment, at a uniform coverage of 20 square meters 200 square feet per 3.8 L. gallon. Concrete surfaces which have been subjected to rainfall within 3 hours after curing compound has been applied shall be resprayed by the method and at the coverage specified. Surfaces coated with curing compound shall be kept free of foot and vehicular traffic, and from other sources of abrasion and contamination during the curing period.

3.6.3 Epoxy Adhesives

Epoxy adhesives shall be protected and cured in accordance with the manufacturer's recommendations. The adjacent surfaces and ambient conditions shall be maintained within the manufacturer's recommendations. The patch anchors and epoxy adhesive shall be protected from displacement and disturbances.

3.7 CONCRETE AND MORTAR FINISHES AND COLOR

3.7.1 Matching Adjacent Concrete

Concrete and mortar finishes and color shall match the finish and color of the existing adjacent concrete. Finishing shall be accomplished at the time of concrete placement or immediately after formwork removal.

3.7.2 Non-Standard Finish

The exposed surfaces of concrete and mortar patching shall match the finish, texture, and surface detail of the original surface. Mechanical finishing and texturing may be required to produce the required finish and appearance. The finishing and texturing shall be accomplished in such a way as to help conceal bond lines between the patch and adjacent surfaces. The texturing shall provide replication of all surface details, including tooling and machine marks. The equipment used in finishing and texturing shall be a low-impact energy type which will not weaken the patch or damage the patch bond and the adjacent concrete. Equipment used for finishing and texturing shall be demonstrated on sample panels of concrete and mortar to demonstrate performance and suitability of the equipment and methods. Equipment and methods shall be subject to approval.

3.8 FINAL CLEANING

No sooner than 72 hours after completion of the curing period and after joints are sealed, faces and other exposed surfaces of concrete shall be washed down with water applied with a soft bristle brush, then rinsed with clean water. Discolorations which cannot be removed by these procedures, will be considered defective work. Cleaning work shall be done when temperature and humidity conditions are such that surfaces dry rapidly. Adjacent surfaces shall be protected from damage during cleaning operations.

3.9 PROTECTION OF WORK

Work shall be protected against damage from subsequent operations.

3.10 DEFECTIVE WORK

Defective work shall be repaired or replaced, as directed, using approved procedures.

3.11 FINAL INSPECTION

Following completion of the work, the structure shall be inspected for damage, staining, and other distresses. The patches shall be inspected for cracking, crazing, delamination, unsoundness, staining and other defects. The finish, texture, color and shade, and surface tolerances of the patches shall be inspected to verify that all requirements have been met. All surfaces exhibiting defects shall be repaired as directed.

-- End of Section --1