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USACE / NAVFAC / AFCEC / NASA **UFGS-03 37 00 (November 2009)**

Preparing Activity: USACE **Superseding**
UFGS-03 37 00 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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PREPLACED-AGGREGATE CONCRETE

11/09

ATTACHMENTS:

concrete aggregates sources

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SECTION 03 37 00

PREPLACED-AGGREGATE CONCRETE
11/09

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NOTE: This guide specification covers the requirements for furnishing, hauling, and preplacing aggregate concrete incidental to the drilling and the grouting. 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).
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PART 1 GENERAL

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

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NOTE: If Section 01 20 00 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 20 00.

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1.1.1 Payment

Payment will be made for all costs associated with unloading, handling, and storage of all aggregate, cement, [pozzolan,] fluidifier, and chemical admixture used in the work, including all costs of labor and the use of all equipment, tools, 150 by 300 mm 6 by 12 inch cylinder molds, and other materials required to complete the work, excluding cost of reinforcement and embedded parts which are specified to be paid for separately.

1.1.2 Measurement

Preplaced-Aggregate Concrete will be measured for payment based on the actual volume placed within the paylines of the structures as indicated.

1.1.3 Unit of Measure

Unit of measure: cubic meter yard.

1.2 REFERENCES

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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 ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2017) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for

	Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete
ACI 305R	(2020) Guide to Hot Weather Concreting

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B36.10M	(2022) Welded and Seamless Wrought Steel Pipe

ASTM INTERNATIONAL (ASTM)

ASTM C39/C39M	(2021) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C87/C87M	(2017) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
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 C127	(2015) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2022) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) 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 C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet

	Materials for Curing Concrete
ASTM C231/C231M	(2022) 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	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C441/C441M	(2017) Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction
ASTM C494/C494M	(2019; E 2022) 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 C618	(2023; E 2023) 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 C937	(2016) Grout Fluidifier for Preplaced-Aggregate Concrete
ASTM C938	(2016) Standard Practice for Proportioning Grout Mixtures for Preplaced-Aggregate Concrete
ASTM C939/C939M	(2022) Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
ASTM C943	(2017) Standard Practice for Making Test Cylinders and Prisms for Determining Strength and Density of Preplaced-Aggregate Concrete in the Laboratory
ASTM C989/C989M	(2022) Standard Specification for Slag

	Cement for Use in Concrete and Mortars
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	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1260	(2021) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2022) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 94	(1995) Corps of Engineers Specification for Surface Retarders
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
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 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

1.3 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified 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 Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters 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.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

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" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Grout Mixture Proportioning

Grout Mixer

Equipment

Vibrators

Testing and Quality Verification for Contractor Quality Control

Curing and Protection; G[, [_____]]

Cold-Weather Placing; G[, [_____]]

Hot-Weather Placing; G[, [_____]]

SD-04 Samples

Aggregates; G[, [_____]]

Cementitious Materials, Admixtures, and Curing Compound; G[, [_____]]

SD-06 Test Reports

Quality of Aggregates; G[, [_____]]

Testing and Quality Verification for Contractor Quality Control

SD-07 Certificates

Cementitious Materials

Impervious-Sheet Curing Materials

Air-Entraining Admixture

Nonshrink Grout

Grout Fluidifier

Membrane-Forming Curing Compound

1.4 QUALITY ASSURANCE

The individuals who sample and test concrete or the constituents of concrete as required in this specification 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 have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of [Concrete Transportation Construction Inspector (CTCI)] [Concrete Construction Inspector (CCI)], Level II.

1.4.1 Government Preconstruction Sampling and Testing

1.4.1.1 Aggregates

****
NOTES: The Designer should consult the appropriate DM, identify the sources for aggregates, and include them in the Aggregate Sources Template attached to the end of this section. Contact the Division Laboratory for information to fill in the blanks below.
****

The aggregate sources listed at the end of this section have been tested and, at the time testing was performed, were capable of producing materials of a quality required for this project, provided suitable processing is performed. The Contractor may furnish materials from a listed source or from a source not listed. Deliver samples from any

source of coarse aggregate and any source of fine aggregate, consisting of not less than [70] [_____] kg [150] [_____] pounds of each coarse aggregate and [35] [_____] kg [75] [_____] pounds taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 to [_____] within 15 days after notice to proceed. Sampling and shipment of samples is at the Contractor's expense. [_____] days will be required to complete evaluation of the aggregates. Testing will be performed by and at the expense of the Government in accordance with COE CRD-C 114 or ASTM test methods. The cost of testing one source for each size of aggregate will be borne by the Government. If the Contractor selects more than one source for each aggregate size or selects a substitute source for any size aggregate after the original source was tested, the cost of that additional testing will be borne by the Contractor. Tests to which aggregate may be subjected are listed in paragraph QUALITY OF AGGREGATES in PART 3. Provide material from the proposed source meeting the quality requirements of this paragraph. The Government's test data and other information on aggregate quality of those sources listed at the end of this section are included in the Design Memorandum and are available for review in the district office. Quality Assurance testing of aggregates by the Government does not relieve the Contractor of quality control requirements as outlined in paragraph TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL in PART 3.

1.4.1.2 Cementitious Materials, Admixtures, and Curing Compound

****
NOTE: When the optional sentence below is deleted, the corresponding manufacturer's certification 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 source of materials, along with sampling location, brand name, type, and quantity to be used in the manufacture and/or curing of the concrete. [Sampling and testing will be performed by and at the expense of the Government except as otherwise specified. Do not use material until notice has been given by the Contracting Officer that test results are satisfactory. Submit samples of materials for Government testing and approval. The Government will sample and test other chemical admixtures, curing compounds, and cementitious materials].

a. Chemical Admixtures - Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing at the expense of the Contractor when directed by the Contracting Officer and reject if test results are not satisfactory. Chemical admixtures will be accepted based on compliance with the requirements in paragraph CHEMICAL ADMIXTURES in PART 2.

[b. Cement and Pozzolan - 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.]

****
NOTE: Delete this paragraph if materials are to be accepted on the basis of a manufacturer's

certification of compliance and mill test reports. See the appropriate DM or consult the Materials Engineer to select prequalified sources, (1) and (2), sealed bins, (3) and (4), or both options, (1), (2), (3), and (4). Selection of the sealed bin method, subparagraphs (3) and (4), must be fully justified in the appropriate DM.

****

[(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 Engineer Waterways Experiment Station (USACE-WES), 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.]

[(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, USACE-WES, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.]

[(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 notice has been given by the Contracting Officer that test results are satisfactory. In the event of failure, the cement may be resampled and tested at the Contractor's request and expense. 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 of cement represented by the tests.]

****

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

****

[(4) Nonprequalified Pozzolan Sources: 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 at the expense of the Contractor when directed by the Contracting Officer and reject 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 of pozzolan represented by the test. The amount will be deducted from payment to the Contractor.]

1.4.2 Construction Testing by Government

The Government will sample and test aggregates, grout, and preplaced-aggregate 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 placement in accordance with COE CRD-C 100. Grout will be sampled after the agitator and tested for flow in accordance with ASTM C939/C939M and air content in accordance with ASTM C231/C231M. Unconfined compressive strength test specimens will be made and cured in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

Provide steel bars, welded steel wire fabric and accessories for concrete reinforcement in compliance with Section 03 30 00 CAST-IN-PLACE CONCRETE. Provide concrete formwork complying with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.1.1 Design of Preplaced Aggregate

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

Specified compressive strength is as follows:

COMPRESSIVE STRENGTH (MPa)	STRUCTURE OR PORTION OF STRUCTURE
34.5 MPa 5,000 psi @ [_____] days	[_____]
27.6 MPa 4,000 psi @ [_____] days	[_____]
20.7 MPa 3,000 psi @ [_____] days	[_____]
17.2 MPa 2,500 psi @ [_____] days	[_____]

2.1.2 Maximum Water-Cement Ratio (W/C)

****

NOTE: Consult EM 1110-2-2000 and the appropriate DM to fill in the blanks and to select the appropriate W/C. When cementitious materials other than portland cement are used, see paragraph GROUT MIXTURE PROPORTIONING in PART 2 for definitions of W/C.

****

Maximum W/C is 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/Cs may cause higher strengths than required by above paragraph.

2.2 MATERIALS

2.2.1 Cementitious Materials

****

NOTE: See the appropriate DM to select the proper requirements for the Cementitious Materials Options. Other cementitious materials may be added if specifically recommended and approved in the concrete materials DM.

Delete the requirements for certificates for air-entraining admixtures, other chemical admixtures, curing compounds, portland cement, and

pozzolan if the optional parts of paragraph CEMENTITIOUS MATERIALS, ADMIXTURES, AND CURING COMPOUND (above) are used.

****

Provide cementitious materials that is portland cement or portland cement in combination with pozzolan [or [_____]] and conforming to appropriate specifications listed below. Do not use cementitious materials until notice of acceptance has been given by the Contracting Officer. Cementitious materials will be subject to check testing from samples obtained at the mill, 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 manufacturer's certification of compliance, accompanied by mill test reports attesting that materials meet the requirements of the specification under which they are furnished. Provide certification and mill test reports that are from samples taken from the particular lot furnished. Submit certificate of compliance for the following: Impervious-Sheet Curing Materials, Air-Entraining Admixture, Nonshrink Grout, Grout Fluidifier, and Membrane-Forming Curing Compound.

2.2.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of tricalcium aluminate (C3A) in Type I cement consisting of 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 slag provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441/C441Mmust 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/C441M. 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.]

2.2.1.2 Pozzolan

Provide pozzolan conforming to ASTM C618, Class [C], [F], [N], with the optional requirements for multiple factor, drying shrinkage, and uniformity [and [moderate] [severe] sulfate resistance requirements] of Table 2A. Table 1A requirement for maximum alkalis applies when used with aggregates listed at the end of this section to require low-alkali cement.

2.2.1.3 [Ground Granulated Blast-Furnace Slag

Provide ground granulated blast-furnace slag conforming to ASTM C989/C989M, Grade [_____].]

2.2.2 Aggregates

****

NOTE: This note may be disregarded for regions where Alkali-Silica Reactivity (ASR) is not a concern. Some aggregate sources may exhibit an ASR

potential. ASR is a potentially deleterious reaction between alkalis present in concrete and some siliceous aggregates, reference EM 1110-2-2000 paragraph 2-3b(6) and appendix D. Where ASR is known or suspected to pose a concern for concrete durability, it is recommended that aggregates proposed for use in concrete be evaluated to determine ASR potential and an effective mitigation. EM 1110-2-2000, provides recommendations for evaluating and mitigating ASR in concrete mixtures. Aggregate evaluations may not be practical for projects requiring small quantities of concrete (less than 200 cubic meters 250 cubic yards).

Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS, paragraph Alkali-Silica Reactivity, provides a specification method for the Contractor to evaluate and mitigate ASR in concrete mixtures. The expansion limits specified in Section 32 13 14.13 are requirements for pavements and exterior slab construction. For structural concrete applications the measured expansion must be less than 0.10 percent. It may not be economical or practical to specify different test limit requirements for use on the same project. In which case the lower limit required by the application should be used.

The designer may use the specification method in Section 32 13 14.13 by incorporating the relevant paragraphs into this specification, or may use the following requirements (retain either the 0.10 or the 0.08 percent expansion limits as appropriate) included in the paragraph below. Delete the following paragraph if not required in the project.

****

Alkali-Silica Reactivity: Test and evaluate fine and coarse aggregates proposed for use in concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Evaluate the fine and coarse aggregates separately and in combination, matching the Contractor's proposed mix design proportioning. All results of the separate and combination testing must have a measured expansion less than 0.10 (0.08) percent at 16 days after casting. Should the test data indicate an expansion of 0.10 (0.08) percent or greater, reject the aggregate(s) or perform additional testing using ASTM C1260 and ASTM C1567. Perform the additional testing using ASTM C1260 and ASTM C1567 using the low alkali portland cement in combination with ground granulated blast furnace (GGBF) slag, or Class F fly ash. Use GGBF slag in the range of 40 to 50 percent of the total cementitious material by mass. Use Class F fly ash in the range of 25 to 40 percent of the total cementitious material by mass.

2.2.2.1 Listed Sources

****

NOTE: The list of sources and required tests and test limits will be taken from the concrete materials DM.

****

Concrete aggregates may be furnished from any source capable of meeting the quality requirements as stated in paragraph QUALITY OF AGGREGATES in PART 3. The sources listed at the end of this section were evaluated during the design phase of the project in [_____] and were found at that time capable of meeting the quality requirements when suitably processed. No guarantee is given or implied that any of the listed sources are currently capable of producing aggregates that meet the required quality specified above. A Design Memorandum containing the results of the Government investigation and test results is available for review in the [_____] district office. Contact [_____] at [_____] to arrange for review of the memorandum. Consider the test results and conclusions valid only for the sample tested and do not take them as an indication of the quality of all material from a source nor for the amount of processing required.

2.2.2.2 Fine-Aggregate Grading

Provide grading and uniformity of the fine aggregate conforming to the following requirements as delivered to the grout mixer:

U. S. STANDARD SIEVE SIZE	PERCENT BY MASS, PASSING
2.36 mmNo. 8	100
1.18 mmNo. 16	95 - 100
600 µmNo. 30	55 - 80
300 µmNo. 50	30 - 55
150 µmNo. 100	10 - 30
75 µmNo. 200	0 - 10

In addition to the grading limits specified above, provide fine aggregate with a fineness modulus of not less than 1.30 nor more than 2.10. Control the grading of the fine aggregate so that the fineness moduli of at least four of any five consecutive test samples does not vary more than 0.15 from the average fineness modulus of all samples previously taken.

2.2.2.3 Coarse-Aggregate Grading

Provide grading of the coarse aggregate conforming to the following requirements:

PERCENT BY MASS, PASSING		
U.S. STANDARD SIEVE SIZE	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inches
75 mm3 inches		95 - 100

PERCENT BY MASS, PASSING		
U.S. STANDARD SIEVE SIZE	19.0 mm 3/4 inch to 37.5 mm 1-1/2 inch	37.5 mm 1-1/2 inch to 75 mm 3 inches
50 mm2 inches	100	20 - 55
37.5 mm1-1/2 inch	95 - 100	0 - 5
25.0 mm1 inch	40 - 80	0 - 2
19.0 mm3/4 inch	20 - 45	
12.5 mm1/2 inch	0 - 5	
9.5 mm3/8 inch	0 - 2	

2.2.2.4 Coarse-Aggregate Particle Shape

The quantity of flat and elongated particles of the coarse aggregate, as defined and determined by ASTM D4791, must not exceed 25 percent.

2.2.2.5 Concrete Aggregate Sources

****

NOTE: If an aggregate source is provided by the Government, the appropriate paragraphs from Section 03 70 00 MASS CONCRETE should be used.

****

2.2.2.5.1 List of Sources

The concrete aggregates sources may be selected from sources listed at the end of this section.

2.2.2.5.2 Selection of Source

After the award of the contract, designate in writing only one source or combination of sources from which to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or from sources not listed at the end of this section, designate only a single source or single combination of sources for aggregates. If a source for coarse or fine aggregates does not meet the quality requirements stated in paragraph QUALITY OF AGGREGATES in PART 3, the Contractor may not submit for approval other nonlisted sources but furnish the coarse or fine aggregate, as the case may be, from sources listed at the end of this section at no additional cost to the Government.

2.2.2.6 Coarse-Aggregate Quality

****

NOTES: The tests selected should be those which are applicable to the concrete to be used in the project. These tests may include those listed below in addition to others not listed. See Chapter 2 of

EM 1110-2-2000 for discussion of tests.

A list of properties and test values are unique to each project and should be taken from the concrete materials design memorandum. Delete the quality tests not required in the DM.

Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

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

****

Deliver aggregates to the mixer that meet the following requirements:

	TEST LIMITS		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128
Durability Factor	[_____]	[_____]	COE CRD-C 114 ASTM C666/C666M
Clay Lump and Friable Particles	[_____]	[_____]	ASTM C142/C142M
Material Finer than 75-µm (No. 200) Sieve	[_____]	[_____]	ASTM C117
Organic Impurities	Not darker than No. 3 Not less than 95 percent	[_____]	ASTM C40/C40M ASTM C87/C87M
L.A. Abrasion	[_____]	[_____]	ASTM C131/C131M ASTM C535
Soft Particles	[_____]	[_____]	COE CRD-C 130

	TEST LIMITS		
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Petrographic Examination	List unwanted deleterious materials and their limits	[_____]	ASTM C295/C295M
[Chert, Less than 2.40 specific gravity]	[_____]	[_____]	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	[_____]	[_____]	ASTM C123/C123M

2.2.3 Chemical Admixtures

Use chemical admixtures, when required or permitted, conforming to the appropriate specification listed.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture conforming to ASTM C260/C260M.

2.2.3.2 Grout Fluidifier

Provide grout fluidifier conforming to ASTM C937.

2.2.3.3 Water-Reducing or Retarding Admixtures

Provide water-reducing or retarding admixtures meeting the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived.

2.2.4 Curing Materials

2.2.4.1 Impervious-Sheet Curing Materials

Provide impervious-sheet curing materials conforming to ASTM C171, type optional, except do not use polyethylene film.

2.2.4.2 Membrane-Forming Curing Compound

Furnish membrane-forming curing compound that meets the requirements of ASTM C309, Type 1-D or 2, except use a styrene acrylate or chlorinated rubber compound meeting Class B requirements for surfaces that are to be painted. Select curing compound that is compatible with any subsequent paint specified. Use nonpigmented compound containing a fugitive dye and has the reflective requirements in ASTM C309 waived.

2.2.4.3 Burlap

Use burlap for curing that conforms to AASHTO M 182.

2.2.5 Water

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

2.2.6 Nonshrink Grout

Furnish nonshrink grout conforming to ASTM C1107/C1107M and is a commercial formulation suitable for the application proposed.

2.3 GROUT MIXTURE PROPORTIONING

Submit determined grout mixture proportions for review, including the quantities of all ingredients per cubic meter yard and stating the grading of the fine aggregate size that will be used in the manufacture of each quantity of concrete. Include test reports from a laboratory complying with ASTM C1077 which show that proportions thus selected will produce preplaced-aggregate concrete of the qualities indicated. Provide grout mixture proportioning meeting the following requirements:

2.3.1 Quality of Mixture

For each portion of the structure, select mixture proportions so that the strength and water-cement ratio requirements listed in paragraph DESIGN OF PREPLACED AGGREGATE in PART 1 are met. State the source of materials and proportions of portland cement, [pozzolan], fluidifier, fine aggregate, and water. Determine the grout proportions for the preplaced-aggregate concrete in accordance with ASTM C938. Use grout proportions for the preplaced-aggregate concrete meeting the specified strength as determined by specimens molded in accordance with ASTM C943 and tested in accordance with ASTM C39/C39M. Convert the maximum water-cement ratios required in paragraph MAXIMUM WATER-CEMENT RATIO (W/C) in PART 1 to a ratio by mass of water to cement plus pozzolan or GGBF slag by mass equivalency as described in ACI 211.1. In the case where GGBF slag is used, include the mass of the slag in the equations for the term P, which is used to denote the mass of pozzolan. If pozzolan is used in the concrete mixture, use pozzolan with a minimum pozzolan content that is 15 percent of the total cementitious material. Make no substitution in the source or type of materials used in the work without additional tests to show that the new quality of materials and concrete are satisfactory.

2.3.2 Air Content

The air content of the grout mixture as determined by ASTM C231/C231M within 15 minutes after mixing must be 9.0 plus or minus 1.0 percent.

2.3.3 Grout Flow

Use grout flow of 18.0 plus or minus 2.0 seconds when sampled from the agitator and test in accordance with ASTM C939/C939M.

2.4 EQUIPMENT

Submit data on the pumping equipment and methods for pumping and delivering the grout for preplaced-aggregate concrete for review by the Contracting Officer, including the methods for transporting, handling, and depositing the coarse aggregate, the location, arrangement, and size of the pipe and inserts, sequence of pumping, method of withdrawal of

injection pipe, and the rate of grout injection. Also include methods for venting of air from under embedded projections.

2.4.1 Capacity

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

Provide mixing and pumping equipment with a capacity of at least [_____] cubic meters yards per hour.

2.4.2 Batching Equipment

Mechanically batch all materials by mass except the water and admixture which may be batched by volume.

2.4.2.1 Scales

Use equipment for determining mass conforming to the applicable requirements of NIST HB 44, except that the accuracy must be plus or minus 0.2 percent of scale capacity. Provide standard test reference masses and any other auxiliary equipment required for checking the operating performance of each scale or other measuring devices. Make tests at the frequency required in paragraph TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL in PART 3, in the presence of a Government representative.

2.4.2.2 Batching Tolerances

2.4.2.2.1 Tolerances on Mass

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

2.4.2.2.2 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.

2.4.2.3 Grout Mixer

Provide a machine especially designed for the mixing of grout, capable of mixing grout mechanically to a uniform consistency. Maintain the mixer in satisfactory operating condition and kept free of hardened grout. Should any grout mixer at any time produce unsatisfactory results, promptly discontinue its use until the condition is corrected. Provide the grout mixer with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Use of revolving-drum concrete mixers will not be permitted. Submit Grout-mixer data including the make, type, and capacity of grout mixers, grout agitators, tank, pump, and pipe system proposed for producing the grout for preplaced-aggregate concrete.

2.4.2.4 Agitator Tank

Furnish agitator tank that has at least the same capacity as the mixer and equip to agitate the grout effectively and continuously. Pass all grout entering the tank through a wire sieve. A sieve size less than 4.75 mm No. 4 and greater than 9.5 mm 3/8 inch is not permitted.

2.4.2.5 Grout Pump

Furnish grout pump that operates by positive displacement or progressive cavity. Equip the pump with a by-pass line connecting the discharge and inlet or provide circulation into the agitator for continuous operation if line blockage or temporary shutdown of grouting operation occurs. Install a pressure gauge on the pump discharge line to indicate incipient line blockage or a plugged insert pipe. Provide standby pumping equipment.

2.4.3 Grout Pipe System

2.4.3.1 Delivery Pipes

Provide main delivery line carrying grout from the grout pump to the vicinity of the insert pipes of such diameters that grout velocity at the planned operating rate will range between 0.6 and 1.2 meters 2 and 4 feet per second. All pipe fittings must be watertight. Provide unions for quick disconnect to facilitate pipe cleanup when required. A manifold system, in which more than one grout insert is operative at the same time, will not be permitted.

2.4.3.2 Grout Insert Pipes

Provide pipes that are [19] [25] [40] mm [3/4] [1] [1-1/2] inch in diameter conforming to ASME B36.10M Schedule 40. Standard pipe couplings may be used if the couplings are to be withdrawn not more than 4.5 m 15 feet through the preplaced aggregate. Where pipe couplings are required for greater depths of preplaced aggregate, use flush-coupled pipe conforming to ASME B36.10M Schedule 160. Make connections between grout delivery hoses and insert pipes using quick-opening fittings. Quick-disconnect pneumatic fittings will not be permitted for this purpose. Provide valves in the pipe system that are plug or ball type, quick-opening, and which can be easily taken apart and cleaned. Stem lubricate valves over 25 mm 1 inch in diameter.

2.4.3.3 Sounding Wells

Provide sounding wells that are 50 mm 2 inch diameter steel pipe provided with milled (not burned) 13 mm 1/2-inch open slots 150 mm 6 inches long

with 300 mm 12 inches between slots. Ream the pipe and remove burrs before installation. Equip the sounding line with a 25 mm 1 inch diameter float having a mass so as to sink in water, yet float on the grout surface within the slotted pipe.

PART 3 EXECUTION

3.1 PREPARATION FOR PLACEMENT

3.1.1 Embedded Items

Before placement of coarse aggregate for preplaced-aggregate concrete, take care to determine that all embedded items are firmly and securely fastened in place as indicated on the drawings, or required. Provide embedded items that are 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. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable materials to prevent the entry of grout into voids. Welding, including tack welding, will not be permitted on embedded metals within 600 mm 2 feet of the surface of the preplaced-aggregate concrete.

3.1.2 Concrete on Earth Foundations

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NOTE: The Designer should insert the appropriate Section number and title below.
****

Use earth surfaces upon which preplaced-aggregate concrete is to be placed that are clean, damp, and free from debris, frost, ice, and standing or running water. Prior to placement of coarse aggregate, satisfactorily compact the earth foundation in accordance with the provisions of [Section 31 00 00 EARTHWORK] [_____].

3.1.3 Concrete on Rock Foundations

Use rock surfaces upon which coarse aggregate for preplaced-aggregate concrete is to be placed that are 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 coarse aggregate is placed, clean all rock surfaces thoroughly by the use of air-water jets or sandblasting as defined in paragraph CONSTRUCTION JOINT TREATMENT below.

3.1.4 Underwater Placement

Place coarse aggregate for underwater preplaced-aggregate concrete on rock surfaces which are clean, free from drummy rock, coatings, debris, and loose semidetached or unsound fragments.

3.1.5 Concrete Surfaces

Use concrete surfaces on which coarse aggregate is to be placed or preplaced-aggregate concrete surfaces between stages that are clean and free from foreign material. Remove excessive accumulation of fine material on the surface with high-pressure water jets or other approved methods.

3.1.6 Construction Joint Treatment

3.1.6.1 Joint Preparation

a. If grout in a preplaced-aggregate placement is not brought to the surface in order to form a construction joint, stop the intrusion grout rise 300 mm 12 inches below the aggregate surface. Do not allow dirt and debris to collect on the aggregate surface or to filter down to the grout surface. Pull the insert pipes just above the grout surface before the grout stiffens and rodded clear. When pumping is ready to resume, work the insert pipes back to near contact with the hardened grout surface and then slowly resume pumping for a few minutes.

b. Prepare preplaced-aggregate concrete in which the grout has been brought to the surface and any other concrete surfaces to which preplaced-aggregate concrete is to be bonded for receiving the next lift or adjacent preplaced-aggregate concrete by cleaning with 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 clean the surface again as the last operation prior to placing the next lift.

3.1.6.2 Air-Water Cutting

Perform air-water cutting of a construction joint at the proper time and only on horizontal construction joints. Use an air pressure in the jet of 690 kPa 100 psi plus or minus 70 kPa 10 psi, and use a sufficient water pressure 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 as 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.

3.1.6.3 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.

3.1.6.4 Wet Sandblasting

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

3.1.6.5 Waste Disposal

Use a method in disposing of 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 COARSE-AGGREGATE AND GROUT PLACEMENT

3.2.1 Coarse-Aggregate Washing and Screening

Wash, screen, and immediately saturate coarse aggregate before placement. Washing of the aggregate in the forms will not be permitted. If more than one size of coarse aggregate is used, weigh, batch, and mix the aggregate in the proper proportions onto the wash screen. The wash screen may be a vibrating deck or revolving.

3.2.2 Transporting and Placing Coarse Aggregate

Transport coarse aggregate to the forms and place in substantially horizontal layers by means which will prevent objectionable segregation and breakage. Remove foreign material and excessive accumulation of fine material on the lift surface before placing the next lift. Place coarse aggregate under water continuously in each stage or lift until placement in that stage or lift is completed. When the coarse aggregate is to be placed in the dry, there must be no vertical drop greater than 1.5 m 5 feet except where suitable equipment is provided to prevent breakage and segregation and where specifically authorized. Vehicle traffic on top of preplaced-coarse aggregate is not permitted.

3.2.3 Cold-Weather Placing of Preplaced-Aggregate Concrete

When the cold-weather placing of preplaced-aggregate concrete is likely to be subjected to freezing temperatures before the expiration of the curing period, place concrete in accordance with the approved procedures. Submit for approval the proposed materials, methods, and protection if preplaced-aggregate concrete is to be placed under cold-weather conditions. Use an ambient temperature of the space adjacent to the preplaced-aggregate concrete placement and surfaces to receive preplaced-aggregate concrete that is above 0 degrees C 32 degrees F. Use a placing temperature of the preplaced aggregate concrete having a minimum dimension less than 300 mm 12 inches between 13 and 24 degrees C 55 and 75 degrees F when measured in accordance with ASTM C1064/C1064M. Use a placing temperature of the preplaced-aggregate concrete having a minimum dimension greater than 300 mm 12 inches between 10 and 21 degrees C 50 and 70 degrees F. Heating of the mixing water or aggregates will be required to regulate the concrete-placing temperatures. Ensure materials entering the grout mixer are free from ice, snow, or frozen lumps. Do not mix salt, chemicals, or other materials with the grout to prevent freezing. Provide forms that are free of frost, and use aggregate, when deposited in the form, that is free of ice, snow, and frozen lumps.

3.2.4 Hot-Weather Placing of Preplaced-Aggregate Concrete

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NOTE: See the appropriate DM for the proper placing temperature.

****

Properly perform hot-weather placing of preplaced-aggregate concrete and finish per the approved procedures. Submit for review and approval by the Contracting Officer the proposed materials and methods, if preplaced-aggregate concrete is to be placed under hot-weather conditions. Preplaced-aggregate concrete temperature exceeding [_____] degrees C F when measured in accordance with ASTM C1064/C1064M is not acceptable. Cooling of the mixing water may be required to obtain an adequate placing temperature. A retarder meeting the requirements of paragraph WATER-REDUCING OR RETARDING ADMIXTURES in PART 2, may be used to facilitate placing and finishing. Cool steel forms and reinforcement prior to concrete placement when steel temperatures are greater than 49 degrees C 120 degrees F.

3.2.5 Grout Mixing and Pumping

3.2.5.1 Charging Sequence

The order of placing material in the mixer is as follows:

a. Water, or premixed water and fluidifier, if the fluidifier is in a liquid form.

b. Cement, or preblended cement and fluidifier, if the fluidifier is in a powder form.

c. Remaining ingredients.

3.2.5.2 Mixing Time

After all solids are in the mixer, mix each batch for at least 2 minutes. Provide the mixer with an acceptable device to lock the discharge mechanism until the required mixing time has elapsed. Do not charge the mixer in excess of the capacity recommended by the manufacturer nor operate it at a speed in excess of the manufacturer's recommendation.

3.2.5.3 Pumping Procedure

Before starting to mix and pump grout, disconnect the grout hoses from inserts or from inlet points and flush the lines with water. Clear excess water from the pumps and lines. At the start of grouting, with the grout delivery lines disconnected at the inserts, pump and waste grout until grout exiting the line is the same uniform consistency as that being discharged from the mixer. The coarse aggregate within the forms must be in a moist condition at the time of intrusion. Start the intrusion at the lowest point in the aggregate. Perform uniform pumping and at the rate that will permit the grout to fill all voids and avoid displacing the aggregate. After being discharged into the agitator tank, continuously agitate each batch of grout until that batch is fully discharged into the pump. Properly arrange and space insert pipes to ensure a relatively level uniform grout surface. Initially the outlet end of the intrusion lines must penetrate the aggregate mass to within 50 mm 2 inches of the base of the aggregate, unless otherwise directed. Raise the outlets as the grout rises, and after grouting has progressed sufficiently to so permit, extend the outlets into the grout no less than 300 mm 12 inches. Provide satisfactory means for venting the underside of embedded projections with procedures previously submitted in accordance with paragraph SUBMITTALS. Continue grouting until grout of the specified quality is returned from the vent pipes, thereby indicating completeness

of grout injection. During the intrusion procedure, externally vibrate the forms in the vicinity of the grout surface. Provide sounding wells or other approved means of accurately locating the grout surface without interrupting the intrusion procedure for observation and regulation of the level of the grout. Provide continuous agitation of grout during any shutdown of the intrusion procedure. When there is a lapse in the operation of intrusion in excess of 15 minutes, recirculate the grout through the pump, or agitator and pump. Flush the grout delivery lines with clean water if they become blocked. Disconnect them from grout insert pipe before the flushing operation is performed and do not reconnect to grout insert pipe after flushing until pumping is resumed and grout appears. Do not use grout after appreciable stiffening of the grout mixture has occurred. [When placed underwater, begin intrusion while aggregates are being placed and follow closely behind aggregate placement unless otherwise approved. Do not bring the grout surface closer than 300 mm 1 foot of the lowest point of the aggregate lift prior to topping out.]

3.2.5.4 Blocked Pipes

Exercise care to avoid blocking grout insert pipes by avoiding interruptions in pumping; however, when a pipe becomes blocked, withdraw it immediately until the end is at least 600 mm 2 feet above the level of the grout before an attempt is made to unblock it by washing out the line. Do not attempt washing with the end of the grout line inserted in the grout.

3.2.5.5 Placing Temperature

Do not place intrusion grout when the ambient temperature is below 2 degrees C 35 degrees F, unless specifically approved by the Contracting Officer. Do not subject preplaced-aggregate concrete, without special protection, to freezing temperatures before grout reaches a unconfined compressive strength of 3500 kPa 500 psi. Grout which is intruded during cold weather must have a temperature of not less than 5 degrees C 40 degrees F nor more than 15 degrees C 60 degrees F. Heating of the mixing water or fine aggregate will not be permitted until the temperature of the grout has decreased to 7 degrees C 45 degrees F. All methods and equipment for heating are subjected to approval.

3.3 FINISHING

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NOTE: Consult the appropriate DM for those surfaces to receive a trowel finish, abrasive aggregate finish, or broom finish. Be sure those special finishes are shown.

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An ambient temperature of spaces adjacent to surfaces being finished less than 10 degrees C 50 degrees F is not permitted. In hot weather when the rate of evaporation of surface moisture, as determined by use of Figure 2.1.5 of ACI 305R, may reasonably be expected to exceed 1 kg/square meter 0.2 psf per hour, make provisions for windbreaks, shading, fog spraying, or wet covering with a light-colored material in advance of placement. Take such protective measures as quickly as finishing operations will allow. Provide a float finish for all unformed surfaces that are not to be covered by additional concrete or backfill. Provide additional finishing as specified below and true to the elevation shown in the drawings. Bring surfaces to receive additional concrete or backfill to

the elevation shown in the drawings and leave true and regular. Slope exterior surfaces for drainage unless otherwise shown in the drawing or as directed.

3.3.1 [Formed Top Surface

Use a venting form constructed of muslin to produce the finished surface. Place the venting form on top of the aggregate and back up by fly screen, diamond metal lath, and sheeting boards spaced from 13 to 25 mm 1/2 to 1 inch apart. Tie down the form against uplift pressure.]

3.3.2 [Screeded or Trowelled Surface

Bring the grout up to flood the aggregate surface and any remove diluted surface grout by brooming. Following this, work a thin layer of pea gravel or 9.5 to 12.5 mm 3/8 to 1/2 inch crushed aggregate down into the surface by tamping and raking. When the surface is sufficiently hardened to permit working, screed, float, or trowel the surface to the specified finish.]

3.4 CURING AND PROTECTION

Submit curing medium and methods to be used, for review and approval. Provide curing and protection conforming to the following requirements:

3.4.1 Duration

Determine the length of the curing period by the type of cementitious material, as specified below. Cure concrete by an approved method.

CONCRETE CURING PERIOD	
Type I portland cement	7 days
Type II portland cement	14 days
Portland cement blended with 25 percent or less fly-ash	14 days
Portland cement blended with more than 25 percent Fly-ash	21 days

Immediately after placement, protect preplaced-aggregate concrete from premature drying, extremes in temperatures, rapid temperature change, and mechanical damage. Make all materials and equipment needed for adequate curing and protection available and at the placement site to the start of grouting. Protect preplaced-aggregate concrete from the damaging effects of rain for 12 hours and from flowing water for 14 days. Fire or excessive heat, including welding, is not permitted near or in direct contact with concrete or concrete embedments at any time.

3.4.2 Moist Curing

Maintain preplaced-aggregate concrete that is moist-cured continuously, not periodically, wet for the entire curing period. If water or curing materials stain or discolor concrete surfaces that are to be permanently exposed, clean them as required in paragraph APPEARANCE, below. Where

wooden form sheathing is left in place during curing, keep the sheathing wet at all times. Where steel forms are left in place during curing, carefully braek the forms loose from the hardened concrete and continuously apply curing water into the void to continuously saturate the entire concrete surface. Horizontal surfaces may be moist cured by ponding, by covering with a minimum uniform thickness of 50 mm 2 inches of continuously saturated sand, or by covering with saturated nonstaining burlap or cotton mats. Rinse burlap and cotton mats to remove soluble substances before using. Furnish water for curing in compliance with the requirements of paragraph WATER in Part 2.

3.4.3 Curing with Membrane-Forming Curing Compound

Concrete may be cured with an approved membrane-forming curing compound in lieu of moist curing, except that membrane curing will not be permitted on any surface to which a grout-cleaned finish is to be applied or other concrete is to be bonded, on any surface containing protruding steel reinforcement, on an abrasive aggregate finish, or any surface maintained at curing temperature by use of free steam. A styrene acrylate or chlorinated rubber compound may be used for surfaces that are to be painted. Select curing compound that is compatible with any subsequent paint specified.

3.4.3.1 Pigmented Curing Compound

A pigmented curing compound meeting the requirements of paragraph MEMBRANE-FORMING CURING COMPOUND in PART 2, may be used on surfaces that will not be exposed to view when the project is completed.

3.4.3.2 Nonpigmented Curing Compound

A nonpigmented curing compound containing a fugitive dye may be used on surfaces that will be exposed to view when the project is completed. Concrete cured with nonpigmented curing compound must be shaded from the sun for the first 3 days when the ambient temperature is 32 degrees C 90 degrees F or higher.

3.4.3.3 Application

Apply the curing compound 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. Thoroughly moisten the surfaces with water, and apply the curing compound as soon as free water disappears. Apply the curing compound to unformed surfaces as soon as free water has disappeared. Apply the curing compound in a two-coat continuous operation by approved motorized power-spraying equipment operating at a minimum pressure of 520 kPa 75 psi, at a uniform coverage of not more than 10 square meters/L 400 square feet/gallon for each coat, and apply the second coat perpendicular to the first coat. Respray concrete surfaces that have been subjected to rainfall within 3 hours after curing compound has been applied by the method and at the coverage specified. Adequately protect all concrete surfaces on which the curing compound has been applied for the duration of the entire curing period from pedestrian and vehicular traffic and from any other cause that will disrupt the continuity of the curing membrane.

3.4.4 Impervious-Sheet Curing

Horizontal surfaces may be cured using impervious sheets. Provide sheets

that comply with the requirements of ASTM C171, except do not use polyethylene film. Thoroughly wet all surfaces and be completely cover with waterproof paper, or with polyethylene-coated burlap having the burlap thoroughly water-saturated before placing. Lapcovering no less than 300 mm 12 inches and securely weigh down or lap no less than 100 mm 4 inches and tape to form a continuous cover with completely closed joints. Provide weighted sheet to prevent displacement so that it remains in contact with the concrete during the specified length of curing. Fold cover down over exposed edges of the slabs and secure by approved means. Immediately repair or replace sheets if tears or holes appear during the curing period.

3.4.5 Cold-Weather Curing and Protection

When the daily outdoor low temperature is less than 0 degrees C 32 degrees F, manitain the temperature of the concrete above 5 degrees C 40 degrees F for the first 7 days after placing. In addition, during the period of protection removal, control the air temperature adjacent to the concrete surfaces so that concrete near the surface will not be subjected to a temperature differential of more than 15 degrees C 25 degrees F. Determine this by observation of ambient and concrete temperatures indicated by suitable temperatures measuring devices furnished by the Government as required and installed adjacent to the concrete surface and 50 mm 2 inches inside the surface of the concrete. Install thermometers at such locations as may be directed.

3.4.6 Appearance

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

3.5 TESTING AND QUALITY VERIFICATION FOR CONTRACTOR QUALITY CONTROL

Submit statements attesting that the concrete testing technicians and the concrete inspectors meet the specified requirements, also Contractor quality control test results and inspection reports daily and weekly as required. With the testing and quality verification, conform to the following requirements.

3.5.1 General

Perform the inspection 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 preplaced-aggregate concreting operations are out of control, cease aggregate and intrusion grouting. Perform tests using an onsite laboratory and conforming 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.

3.5.2 Testing and Inspection Requirements

3.5.2.1 Fine Aggregate

3.5.2.1.1 Grading

At least once during each shift when the grout 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. The grading must conform to requirements in paragraph FINE-AGGREGATE GRADING in PART 2. 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.

3.5.2.1.2 Corrective Action for Fine-Aggregate Grading

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

3.5.2.1.3 Moisture Content Testing

Perform at least four tests for moisture content in accordance with ASTM C566 during each 8-hour period of mixing plant operation. Select random times for the tests within the 8-hour period. Make an additional test whenever the grout flow is out of control or excessive variation in consistency is reported by the placing foreman. Use the results of tests for moisture content to adjust the added water in the control of the grout mixing.

3.5.2.1.4 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 flow.

3.5.2.2 Coarse Aggregate

3.5.2.2.1 Gradinge

At least once during each shift in which the coarse aggregate is being placed in the forms, perform a sieve analysis in accordance with ASTM C136/C136M for each size of coarse aggregate. Furnish coarse aggregates conforming to the requirements found in paragraph COARSE-AGGREGATE GRADING in PART 2. The location at which samples are taken may be selected by the Contractor as the most advantageous for production control. Maintain a test record of samples of aggregate taken at the same locations showing 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 forms to allow for degradation during handling.

3.5.2.2.2 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 it to the Contracting Officer. Stop aggregate placement and take immediate steps to correct the grading.

3.5.2.3 Quality of Aggregates

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

Use the petrographic examination to identify deleterious substances in aggregates. List deleterious substances individually with respective limits.

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Submit aggregate quality test results, at least 30 days prior to start of preplaced-aggregate concrete placement. Provide quality of aggregates meeting the following requirements.

3.5.2.3.1 Frequency of Quality Tests

Thirty days prior to the start of preplaced-aggregate concrete placement perform all tests for aggregate quality listed on the following page. In addition, after the start of concrete placement, perform tests for aggregate quality in accordance with the frequency schedule. Take samples of fine aggregate tested after the start of concrete placement immediately prior to entering the grout mixer. Take samples of coarse aggregate tested after the start of concrete placement immediately prior to entering the forms.

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
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 the 75 µm No. 200 Sieve	Every 3 months	Every 3 months	ASTM C117
Organic Impurities	Every 3 months	Not applicable	ASTM C40 ASTM C87/C87M
L.A. Abrasion	Not applicable	Every 6 months	ASTM C131/C131M ASTM C535

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Soft and Friable (Scratch Hardness)	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M
[Chert, less than 2.40 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M
[Coal and Lignite, less than 2.00 specific gravity]	Every 6 months	Every 6 months	ASTM C123/C123M

3.5.2.3.2 Corrective Action for Aggregate Quality

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

3.5.2.4 Scales

3.5.2.4.1 Accuracy in Determination of Mass

Check the accuracy of the scales by reference masses prior to start of grouting operations and at least once every 3 months for conformance with the applicable requirements of paragraph BATCHING EQUIPMENT in PART 2. Also make such tests as directed whenever there are variations in properties of the fresh grout that could result from batching errors.

3.5.2.4.2 Scales Corrective Action

When the accuracy of determination of mass does not comply with specification requirements, do not perform grouting until necessary adjustments or repairs have been made. Correct discrepancies in recording accuracies immediately and report to the Contracting Officer.

3.5.2.5 Grout Plant Control

Continuously control the measurement of all constituent materials including cementitious materials, aggregate, water, and admixtures. Adjust the fine aggregate mass and amount of added water as necessary to compensate for free moisture in the fine aggregate. 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 used, amount and source of admixtures used, aggregate source, the required aggregate and water in mass per cubic meter, amount

of water as free moisture in the fine aggregate, and the batch aggregate and mass of water per cubic meter for each mixture batched during grouting operations.

3.5.2.6 Grout Mixture

3.5.2.6.1 Air-Content Testing

Make 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 grout mixture produced during each 8-hour period of grout production. Make additional tests when excessive variation in consistency is reported by the placing foreman or Government quality assurance representative. Make tests in accordance with ASTM C231/C231M. Plot test results on control charts which will at all times be readily available to the Government. 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 test result reaches the upper or lower action limit, make a second test immediately. Average the results of the two tests. Use this average as the air content of the batch to plot on the control chart for air content and on the control chart for range and to determine 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 in PART 2. 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 grout to the placement site at the stipulated flow. If the Contractor's materials or transportation methods cause flow 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.

3.5.2.6.2 Air-Content Corrective Action

Whenever points on the control chart for percent air reach either warning limit, make an adjustment immediately in the amount of air-entraining admixture batched. As soon as is practical after each adjustment, make 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, consider the air content out of control and immediately halt the concreting operation until the air content is under control. make additional air-content tests when grout mixing is restarted. All this will be at no extra cost to the Government.

3.5.2.7 Test for Grout Flow

3.5.2.7.1 Tests

Make at least two tests on randomly selected batches of grout mixture during each shift's production in accordance with ASTM C939/C939M. Make additional tests when excessive variation in flow of grout mixture is

reported by the grout foreman or Government inspector. Plot test results on control charts which will at all times be readily available to the Government. 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-flow test reaches or goes beyond the upper or lower action limit, make a second test immediately on the same batch of concrete. Average the results of the two tests. Use this average as the flow of the batch to plot on the control chart for flow and the chart for range and to determine the need for any remedial action. Set an upper warning limit at 1 second below the maximum allowable flow on separate control charts for flow used for each type of mixture, and set upper and lower action limit lines at the maximum and minimum allowable flows, respectively. Plot the range between each consecutive flow test for each type of mixture on a single control chart for range on which an upper action limit is set at 2 seconds. Take samples for flow at the agitator; however, the Contractor is responsible for delivering the grout to the placement site at the stipulated flow. If the Contractor's materials or transportation methods cause flow loss between mixer and the placement, takecorrelation samples at the placement site as required by the Contracting Officer and control the flow at the mixer as directed.

3.5.2.7.2 Grout Flow Corrective Action

Whenever points on the control chart for flow reach the upper warning limit, make an adjustment immediately in the batch weights of water and fine aggregate. The adjustments are to be made 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 flow reaches the upper or lower action limit, do not deliver further grout 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 flow 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, halt the grouting operation immediately, and take appropriate steps to bring the flow under control. Also, make additional flow tests as directed. All this will be at no additional cost to the Government.

3.5.2.7.3 Temperature

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

3.5.2.7.4 Compressive-Strength Specimens

Make at least one set of test specimens each day on each different preplaced-aggregate concrete mixture placed during the day. Make additional sets of test cylinders, as directed by the Contracting Officer, when the mixture proportions are changed or when low strengths have been detected. Develop a random grout sampling plan and obtain approval prior to the start of construction. Assure that sampling is done in a completely random and unbiased manner. Provide a set of test specimens for concrete with a 28-day specified strength, in accordance with paragraph DESIGN OF PREPLACED AGGREGATE in Part 1, consisting of six cylinders, three to be tested at 7 days and three at 28 days. Provide a set of test specimens for concrete with a 90-day strength, in accordance with the same paragraph, consisting of nine cylinders, three tested at 7 days, three at 28 days, and three at 90 days. Mold and cure specimens in

accordance with ASTM C943 and test in accordance with ASTM C39/C39M. Report all compressive-strength tests immediately to the Contracting Officer. Keep quality control charts for individual strength tests, moving average for strength, and moving average for range for each mixture, that are similar to those found in ACI 214R.

3.5.2.8 Inspection Before Pumping Grout

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

3.5.2.9 Grout Pumping

3.5.2.9.1 Placing Inspection

The placing foreman will supervise all placing operations, will determine that the correct quality of grout is placed in each location as directed by the Contracting Officer, and is responsible for measuring and recording grout temperatures and ambient temperature hourly during placing operations, weather conditions, time of grout placement, amount of grout placed, and method of placement.

3.5.2.9.2 Pumping Corrective Action

Do not permit grouting operations to begin until it has been verified that an adequate number of vibrators in working order and with competent operators are available. If any batch of grout fails to meet the temperature requirements, take immediate steps to improve temperature controls. Submit data on the size, frequency, and amplitude of the external vibrators for review.

3.5.2.10 Curing

3.5.2.10.1 Moist-Curing Inspections

At least once each shift and once per day on nonwork days, inspect all areas subject to moist curing. Note and record surface moisture condition.

3.5.2.10.2 Moist-Curing Corrective Action

When a daily inspection report lists an area of inadequate curing, take immediate corrective action, and extend the required curing period for such areas by 1 day.

3.5.2.10.3 Membrane-Curing Inspection

Do not apply curing compound until the Contractor's authorized representative has verified that the compound is properly mixed and ready for spraying. At the end of each operation, estimate the quantity of compound used by measurement of the container and the area of concrete surface covered and compute the rate of coverage in square meters/L square feet/gallon. Note whether or not coverage is uniform.

3.5.2.10.4 Membrane-Curing Corrective Action

When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, spray the entire surface again.

3.5.2.10.5 Sheet-Curing Inspection

At least once each shift and once per day on nonwork days, inspect all areas being cured using material sheets. Note and record the condition of the covering and the tightness of the laps and tapes.

3.5.2.10.6 Sheet-Curing Corrective Action

When a daily inspection report lists any tears, holes, or laps or joints that are not completely closed, promptly repair the tears and holes or replace the sheets, close the joints, and extend the required curing period for those areas by 1 day.

3.5.2.11 Cold-Weather Protection and Sealed Insulation Curing

At least once each shift and once per day on nonwork days, inspect all areas subject to cold-weather protection. Inspect the protection system for holes, tears, unsealed joints, or other deficiencies that could result in damage to the concrete. Take special attention at edges, corners, and thin sections. Note, correct, and report any deficiencies.

3.5.2.12 Cold-Weather Protection Corrective Action

When a daily inspection report lists any holes, tears, unsealed joints, or other deficiencies, correct the deficiency immediately and extend the period of protection 1 day.

3.5.3 Reports

Informally report all results of tests or inspections conducted 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 contractor quality control records.

-- End of Section --