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USACE / NAVFAC / AFCEC / NASA **UFGS-03 31 01.00 10 (May 2014)**

Preparing Activity: USACE **Superseding UFGS-03 31 01 00 10 (November 2010)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2018
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DIVISION 03 - CONCRETE

SECTION 03 31 01.00 10

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS

05/14

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USACE / NAVFAC / AFCEC / NASA **UFGS-03 31 01.00 10 (May 2014)**

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SECTION 03 31 01.00 10

CAST-IN-PLACE STRUCTURAL CONCRETE FOR CIVIL WORKS
05/14

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NOTE: This guide specification covers the requirements for furnishing, hauling, and placing the cast-in-place structural concrete complete, as specified herein and shown on the contract drawings. This section was originally developed for USACE Civil Works projects.

Adhere to UFC 1-300-02 **Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.**

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR)**.**

****

PART 1 GENERAL

****

NOTE: The characteristics that distinguish this specification from Section 03 70 00 MASS CONCRETE, are:

1. Concrete strengths and maximum permitted water-cementitious material ratios are specified.

2. The proportioning of concrete mixtures is the responsibility of the Contractor.

3. Measurement of concrete is on the basis of the actual volume of concrete within pay lines of the

structure as indicated on the drawings. Payment is made at contract prices per cubic meter yard for various items on the schedule. As an option payment may be by lump sum for various items on the schedule.

4. For large complex projects, this specification may be used in conjunction with Section 03 70 00 MASS CONCRETE. If so used, the portions of the project to be constructed under the respective specifications must be clearly called out in the contract documents.

The content of this specification is such that guidance given in EM 1110-2-2000, "Standard Practice for Concrete", is applicable.

****

1.1 UNIT PRICES

****

NOTE: If Section 01 22 00.00 10 PRICE AND PAYMENT PROCEDURES is included in the project specifications, this paragraph title, UNIT PRICES, should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01 22 00.00 10.

Consult the concrete materials design memorandum to choose the appropriate cementitious materials and admixtures for measurement and payment.

****

1.1.1 Structure [_____]

****

NOTE: Repeat this lump sum bid item and its respective subparagraphs for each structure to be paid for by lump sum, renumbering the bid items appropriately. Lump sum bid items should be inserted in paragraph LUMP SUM BID ITEMS of Section 01 22 00.00 10 PRICE AND PAYMENT PROCEDURES.

****

1.1.1.1 Payment

Payment will be made for costs associated with operations necessary for construction of the structure at Station [_____].

1.1.1.2 Unit of Measure

Unit of measure: lump sum.

1.1.2 Concrete for [_____]

****

NOTE: Repeat this bid item and its respective subparagraphs for each bid item of concrete, renumbering the bid items appropriately. Unit price bid items should be inserted in paragraph UNIT PRICE

BID ITEMS of Section 01 22 00.00 10 PRICE AND PAYMENT PROCEDURES.

****

1.1.2.1 Payment

Payment will be made for costs associated with completing the concrete work for concrete placed in the [_____]. However, these costs will not include the cost of embedded parts that are specified to be paid for separately. No payment will be made for concrete, as such, that is placed in structures of which payment is made as a lump sum.

1.1.2.2 Measurement

Concrete will be measured for payment based upon the actual volume of concrete within the pay lines of the structures as indicated on the drawings. Measure concrete placed against the sides of any excavation without the use of intervening forms only within the pay lines of the structure. Make no deductions for rounded or beveled edges, space occupied by metal work, electrical conduits or reinforcing steel, or for voids or embedded items that are either less than 0.14 cubic meters 5 cubic feet in volume or 0.09 square meter 1 square foot in cross section.

1.1.2.3 Unit of Measure

Unit of measure: cubic meters yards.

1.2 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

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

AMERICAN CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 117 (2010; Errata 2011) Specifications for Tolerances for Concrete Construction and Materials and Commentary

ACI 301	(2016) Specifications for Structural Concrete
ACI 301M	(2016) Metric Specifications for Structural Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI SP-15	(2011) Field Reference Manual: Standard Specifications for Structural Concrete ACI 301-05 with Selected ACI References

ASTM INTERNATIONAL (ASTM)

ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1157/C1157M	(2017) Standard Performance Specification for Hydraulic Cement
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2014) Standard Test Method for Lightweight Particles in Aggregate
ASTM C1240	(2014) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

ASTM C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2014) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2014) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231/C231M	(2017a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2012) Petrographic Examination of Aggregates for Concrete
ASTM C31/C31M	(2017) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2017b) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2016) Standard Test Method for Organic

	Impurities in Fine Aggregates for Concrete
ASTM C441	(2011) Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2017) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016) Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2017) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2017) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C87/C87M	(2017) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2017) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D75/D75M	(2014) Standard Practice for Sampling Aggregates
ASTM E1155	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers
ASTM E1155M	(2014) Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers (Metric)

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

CRSI 10MSP	(2009; 28th Ed; Errata) Manual of Standard Practice

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2016) Specifications, Tolerances, and Other Technical Requirements for Weighing

and Measuring Devices

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000; R 2006) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 104	(1980) Method of Calculation of the Fineness Modulus of Aggregate
COE CRD-C 114	(1997) Test Method for Soundness of Aggregates by Freezing and Thawing of Concrete Specimens
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete
COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders

1.3 DESIGN REQUIREMENTS

Design in accordance with ACI 301M ACI 301, Section 4. Submit concrete mix designs with the following properties.

1.3.1 Air Content

****
NOTE: For a specified compressive strength (f'c) of 34.5 MPa 5,000 psi or greater the air content may be reduced by 1.0 percent.
****

Air content between 4 and 7 percent as delivered to the forms and as determined by ASTM C231/C231M, except that when the nominal maximum-size coarse aggregate is 19.0 mm 3/4 inch, between 4.5 and 7.5 percent.

1.3.2 Slump

****
NOTE: Consult the appropriate DM and or the Materials Engineer to fill in the blank and to use the optional sentence.
****

The slump within the range of 25 to 100 mm 1 to 4 inches as determined in accordance with ASTM C143/C143M. Where placement by pump is approved, the slump must not exceed 150 mm 6 inches. [Concrete to be placed in [_____] may contain a chemical admixture for use in producing flowing concrete in accordance with ASTM C1017/C1017M, and the slump of the concrete must not

exceed 200 mm 8 inches].

1.3.3 Concrete Strength

****
NOTE: Consult the Structural Design Engineer and the appropriate DM to fill in the blanks.
****

Provide specified compressive strength f'c as follows:

COMPRESSIVE STRENGTH (MPa) (PSI)	STRUCTURE OR PORTION OF STRUCTURE
34.5 @ [_____] days5,000 @ [_____] days	[_____]
27.6 @ [_____] days4,000 @ [_____] days	[_____]
20.7 @ [_____] days3,000 @ [_____] days	[_____]
17.2 @ [_____] days2,500 @ [_____] days	[_____]
[_____] @ [_____] days	[_____]

1.3.4 Maximum Water-Cementitious Material (W/C) Ratio

****
NOTE: Consult ACI 318 to fill in the blanks and to select the appropriate W/C. When cementitious materials other than portland cement are used, see ACI 211.1, for definitions of W/C.
****

Maximum W/C allowed as follows:

WATER-CEMENT RATIO, BY MASS	STRUCTURE OR PORTION OF STRUCTURE
0.40	[_____]
0.45	[_____]
0.50	[_____]
0.55	[_____]
0.60	[_____]
0.65	[_____]

These W/C's may cause higher strengths than that required by paragraph CONCRETE STRENGTH.

1.3.5 Construction Tolerances

****
NOTE: Finished or formed surfaces subject to high-velocity flow (12 m/s 40 fps and greater) will

meet the tolerances for Class A-HV surfaces specified in paragraph FORMED CONCRETE SURFACES below.

****

Except as specified otherwise, a plus tolerance increases and a minus tolerance decreases the dimension to which it applies. A tolerance without sign means plus or minus. Where only one sign is specified, there is no limit in the other direction. Tolerances are not cumulative. The most restrictive tolerance will control. Tolerances can not extend the structure beyond legal boundaries.

a. Make level and grade tolerance measurements of slabs as soon as possible after finishing. When forms or shoring are used, make the measurements prior to removal.

b. Construction tolerances must meet the requirements of ACI 117 and any of the following requirements that are applicable.

1.3.5.1 Formed Concrete Surfaces

For High Velocity flow, Class A-HV-Abrupt variation, a positive offset between concrete surfaces is a raise of elevation in the direction of water flow and a negative offset is a drop of elevation in the direction of the water flow.

Direction of water flow	+0 mm 0 inches
	-3 mm 1/8 inch
Perpendicular to the direction of water flow	3 mm 1/8 inch

1.3.5.2 Floor Finish by the F-Number System

****

NOTE: Delete this paragraph if floor finish tolerances are not applicable. If surface is subjected to high-velocity flow (12 m/s 40 fps or greater), the tolerances for Class A-HV surfaces specified above, apply. Be aware that the "very flat surface" is difficult to obtain and may require special finishing techniques.

Flatness affects the appearance and function of finishes applied to the concrete and in situations such as large or long expanses of glossy floor materials. Low tolerance for product (for example , thin set tile and wood gymnasium floors) and equipment dictates to the designer to specify higher than normal flatness requirements. The numbers provided in brackets are typical numbers, but A/E should research and select F numbers high enough to get desired results but not so high as to cause undue cost increases and construction problems. Ff/FL 20/15 is equivalent to 8 mm in 5.05 mm 5/16 inches in 10 feet. This test method is not suitable for unshored deck. Fitted partitions need FL greater than or equal to 25.

****

Carefully control the flatness and levelness of the floors in the following listed areas and measure the tolerances by the F-Number system:

Floor Flatness (FF) [20] [_____] [13] [_____] minimum
Floor Levelness (FL) [15] [_____] [10] [_____] minimum

Furnish a floor profilograph or other equipment capable of measuring the floor flatness (FF) number and the floor levelness (FL) number, in accordance with ASTM E1155M ASTM E1155. Perform the tolerance measurements while being observed by the Contracting Officer. Special finishing procedures and special care will be required to meet these tolerances.

1.3.5.3 Tunnel Linings, Conduits, Filling & Emptying Culverts

Water Conveying:

Lateral alignment	
Centerline alignment	13 mm 1/2 inch
Inside dimensions	0.005 times inside dimension
Level alignment	
Profile grade	13 mm 1/2 inch
Cross-Sectional dimension	
Tunnel and culvert lining	-0 mm 0 inch

1.3.5.4 Appearance

Clean permanently exposed surfaces, if stained or otherwise discolored, by a method that does not harm the concrete and that is approved by the Contracting Officer.

1.4 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within

the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Reinforcing steel; G[, [_____]]

SD-03 Product Data

Concrete Mix Designs; G[, [_____]]
Batch Plant; G[, [_____]]
Concrete Mixers
Conveying Equipment
Placing Equipment
Construction Joint Treatment; G[, [_____]]
Cold-Weather Requirements; G[, [_____]]
Hot-Weather Requirements; G[, [_____]]
Cementitious Materials, Admixtures, and Curing Compound; G[, [_____]]
Nonshrink Grout
Mechanical Reinforcing Bar Connectors

SD-06 Test Reports

Aggregates; G[, [_____]]
Mill Test Reports
Tests and Inspections
Quality of Aggregates; G[, [_____]]
[Mixer Uniformity]
Water

SD-07 Certificates

Concrete Field Testing Technicians
Concrete Construction Inspector (CCI)
Cementitious Materials
Blended Hydraulic Cement

SD-08 Manufacturer's Instructions

Curing Compound

1.5 QUALITY ASSURANCE

The Government will sample and test aggregates and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with ASTM D75/D75M. Concrete will be sampled in accordance with ASTM C172/C172M. Do not use a material until the Contracting Officer gives notice that test results are satisfactory.[The Government will sample and test chemical admixtures, curing compounds, and cementitious materials.] The individuals who sample and test concrete or the constituents of concrete as required in this specification must 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. The individuals who perform the inspection of concrete construction must have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector (CCI). Submit statements that the concrete testing technicians and the concrete inspectors meet the specified requirements. Maintain a copy of ACI SP-15 and CRSI 10MSP at project site.

1.5.1 Cement and Pozzolan

****
NOTE: Delete this paragraph if materials are to be accepted on the basis of a manufacturer's certification of compliance and mill test reports. Consult the Materials Engineer to select prequalified sources, first and second subparagraphs, sealed bins, third and fourth subparagraphs, or both options, all subparagraphs.
****

If cement or pozzolan is to be obtained from more than one source, state the estimated amount to be obtained from each source and the proposed schedule of shipments in the initial notification.

1.5.1.1 Prequalified Cement Sources

Deliver and use cement directly from a mill of a producer designated as a qualified source. Samples of cement for check testing will be taken at the project site or concrete-producing plant by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified cement sources is available from Director, U.S. Army Corps of Engineers, Engineer Research and Development Center - Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEERD-SC.

1.5.1.2 Prequalified Pozzolan Sources

Deliver and use pozzolan directly from a producer designated as a qualified source. Samples of pozzolan for check testing will be taken at the project site by a representative of the Contracting Officer for testing at the expense of the Government. A list of prequalified pozzolan sources is available from the Director, U.S. Army Corps of Engineers, Engineer Research and Development Center - Structures Laboratory, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEERD-SC.

1.5.1.3 Nonprequalified Cement Sources

Cement, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of testing. Sampling, testing, and the shipping inspection from the point of sampling, when the point is other than at the site of the work, will be made by or under the supervision of the Government and at its expense. Do not use cement until the Contracting Officer gives that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the request and expense of the Contractor. When the point of sampling is other than at the site of the work, the fill gates of the sampled bin and conveyances used in shipment will be sealed under Government supervision and kept sealed until shipment from the bin has been completed. If tested cement is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense. The cost of testing cement excess to project requirements is also at the expense of the Contractor. The charges for testing cement at the expense of the Contractor will be deducted from the payments due the Contractor at a rate of [_____] dollars per ton (metric) of cement represented by the tests.

1.5.1.4 Nonprequalified Pozzolan Sources

****

NOTE: To fill in the blank for cost of testing excess cement contact the Structures Laboratory, Concrete Division at WES.

****

Pozzolan, if not from a prequalified source, will be sampled at the source and stored in sealed bins pending completion of certain tests. Pozzolan will also be sampled at the site when determined necessary. All sampling and testing will be by and at the expense of the Government. Release for shipment and approval for use will be based on compliance with 7-day lime-pozzolan strength requirements and other physical and chemical and uniformity requirements for which tests can be completed by the time the 7-day lime-pozzolan strength test is completed. Release for shipment and approval for use on the above basis will be contingent on continuing compliance with the other requirements of the specifications. If a bin fails, the contents may be resampled and tested at the Contractor's expense. In this event the pozzolan may be sampled as it is loaded into cars, trucks, or barges provided they are kept at the source until released for shipment. Unsealing and resealing of bins and sealing of shipping conveyances will be done by or under the supervision of the Government. Shipping conveyances will not be accepted at the site of the work unless received with all seals intact. If pozzolan is damaged in shipment, handling, or storage, Promptly remove it from the site of the work. Retest pozzolan that has not been used within 6 months after testing when directed by the Contracting Officer and rejectthe pozzolan if the test results are

not satisfactory. If tested pozzolan is rehandled at transfer points, the extra cost of inspection is at the Contractor's expense. The cost of testing excess pozzolan is at the Contractor's expense at a rate of [_____] cents per ton (metric) (2000 lb). The amount will be deducted from payment to the Contractor.

1.5.2 Cementitious Materials, Admixtures, and Curing Compound

****

NOTE: When the optional sentence below is deleted, the corresponding manufacturer's certification described in paragraph SUBMITTALS should be used. EM 1110-2-2000, "Standard Practice for Concrete," provides guidance in selecting the options for Government or for Contractor testing."

****

At least 60 days in advance of concrete placement, notify the Contracting Officer of the sources for cementitious materials, admixtures, and curing compound, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete. Cementitious Materials, including Cement and Pozzolan, [and Ground Granulated Blast-Furnace Slag] will be accepted on the basis of the manufacturer's certification of compliance. Do not use cementitious materials until receiving Contracting Officer notice of acceptance. Cementitious materials will be subject to check testing from samples obtained at the source, at transfer points, or at the project site, as scheduled by the Contracting Officer, and such sampling will be by or under the supervision of the Government at its expense. Promptly remove material not meeting specifications from the site of work. Submit samples of materials for Government testing and approval. Submit manufacturer's instructions for placement of curing compound.

1.6 DELIVERY, STORAGE, AND HANDLING

Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing and reject if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements of paragraph CHEMICAL ADMIXTURES.

PART 2 PRODUCTS

2.1 MATERIALS

****

NOTE: Delete the requirements for Certificates for air entrainment admixtures, other chemical admixtures, curing compounds, portland cement and pozzolan if the optional parts of paragraph CEMENTITIOUS MATERIALS, ADMIXTURES, AND CURING COMPOUND above, is used.

****

Submit mill test reports attesting that materials meet the requirements of the specification under which they are furnished. Certification and mill test reports must be from samples taken from the particular lot furnished. Certify the following for compliance with all specification requirements: Impervious-Sheet Curing Materials, Air-Entraining Admixture, Other Chemical Admixtures, Membrane-Forming Curing Compound. Submit descriptive

literature of the Nonshrink Grout proposed for use together with a certificate from the manufacturer stating that it is suitable for the application or exposure for which it is being considered.

2.1.1 Cementitious Materials

Cementitious materials are portland cement, portland-pozzolan cement, portland blast-furnace slag cement, portland cement in combination with pozzolan or GGBF slag [or [_____]] [or portland cement in combination with silica fume] conforming to appropriate specifications listed below. Restrict the use of cementitious materials in architectural concrete to one color, one source, and one type.

2.1.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of C3A in Type I cement is 15 percent [including the heat of hydration at 7 days] [including false set requirements] [low alkali when used with aggregates listed at the end of this section which require it.] [In lieu of low-alkali cement, the Contractor may use a combination of portland cement that does not meet the low-alkali requirement with a pozzolan or GGBF slag provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441 must be equal to or less than the expansion of a low-alkali cement meeting the requirements of ASTM C150/C150M when tested in general conformance with ASTM C441. Run the expansion tests concurrently at an independent laboratory that is nationally recognized to perform such tests. The Government reserves the right to confirm the test results and to adjust the percentage of pozzolan or slag in the combination to suit other requirements.] [white portland cement must meet the above requirements except that it may be Type I, Type II, or Type III [low alkali]. White Type III may be used only in specific areas of the structure, when approved in writing by the Contracting Officer.]

2.1.1.2 High-Early-Strength Portland Cement

ASTM C150/C150M, Type III, [with C3A limited to [5] [8] percent] [low alkali when used with aggregates listed at the end of this section which require it] [used only when specifically approved in writing].

2.1.1.3 Fly Ash

ASTM C618, Class F, except that the maximum allowable loss on ignition must not exceed [3] [6] percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 8 percent and a total equivalent alkali content less than 1.5 percent. Add with cement.

2.1.1.4 Raw or Calcined Natural Pozzolan

Natural pozzolan must be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and must have an ignition loss not exceeding 3 percent. Class N pozzolan for use in mitigating Alkali-Silica Reactivity must have a Calcium Oxide (CaO) content of less than 13 percent and total equivalent alkali content less than 3 percent.

2.1.1.5 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) must conform to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age is at least 95 percent of the control specimens.

b. The average particle size doest not exceed 6 µm 6 microns.

c. The sum of SiO2 + Al2O3 + Fe2O3 is greater than 77 percent.

[2.1.1.6 Ground Granulated Blast-Furnace Slag

Conform to ASTM C989/C989M, Grade [_____].

][2.1.1.7 Silica Fume

****
NOTE: Optional Table 2 in ASTM C1240 should be included when used with aggregates listed to require low-alkali cement. Other requirements in Table 4 may be specified if necessary. Refer to EM 1110-2-2000 for guidance.
****

Silica fume may be furnished as a dry, densified material or as a slurry. Silica fume, unprocessed, or before processing into a slurry or a densified material, must conform to ASTM C1240 with [Table 2 and] the Specific Surface Area and Uniformity Requirements in Table 4 invoked. Provide the services of a manufacturer's technical representative, experienced in mixture proportioning, placement procedures, and curing of concrete containing silica fume. Make the manufacturer's representative available for consultation by both the Contractor and the Government during mixture proportioning, planning, and production of silica-fume concrete and, onsite immediately prior to and during at least the first placement of concrete containing silica fume, and at other times if directed.

]2.1.1.8 Blended Hydraulic Cement

Conform to ASTM C595/C595M and ASTM C1157/C1157M, Type IP or IS, including the optional requirement for mortar expansion [and sulfate soundness] and consist of a mixture of ASTM C150/C150M Type I, or Type II cement and a complementary cementing material. Provide slag added to the Type IS blend conforming to ASTM C989/C989M ground granulated blast-furnace slag. Use pozzolan added to the Type IP blend conforming ASTM C618 Class F and interground with the cement clinker. Provide the manufacturer's written statement that the amount of pozzolan in the finished cement will not vary more than plus or minus 5 mass percent of the finished cement from lot-to-lot or within a lot. The percentage and type of mineral admixture used in the blend cannot change from that submitted for the aggregate evaluation and mixture proportioning.

2.1.2 Aggregates

ASTM C33/C33M, except as modified herein. Furnish aggregates for exposed concrete surfaces from one source. Provide aggregates that do not contain any substance which may be deleteriously reactive with the alkalies in the cement. Submit test report showing compliance with ASTM C33/C33M.

[2.1.2.1 Aggregate Expansion

Provide fine and coarse aggregates with expansions less than 0.08 percent at 28 days after casting when testing in accordance with ASTM C1260. Should the test data indicate an expansion of 0.08 percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1567 and using the proposed mix design. In this case, include the mix design low alkali portland cement and one of the following supplementary cementitious materials:

a. GGBF slag at a minimum of 40 percent of total cementitious

b. Fly ash or natural pozzolan at a minimum of total cementitious of

(1) 30 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 65 percent or more,
(2) 25 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 70 percent or more,
(3) 20 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 80 percent or more,
(4) 15 percent if (SiO_2 plus Al_2O_3 plus Fe_2O_3) is 90 percent or more.

c. [Silica fume at a minimum of 7 percent of total cementitious.]

If a combination of these materials is chosen, the minimum amount must be a linear combination of the minimum amounts above. Include these materials in sufficient proportion to show less than 0.08 percent expansion at 16 days after casting when tested in accordance with ASTM C1567.

]2.1.2.2 Unfavorable Properties

Do not provide aggregates possessing properties or constituents that are known to have specific unfavorable effects in concrete when tested in accordance with ASTM C295/C295M.

2.1.3 Chemical Admixtures

Provide chemical admixtures, when required or permitted, that conform to the appropriate specification listed.

2.1.3.1 Air-Entraining Admixture

Conform to ASTM C260/C260M and consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.1.3.2 Accelerating Admixture

Meet the requirements of ASTM C494/C494M, Type C or E, except that calcium chloride or admixtures containing calcium chloride is not permitted.

2.1.3.3 Water-Reducing or Retarding Admixture

2.1.3.3.1 Water-Reducing or Retarding Admixtures

ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

2.1.3.3.2 High-Range Water Reducing Admixture

ASTM C494/C494M, Type F or G except that the 6-month and 1-year strength requirements are waived. The admixture may be used only when approved by

the Contracting Officer, such approval being contingent upon particular mixture control as described in the Contractor's Quality Control Plan.

[2.1.3.4 Other Chemical Admixtures

****
NOTE: Use this paragraph when the optional sentences in paragraph SLUMP is used.
****

Provide other chemical admixtures for use in producing flowing concrete in compliance with ASTM C1017/C1017M, Type 1 or 2. Only use these admixture for concrete listed in paragraph SLUMP.

]2.1.4 Water

Provide water for mixing and curing compliance with the requirements of ASTM C1602/C1602M; [potable, and] free of injurious amounts of oil, acid, salt, or alkali. Submit test report showing water complies with ASTM C1602/C1602M.

2.1.5 Reinforcing Steel

****
NOTE: Delete this paragraph if Section 03 20 00.00 10 COCRETE REINFORCING is used. Also delete this paragraph if fibercrete is accepted for use by the Contracting Officer.
****

Provide reinforcing bars conforming to the requirements of ASTM A615/A615M, Grade 60, deformed. Welded steel wire reinforcement must conform to the requirements of ASTM A1064/A1064M. Detail reinforcement not indicated in accordance with ACI 301M ACI 301. Provide mechanical reinforcing bar connectors in accordance with ACI 301 and with 125 percent minimum yield strength of the reinforcement bar.

2.1.6 Nonshrink Grout

Cconform to ASTM C1107/C1107M and a commercial formulation suitable for the application proposed.

2.1.7 Abrasive Aggregates

Fifty-five percent, minimum, aluminum oxide or silicon-dioxide abrasive ceramically bonded together to form a homogeneous material sufficiently porous to provide a good bond with portland paste; or factory-graded emery aggregate consisting of not less than 45 percent aluminum oxide and 25 percent ferric oxide. Provide well graded aggregate from particles retained on the 600-µm (No. 30) sieve to particles passing the 2.36-mm (No. 8) sieve.

[2.2 EQUIPMENT

****
NOTE: Refer to the appropriate DM for the capacity. Guidance is also found in EM 1110-2-2000.
****

Submit data on placing equipment and methods. The batching, mixing, conveying, and placing equipment must have a capacity of at least [_____] cubic meters yards per hour. Conform the batch plant to the requirements of NRMCA CPMB 100 and as specified; however, rating plates attached to batch plant equipment are not required. Submit batch plant data forconformance with applicable specifications.

2.2.1 Batching Equipment

****
NOTE: Refer to the appropriate DM to choose the appropriate alternates.
****

Use [partially automatic], [semiautomatic], [or] [automatic] batching controls.[Provide the semiautomatic batching system with interlocks such that the discharge device cannot be actuated until the indicated material is within the applicable tolerance.] Equip the batching system with an accurate recorder or recorders that meet the requirements of NRMCA CPMB 100. Provide separate bins or compartments for each size group of aggregate and cement, pozzolan, and GGBF slag. Weigh aggregates either in separate weigh batchers with individual scales or cumulatively in one weigh batcher on one scale. Do not weigh aggregate in the same batcher with cement, pozzolan, or GGBF slag. If both cement and pozzolan or GGBF slag are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, do not weigh the mass of the water cumulatively with another ingredient. Interlock water batcher filling and discharging valves so that the discharge valve cannot be opened before the filling valve is fully closed. Provide an accurate mechanical device for measuring and dispensing each admixtured. Interlock each dispenser with the batching and discharging operation of the water so that each admixture is separately batched and discharged automatically in a manner to obtain uniform distribution throughout the batch in the specified mixing period. Do not combine admixtures prior to introduction in water. Arrange the plant to facilitate the inspection of all operations at all times. Provide facilities for obtaining representative samples of aggregates from each bin or compartment. Clearly mark all filling ports for cementitious materials bins or silos with a permanent sign stating the contents.

2.2.2 Scales

Provide equipment for batching by mass conforming to the applicable requirements of NIST HB 44, except that the accuracy is plus or minus 0.2 percent of scale capacity. Provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Perform tests at the frequency required in paragraph TESTS AND INSPECTIONS, and in the presence of a Government inspector.

2.2.3 Batching Tolerances

a. Weighing Tolerances

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	0 to plus 2

MATERIAL	PERCENT OF REQUIRED MASS
Aggregate	plus or minus 2
Water	plus or minus 1
Chemical admixture	0 to plus 6

b. Volumetric Tolerances - For volumetric batching equipment, the following tolerances apply to the required volume of material being batched:

Water	Plus or minus 1 percent
Chemical admixtures	Zero to plus 6 percent

2.2.4 Moisture Control

The plant must be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched. [Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring moisture in the fine aggregate. Arrange the sensing element so that the measurement is made near the batcher charging gate of the sand bin or in the sand batcher.]

2.2.5 Concrete Mixers

Do not charge the concrete mixers in excess of the capacity recommended by the manufacturer. Operate the mixers at the drum or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operating condition, and keep the mixer drums free of hardened concrete. Should any mixer at any time produce unsatisfactory results, promptly discontinue its use until it is repaired. Submit concrete mixer data including the make, type, and capacity of concrete mixers proposed for mixing concrete.

2.2.5.1 Stationary Mixers

Concrete plant mixers must be tilting, nontilting, horizontal-shaft, vertical-shaft, or pugmill and provided with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. The mixing time and uniformity must conform to all the requirements in ASTM C94/C94M applicable to central-mixed concrete.

2.2.5.2 Truck Mixers

Truck mixers, the mixing of concrete therein, and concrete uniformity must conform to the requirements of ASTM C94/C94M. A truck mixer may be used either for complete mixing (transit-mixed) or to finish the partial mixing done in a stationary mixer (shrink-mixed). Equip each truck with two counters from which it will be possible to determine the number of revolutions at mixing speed and the number of revolutions at agitating speed.

2.2.6 Conveying Equipment

Submit data on the conveying equipment and methods for transporting,

handling, and depositing the concrete. Conform the conveying equipment to the following requirements:

2.2.6.1 Buckets

The interior hopper slope shall be not less than 58 degrees from the horizontal, the minimum dimension of the clear gate opening shall be at least five times the nominal maximum-size aggregate, and the area of the gate opening shall not be less than 0.2 square meters 2 square feet. The maximum dimension of the gate opening shall not be greater than twice the minimum dimension. The bucket gates shall be essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that buckets larger than 1.5 cubic meters 2 cubic yards shall not be manually operated. The design of the bucket shall provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

2.2.6.2 Transfer Hoppers

Concrete may be charged into nonagitating hoppers for transfer to other conveying devices. Transfer hoppers must be capable of receiving concrete directly from delivery vehicles and have conical-shaped discharge features. Equip the transfer hopper with a hydraulically operated gate and with a means of external vibration to effect complete discharge. Do not hold concrete in nonagitating transfer hoppers more than 30 minutes.

2.2.6.3 Trucks

Truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete shall conform to the requirements of ASTM C94/C94M. Nonagitating equipment may be used for transporting plant-mixed concrete over a smooth road when the hauling time is less than 15 minutes. Bodies of nonagitating equipment shall be smooth, watertight, metal containers specifically designed to transport concrete, shaped with rounded corners to minimize segregation, and equipped with gates that will permit positive control of the discharge of the concrete.

2.2.6.4 Chutes

When concrete can be placed directly from a truck mixer, agitator, or nonagitating equipment, the chutes attached to this equipment by the manufacturer may be used. Use a discharge deflector when required by the Contracting Officer. Separate chutes and other similar equipment will not be permitted for conveying concrete.

2.2.6.5 Belt Conveyors

Design and operate to assure a uniform flow of concrete from mixer to final place of deposit without segregation of ingredients or loss of mortar and provide with positive means for preventing segregation of the concrete at the transfer points and the point of placing. Construct belt conveyors such that the idler spacing does not exceed 900 mm 36 inches. The belt speed must be a minimum of 90 m 300 feet per minute and a maximum of 230 m 750 feet per minute. If concrete is to be placed through installed horizontal or sloping reinforcing bars, discharge the conveyor concrete into a pipe or elephant trunk that is long enough to extend through the reinforcing bars.

2.2.6.6 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. The pumping equipment must be piston or squeeze pressure. The pipeline must be rigid steel pipe or heavy-duty flexible hose. The inside diameter of the pipe must be at least three times the nominal maximum-size coarse aggregate in the concrete mixture to be pumped but not less than 100 mm 4 inches. Do not use aluminum pipe.

2.2.7 Vibrators

Use vibrators of the proper size, frequency, and amplitude for the type of work being performed in conformance with the following requirements:

APPLICATION	HEAD DIAMETER (mm (inches)	FREQUENCY (VPM)	AMPLITUDE (mm (inches)
Thin walls, beams, etc.	32 to 641-1/4 to 2-1/2	9,000 to 13,500	0.5 to 1.00.02 to 0.04
General construction	50 to 882 to 3-1/2	8,000 to 12,000	0.6 to 1.20.025 to 0.05

Determine the frequency and amplitude in accordance with COE CRD-C 521.

]PART 3 EXECUTION

3.1 PREPARATION FOR PLACING

3.1.1 Embedded Items

Before placement of concrete, take care to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Embedded items must be free of oil and other foreign matter such as loose coatings or rust, paint, and scale. The embedding of wood in concrete will be permitted only when specifically authorized or directed. Temproarily fill voids in sleeves, inserts, and anchor slots with readily removable materials to prevent the entry of concrete into voids. Welding, including tack welding, will not be permitted on embedded metals within 600 mm 2 feet of the surface of the concrete.

3.1.2 Concrete on Earth Foundations

Earth surfaces upon which concrete is to be placed must be clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of concrete, compact the earth foundation in accordance with Section 31 00 00 EARTHWORK.

3.1.3 Concrete on Rock Foundations

Rock surfaces upon which concrete is to be placed mustl be clean, free from oil, standing or running water, ice, mud, drummy rock, coating, debris, and loose, semidetached, or unsound fragments. Clean joints in rock to a satisfactory depth, as determined by the Contracting Officer, and to firm rock on the sides. Immediately before the concrete is placed, thoroughly clean all rock surfaces by the use of air-water jets or sandblasting as described in paragraph CONSTRUCTION JOINT TREATMENT. Keep all rock surfaces continuously wet for at least 24 hours immediately prior to placing concrete thereon. Cover all approximately horizontal surfaces immediately before the concrete is placed with a layer of mortar

proportioned similar to that in the concrete mixture. Cover the mortar with concrete before the time of initial setting of the mortar.

3.1.4 Construction Joint Treatment

Submit the method and equipment proposed for joint cleanup and waste disposal, for review and approval. Conform construction joint treatment to the following requirements:

3.1.4.1 Joint Preparation

Prepare concrete surfaces to which additional concrete is to be bonded for receiving the next lift or adjacent concrete by cleaning with either air-water cutting, sandblasting, high-pressure water jet, or other approved method. Air-water cutting will not be permitted on formed surfaces or surfaces congested with reinforcing steel. Regardless of the method used, the resulting surfaces must be free from all laitance and inferior concrete so that clean, well bonded coarse aggregate is exposed uniformly throughout the lift surface. Do not undercut the edges of the coarse aggregate. Wash the surface again as the last operation prior to placing the next lift. No standing water is allowed on the surface upon which concrete is placed.

3.1.4.2 Air-Water Cutting

Perform air-water cutting of a construction joint at the proper time and only on horizontal construction joints. The air pressure used in the jet must be 620 to 760 kPa 90 to 110 psi, and the water pressure must be just sufficient to bring the water into effective influence of the air pressure. When approved by the Contracting Officer, a retarder complying with the requirements of COE CRD-C 94 may be applied to the surface of the lift to prolong the period of time during which air-water cutting is effective. Prior to receiving approval, furnish samples of the material to be used and demonstrate the method to be used in applications. After cutting, wash and rinse the surface long as there is any trace of cloudiness of the wash water. Where necessary to remove accumulated laitance, coatings, stains, debris, and other foreign material, high-pressure water jet or sandblasting will be required as the last operation before placing the next lift.

3.1.4.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 20.7 MPa 3,000 psi may be used for cleaning. Delay its use until the concrete is sufficiently hard so that only the surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. If the water jet is incapable of a satisfactory cleaning, clean the surface by sandblasting.

3.1.4.4 Wet Sandblasting

This method may be used when the concrete has reached sufficient strength to prevent undercutting of the coarse aggregate particles. Then thoroughly wash the surface of the concrete to remove all loose materials.

3.1.4.5 Waste Disposal

Dispose of the waste water employed in cutting, washing, and rinsing of concrete surfaces such that the waste water does not stain, discolor, or affect exposed surfaces of the structures, or damage the environment of the project area. The method of disposal is subject to approval.

3.2 CONVEYING AND PLACING CONCRETE

Convey and place concrete in accordance with ACI 301M ACI 301, Section 5. Do not reconstitute concrete that has begun to solidify.

3.2.1 Cold-Weather Requirements

Place concrete in cold weather in accordance with ACI 306R.

3.2.2 Hot-Weather Requirements

Place concrete in hot weather in accordance with ACI 305R.

[3.2.3 Placing Concrete in Ogee Section

Finish he unformed portion of the ogee section by placing concrete slightly above grade and striking off to grade by accurate screeding. Screeding may be accomplished by semimechanical devices or by a mechanical screed that consolidates and screeds the surface in one operation. Ribs embedded in the fresh concrete as guides for screeds will not be permitted.

][3.2.4 Placing Concrete Underwater

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NOTE: Delete this paragraph when not applicable. If major underwater concrete placement is required, use specification 03 31 29 MARINE CONCRETE. Contractor will be required to submit proposed procedures.

****

Depost concrete, described in Bid Item [_____], in water by a tremie or concrete pump. The methods and equipment used will be subject to approval. Concrete buckets will not be permitted for underwater placement of concrete except to deliver concrete to the tremie. The tremie must be watertight and sufficiently large to permit a free flow of concrete. Keep the discharge end of the pump line or tremie shaft continuously submerged in the concrete. Effect the underwater seal in a manner that will not produce undue turbulence in the water. Keep the tremie shaft full of concrete to a point well above the water surface. Proceed with placement without interruption until the concrete has been brought to the required height. Do not move the tremie horizontally during a placing operation, and provide a sufficient number of tremies so that the maximum horizontal flow is limited to 5 m 15 feet.

]3.3 SETTING BASE PLATES AND BEARING PLATES

3.3.1 Setting of Plates

After being plumbed and properly positioned, provide column base plates, bearing plates for beams and similar structural members, and machinery and equipment base plates with full bearing with nonshrink grout. The space between the top of concrete or masonry-bearing surface and the bottom of the plate must be approximately 1/24 of the width of the plate, but not less than 13 mm 1/2 inch for plates less than 300 mm 12 inches wide. Concrete surfaces must be rough, clean, and free of oil, grease, and laitance, and damp. Clean metal surfaces free of oil, grease, and rust.

3.3.2 Nonshrink Grout Application

Water content must be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength.

3.3.2.1 Mixing and Placing of Nonshrink Grout

Mix and place in accordance with the material manufacturer's instructions and as specified. Thoroughly dry-mix ingredients before adding water. After adding water, mix the batch for 3 minutes. Size batches to allow continuous placement of freshly mixed grout. Discard grout not used within 30 minutes after mixing. Fill the space between the top of the concrete or masonry-bearing surface and the plate solid with the grout. Use forms of wood or other equally suitable material for retaining the grout and remove after the grout has set. If grade "A" grout as specified in ASTM C1107/C1107M is used, form all surfaces to provide restraint. Work the placed grout to eliminate voids; however, avoid overworking and breakdown of the initial set. Do not be retemper or subject grout to vibration from any source. Where clearances are unusually small, place under pressure with a grout pump. Maintain temperature of the grout, and of surfaces receiving the grout, at 20 to 30 degrees C 65 to 85 degrees F until after setting.

3.3.2.2 Treatment of Exposed Surfaces

After the grout has set, cut back the exposed surfaces of those types containing metallic aggregate 25 mm 1 inch and immediately cover with a parge coat of mortar proportioned by mass of one part portland cement, two parts sand, and sufficient water to make the mixture placeable. The parge coat must have a smooth, dense finish. The exposed surface of other types of nonshrink grout must have a smooth, dense finish.

3.3.2.3 Curing

Cure grout and parge coats in accordance with Section 03 39 00.00 10.

3.4 TESTS AND INSPECTIONS

Submit test results and inspection reports, daily and weekly. Tests and inspect in accordance the following:

3.4.1 General

Perform the inspections and tests described below, and, based upon the results of these inspections and tests, take the action required and submit reports as required. When, in the opinion of the Contracting Officer, the concreting operation is out of control, cease concrete placement. Locate the laboratory performing the tests on site and conform with ASTM C1077. The Government will inspect the laboratory, equipment, and test procedures prior to start of concreting operations and at least once per year thereafter for conformance with ASTM C1077.

3.4.2 Testing and Inspection Requirements

[3.4.2.1 Fine Aggregate

3.4.2.1.1 Grading

At least once during each shift when the concrete plant is operating, perform one sieve analysis and fineness modulus determination in accordance with ASTM C136/C136M and COE CRD-C 104 for the fine aggregate or for each size range of fine aggregate if it is batched in more than one size or classification. The location at which samples are taken may be selected by the Contractor as the most advantageous for control. However, the Contractor is responsible for delivering fine aggregate to the mixer within specification limits.

3.4.2.1.2 Corrective Action for Fine Aggregate Grading

When the amount passing on any sieve is outside the specification limits, immediately resample and retest the fine aggregate. If there is another failure on any sieve, immediately be report to the Contracting Officer.

3.4.2.1.3 Moisture Content Testing

When in the opinion of the Contracting Officer the electric moisture meter is not operating satisfactorily, perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Randomly select the times for the tests within the 8-hour period. Make an additional test whenever the slump is shown to be out of control or excessive variation in workability is reported by the placing foreman. When the electric moisture meter is operating satisfactorily, make at least two direct measurements of moisture content per week to check the calibration of the meter. Use the results of tests for moisture content to adjust the added water in the control of the batch plant.

3.4.2.1.4 Moisture Content Corrective Action

Whenever the moisture content of the fine aggregate changes by 0.5 percent or more, adjust the scale settings for the fine-aggregate batcher and water batcher (directly or by means of a moisture compensation device) if necessary to maintain the specified slump.

3.4.2.2 Coarse Aggregate

3.4.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, conduct a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. A test record of samples of aggregate taken at the same locations must show the results of the current test as well as the average results of the five most recent tests including the current test. The Contractor may adopt limits for control which are coarser than the specification limits for samples taken at locations other than as delivered to the mixer to allow for degradation during handling.

3.4.2.2.2 Corrective Action for Grading

When the amount passing any sieve is outside the specification limits, immediately resample and retest the coarse aggregate. If the second sample fails on any sieve, report that fact to the Contracting Officer. Where two

consecutive averages of five tests are outside specification limits, consider the operation out of control and report to the Contracting Officer. Stop concreting and take immediate steps to correct the grading.

3.4.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate at least twice per week. When two consecutive readings for smallest size coarse aggregate differ by more than 1.0 percent, increase frequency of testing to that specified above for fine aggregate, until the difference falls below 1.0 percent.

3.4.2.2.4 Coarse Aggregate Moisture Corrective Action

Whenever the moisture content of any size of coarse aggregate changes by 0.5 percent or more, adjust the scale setting for the coarse aggregate batcher and the water batcher if necessary to maintain the specified slump.

3.4.2.3 Quality of Aggregates

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NOTES: Tests should be those listed in paragraph QUALITY ASSURANCE.

The petrographic examination shall be used to identify deleterious substances in aggregates. Deleterious substances shall be listed individually with respective limits.

Depending upon the quality pf aggregates available, some tests may not be required. Refer to EM 1110-2-2000 for the purpose of each test.

****

Submit aggregate quality tests at least 30 days prior to start of concrete placement.

3.4.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of concrete placement, perform all tests for aggregate quality listed below. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule shown below. Take amples tested after the start of concrete placement immediately prior to entering the concrete mixer.

	FREQUENCY		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Specific Gravity	Every 3 months	Every 3 months	ASTM C127 ASTM C128
Absorption	Every 3 months	Every 3 months	ASTM C127 ASTM C128

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Durability Factor (using Procedure A)	Every 12 months	Every 12 months	COE CRD-C 114 ASTM C666/C666M
Clay Lumps and Friable Particles	Every 3 months	Every 3 months	ASTM C142/C142M
Material Finer than 75-m No. 200 Sieve	Not applicable	Every 3 months	ASTM C117
Impurities	Every 3 months	Not applicable	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Chert, less than 2.40 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M
Coal and Lignite, less than less than 2.00 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M

3.4.2.3.2 Corrective Action for Aggregate Quality

If the result of a quality test fails to meet the requirements for quality immediately prior to start of concrete placement, change production procedures or materials and perform additional tests until the material meets the quality requirements prior to proceeding with either mixture proportioning studies or starting concrete placement. After concrete placement commences, whenever the result of a test for quality fails the requirements, immediately rerun the test. If the second test fails the quality requirement, report the fact to the Contracting Officer and take immediate steps to rectify the situation.

3.4.2.4 Scales

3.4.2.4.1 Weighing Accuracy

Check the accuracy of the scales by test weights prior to start of concrete operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT. Also make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.4.2.4.2 Batching and Recording Accuracy

Once a week check the accuracy of each batching and recording device during a weighing operation by noting and recording the required weight, recorded weight, and the actual weight batched. Confirm that the calibration devices described in paragraph EQUIPMENT, for checking the accuracy of dispensed admixtures, are operating properly.

3.4.2.4.3 Scales Corrective Action

When either the weighing accuracy or batching accuracy does not comply with specification requirements, do not operate the plant until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately.

3.4.2.5 Batch-Plant Control

Continuously control the measurement of all constituent materials including cementitious materials, each size of aggregate, water, and admixtures. Adjust the aggregate weights and amount of added water as necessary to compensate for free moisture in the aggregates. Adjust the amount of air-entraining agent to control air content within specified limits. Prepare a report indicating type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water weights per cubic meter yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water weights per cubic meter yard for each class of concrete batched during plant operation.

]3.4.2.6 Concrete Mixture

3.4.2.6.1 Air Content Testing

Conduct air content tests when test specimens are fabricated. In addition, make at least two tests for air content on randomly selected batches of each separate concrete mixture produced during each 8-hour period of concrete production. Make additional tests when excessive variation in workability is reported by the placing foreman or Government quality assurance representative. Conduct tests in accordance with ASTM C231/C231M. Plot test results on control charts which at all times are readily available to the Government.[Keep copies of the current control charts in the field, by the Contractor's quality control representatives, and plotted results as tests are made. When a single test result reaches either the upper or lower action limit immediately conduct a second test. Average the results of the two tests and use this average as the air content of the batch to plot on both the control chart for air content and the control chart for range, and for determining the need for any remedial action. Plot the result of each test, or average as noted in the previous sentence, on a separate chart for each mixture on which an "average line" is set at the midpoint of the specified air content range from paragraph AIR CONTENT. Set an upper warning limit and a lower warning limit line 1.0 percentage point above and below the average line. Set an upper action limit and a lower action limit line 1.5 percentage points above and below the average line, respectively. Plot the range between each two consecutive tests on a control chart for range where an upper warning limit is set at 2.0 percentage points and up upper action limit is set at 3.0 percentage points. Samples for air content may be taken at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated air content. If the materials or

transportation methods cause air content loss between the mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the air content at the mixer as directed.]

3.4.2.6.2 Air Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, immediately adjust the amount of air-entraining admixture batched. As soon as is practical after each adjustment, conduct another test to verify the result of the adjustment. Whenever a point on the control chart range reaches the warning limit, recalibrate the admixture dispenser to ensure that it is operating accurately and with good reproducibility. Whenever a point on either control chart reaches an action limit line, the air content is considered out of control and immediately halt the concreting operation until the air content is under control. Make additional air content tests when concreting is restarted.

3.4.2.6.3 Slump Testing

In addition to slump tests made when test specimens are fabricated, make at least four slump tests on randomly selected batches in accordance with ASTM C143/C143M for each separate concrete mixture produced during each 8-hour or less period of concrete production each day. Also, make additional tests shall when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. Plot test results on control charts, which are readily available to the Government at all times. Keep copies of the current control charts in the field by the Contractor's quality control representatives and plot results as tests are made. When a single slump test reaches or goes beyond either the upper or lower action limit, immediately make a second test on the same batch of concrete. Average the results of the two tests and use this average as the slump of the batch to plot on both the control chart for percent air and the chart for range, and for determining the need for any remedial action. Set an upper warning limit at 13 mm 1/2 inch below the maximum allowable slump on separate control charts for percent air used for each type of mixture as specified in paragraph SLUMP, and set an upper action limit line and lower action limit line at the maximum and minimum allowable slumps, respectively, as specified in the same paragraph. Plot the range between each consecutive slump test for each type of mixture on a single control chart for range on which an upper action limit is set at 50 mm 2 inches. Take samples for slump at the mixer, however, the Contractor is responsible for delivering the concrete to the placement site at the stipulated slump. If the materials or transportation methods cause slump loss between mixer and the placement, take correlation samples at the placement site as required by the Contracting Officer and control the slump at the mixer as directed.

[3.4.2.6.4 Slump Corrective Action

Whenever points on the control chart for slump reach the upper warning limit, immediately adjust the batch weights of water and fine aggregate. Make adjustments so that the total water content does not exceed that amount allowed by the maximum W/C specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, no further concrete may be delivered to the placing site until proper adjustments have been made. Immediately after each adjustment, make another test to verify the correctness of the adjustment. Whenever two consecutive slump tests, made during a period

when there was no adjustment of batch weights, produce a point on the control chart for range at or above the upper action limit, immediately halt the concreting operation and take appropriate steps to bring the slump under control. Also, make additional slump tests as directed.

]3.4.2.6.5 Temperature

Measure the temperature of the concrete when compressive strength specimens are fabricated. Measure in accordance with ASTM C1064/C1064M. Report the temperature along with the compressive strength data.

3.4.2.6.6 Compressive-Strength Specimens

Obtain samples and test concrete for quality control during placement. Sample fresh concrete for testing in accordance with ASTM C172/C172M. Make six test cylinders. Test concrete for compressive strength at 7 and 28 days for each design mix and for every 77 cubic meters 100 cubic yards of concrete. Test two cylinders at 7 days; two cylinders at 28 days; and hold two cylinders in reserve. Prepare concrete test specimens in accordance with ASTM C31/C31M. Perform compressive strength testing in accordance with ASTM C39/C39M.

3.4.2.7 Inspection Before Placing

Inspect foundation or construction joints, forms, and embedded items for quality in sufficient time prior to each concrete placement to certify to the Contracting Officer that they are ready to receive concrete. Report the results of each inspection in writing.

3.4.2.8 Placing

3.4.2.8.1 Placing Inspection

The placing foreman supervises all placing operations, determines that the correct quality of concrete or grout is placed in each location as directed and is for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, yardage placed, and method of placement.

3.4.2.8.2 Placing Corrective Action

The placing foreman must not permit batching and placing to begin until he has verified that an adequate number of vibrators in working order and with competent operators are available. Discontinue placing if any pile of concrete is inadequately consolidated. If any batch of concrete fails to meet the temperature requirements, take immediate steps to improve temperature controls.

3.4.2.9 Vibrators

3.4.2.9.1 Vibrator Testing and Use

Determine the frequency and amplitude of each vibrator in accordance with COE CRD-C 521 prior to initial use and at least once a month when concrete is being placed. Make sdditional tests as directed when a vibrator does not appear to be adequately consolidating the concrete. Determine the frequency at the same time the vibrator is operating in concrete with the tachometer held against the upper end of the vibrator head while almost submerged and just before the vibrator is withdrawn from the concrete.

Determine the amplitude with the head vibrating in air. Take two measurements, one near the tip and another near the upper end of the vibrator head and average these results. Report the make, model, type, and size of the vibrator and frequency and amplitude results in writing.

3.4.2.9.2 Vibrator Corrective Action

Immediately remove any vibrator not meeting the requirements of paragraph VIBRATORS from service and repair or replace.

[3.4.2.10 Mixer Uniformity

Submit the results of the initial mixer uniformity tests, at least 5 days prior to the initiation of placing.

3.4.2.10.1 Stationary Mixers

Prior to the start of concrete placing and once every 6 months when concrete is being placed, or once for every 57,000 cubic meters 75,000 cubic yards of concrete placed, whichever results in the longest time interval, dtermine uniformity of concrete mixing in accordance with ASTM C94/C94M.

3.4.2.10.2 Truck Mixers

Prior to the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete in accordance with ASTM C94/C94M. Randomly select the truck mixers for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of the blades may be regarded as satisfactory.

3.4.2.11 Mixer Uniformity Corrective Action

When a mixer fails to meet mixer uniformity requirements, either remove the mixer from service on the work, increase the mixing time, change the batching sequence, reduce the batch size, or adjust the mixer until compliance is achieved.

]3.4.3 Reports

Report all results of tests or inspections conducted informally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make reports of pertinent temperatures daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Contracting Officer has the right to examine all test and inspection records.

-- End of Section --