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USACE / NAVFAC / AFCEC	**UFGS-03 37 29 (November 2009)**
	Change 1 - 11/23

Preparing Activity: USACE	**Superseding**
	UFGS-03 37 29 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2025

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CONCRETE FOR CONCRETE CUTOFF WALLS

11/09, CHG 1: 11/23

ATTACHMENTS:

concrete aggregates sources

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SECTION 03 37 29

CONCRETE FOR CONCRETE CUTOFF WALLS
11/09, CHG 1: 11/23

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NOTE: This guide specification covers the requirements for concrete cutoff wall structures. 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.

With the exception of coring concrete in completed panels, all costs in connection with this section, including all materials, will be included in the payment item(s) specified.

Core recovery percentage for each boring should be a high number such as 90 to 95, since it is expected that a competent concrete material is being cored. The deviation of the core hole should be in relation to the smallest dimension of the panels that will be produced for each jobsite.

****

1.1.1 Coring Concrete in Completed Panels

1.1.1.1 Payment

Payment will be made for costs associated with Coring Concrete in Completed Panels and backfilling the core holes. This price will constitute full compensation for mobilizing and demobilizing and furnishing all equipment and supplies necessary to perform all operations specified. No payment will be made for coring and backfilling at a location where the coring reveals the presence of "unacceptable concrete", as specified in paragraphs QUALITY ASSURANCE and CONCRETE PLACEMENT. All costs incurred, including the initial core boring and as many additional core borings as may be required to delineate the limits of the unacceptable concrete and the repair of the cutoff wall, are borne by the Contractor and will not result in any additional cost to the Government.

1.1.1.2 Measurement

Coring Concrete in Completed Panels will be measured for payment from the top of the panel to the bottom of the core hole. If overall core recovery for a boring is less than [_____] percent or the boring deviates from the cutoff wall prior to reaching a depth of [_____] meters feet, redrill and backfill the boring at no additional cost to the Government.

1.1.2 Unit of Measure

Unit of measure: per linear meter foot of cored hole.

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.

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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 (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2025b) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2024a) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2020) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C70	(2020) Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C87/C87M	(2023) Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C94/C94M	(2025) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2023) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2023) Standard Test Method for Lightweight Particles in Aggregate
ASTM C127	(2024) 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; R 2023) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2024) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C192/C192M	(2025) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2024) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for 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	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C535	(2016; R 2024) 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	(2025) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2025a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	(2025) Standard Specification for Slag

	Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(2023) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2025a) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2025) Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates

NATIONAL DRILLING ASSOCIATION (NDA)

DCDMA TM	(1991; Reviewed 2012) DCDMA Technical Manual

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(2018) 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 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 112	(1969) Method of Test for Surface Moisture in Aggregate by Water Displacement
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 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

1.3 SUBMITTALS

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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 and Air Force 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.

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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. Submittals not having a "G" or "S" classification are 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

Concrete Mixture Proportions; G, [_____]

Batch Plant

Concrete Mixers

Capacity

Conveying Equipment

Plant and Equipment

Tests and Inspections

Vertical Construction Joints; G, [_____]

Curing and Protection; G, [_____]

SD-04 Samples

Cementitious Materials; G, [_____]

Admixtures; G, [_____]

SD-06 Test Reports

Aggregates

Quality of Aggregates; G, [_____]
Mixer Uniformity

Tests and Inspections

Unacceptable Concrete

SD-07 Certificates

Cementitious Materials; G, [_____]

Air-Entraining Admixture

Accelerators

Other Chemical Admixtures

1.4 QUALITY ASSURANCE

"Unacceptable Concrete" is concrete that is honeycombed, segregated, uncemented, or contains voids greater than the diameter of the core boring. When such concrete is encountered in any panel, replace or repair the unacceptable concrete in accordance with paragraph CONCRETE PLACEMENT. Submit a copy of the records and Contractor tests, as well as the records of the corrective action taken where testing has determined that concrete in completed panels is unacceptable, as directed by the Contracting Officer.

1.4.1 Government Testing and Sampling

Provide facilities and labor as may be necessary for procurement of representative test samples. The Government will sample and test aggregates and concrete to determine compliance with the specifications. 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.

1.4.2 Preconstruction Sampling and Testing

1.4.2.1 Aggregates

****
NOTE: The Designer should consult the appropriate DM, identify the sources for aggregates, and attach them to the end of this section. A Format Template for Aggregate Sources is located in the Template Menu of UFGS. 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 selected by the Contractor, consisting of not less than [_____] [70 kg 150 pounds] of each size coarse aggregate and [_____] [35 kg 75 pounds] of fine aggregate 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 are 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 the applicable COE CRD-C 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 in PART 2. 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 DM and are available for review in the district office. Testing of aggregates by the Government does not relieve the Contractor of the requirements outlined in paragraph TESTS AND INSPECTIONS in PART 3.

1.4.2.2 Cementitious Materials and Admixtures

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NOTE: 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.

1.4.3 Construction Testing by the Government

[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.] [The Government will sample and test chemical admixtures,

curing compounds, and cementitious materials].

1.4.3.1 Chemical Admixtures Requirements

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 paragraph CHEMICAL ADMIXTURES of PART 2.

1.4.3.2 Cement and Pozzolan

****

NOTES: Delete this paragraph if materials are to be accepted on the basis of a manufacture's certification of compliance and mill test reports, and the optional sentence in paragraph SUBMITTALS, SD-07 Certificates, will be used. See the appropriate DM or consult the Materials Engineer to select prequalified sources, subparagraphs "a" and "b" below, or sealed bins, subparagraphs "c" and "d" below, or both options, subparagraphs "a" and "b" and "c" and "d". Selection of the sealed bin method, subparagraphs "c" and "d", must be fully justified in the appropriate DM.

In subparagraph "c" below, to fill in the blank for cost of testing excess cement, contact the Structures Laboratory, Concrete Technology Division, WES.

****

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.

[1.4.3.2.1 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, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.

][1.4.3.2.2 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 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, Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199, ATTN: CEWES-SC.

][1.4.3.2.3 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 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 be 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.

][1.4.3.2.4 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 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. The amount will be deducted from payment to the Contractor.

]1.4.3.3 Concrete Tests

Provide facilities and labor as necessary for procurement of representative test samples. The Government will sample and test concrete to determine compliance with the specifications. Concrete will be sampled in accordance with ASTM C172/C172M. Slump and air content will be determined in accordance with ASTM C143/C143M and ASTM C231/C231M, respectively. Compression test specimens will be made and laboratory cured in accordance with ASTM C31/C31M, and compression test specimens tested in accordance with ASTM C39/C39M, but results will be used only for determination of the uniformity of the mixture produced.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Well-rounded natural aggregates are preferred due to the increased flowability of concrete containing these aggregates. If crushed aggregates are used, the fine aggregate and cementitious materials contents may have to be increased to achieve satisfactory flowability. If crushed aggregate is used, increase the specified minimum cement content to 335 kg per cubic meter 564 pounds per cubic yard.

****

Submit concrete mixture proportions as determined by the Contractor for review. State concrete mixture quantities of all ingredients per cubic meter yard and nominal maximum coarse aggregate size that will be used in the manufacture of each quality of concrete. Indicate the mass of cement, pozzolan, slag cement when used, and water; the mass of aggregates in a saturated surface-dry condition; and the quantities of admixtures. Include test reports from a laboratory complying with ASTM C1077 which show that proportions thus selected will produce concrete of the qualities indicated. Make no substitution in the source or type of materials used in the work without additional tests to show that the quality of the new materials and concrete are satisfactory. Perform concrete mixture proportioning conforming to the following:

2.1.1 Maximum Water-Cement Ratio

The maximum water-cement ratio by weight of equivalent portland cement must be 0.50, unless otherwise approved in writing.

2.1.2 Cement Content

The cement content of the concrete must be within the range from a minimum of [279 kg] [470 pounds] [_____] to a maximum of 446 kg/cubic meter 752 pounds/cubic yard. When a pozzolan is used, the total absolute volume of cementitious material must be within the same range in absolute volume as previously specified. Of the total absolute volume of cementitious materials, between 20 and 30 percent may be pozzolan that meets the requirements of paragraph POZZOLAN, OTHER THAN SILICA FUME in PART 2. [If slag cement is used, do not exceed 25 percent by absolute volume, and percentage must be as approved before mixture proportioning studies commence.]

2.1.3 Nominal Maximum-Size Coarse Aggregate

The nominal maximum-size coarse aggregate is [19.0 mm 3/4 inch] [25.0 mm 1 inch].

2.1.4 Fine Aggregate

Fine aggregate comprises approximately 40 to 50 percent, by volume, of the total aggregate.

2.1.5 Air Content

Air Content as determined by ASTM C231/C231M to be 6.0 ± 1.5 percent.

2.1.6 Slump

Determined by ASTM C143/C143M between 150 and 225 mm 6 and 9 inches.

2.1.7 Responsibility of Mixture Proportioning

Proportioning of concrete for use in construction of the cutoff wall is the responsibility of the Contractor and to be performed by a laboratory complying with ASTM C1077.

2.1.8 Concrete Proportioning

****
NOTE: There is no requirement for fc'. The results of trial mixture should be basis for QC.
****

Trial batches and testing requirements for concrete are the responsibility of the Contractor. Obtain samples of approved aggregates in accordance with the requirements of ASTM D75/D75M. Use samples of materials other than aggregate that are representative of those proposed for the project and provide manufacturer's test reports indicating compliance with applicable specified requirements. Make trial mixtures having proportions, slumps, and air content suitable for the work based on ACI 211.1. The maximum water-cement ratio required in the paragraph MAXIMUM WATER-CEMENT RATIO above will be converted to a weight ratio of water to cement plus pozzolan or slag cement by mass equivalency as described in ACI 211.1. In the case where GGBFS is used, include the mass of the slag in the equation for the term P, which is used to denote the mass of pozzolan. Proportion trial mixtures for specified slump and air content. Report the temperature of concrete in each trial batch. If a chemical admixture is used, report slump loss versus time in each trial batch. For each trial mixture, make at least three test cylinders for each test age and cure in accordance with ASTM C192/C192M. Test cylinders at 7 and 28 days in accordance with ASTM C39/C39M, or if a pozzolan or slag cement is used, test cylinders at 7, 28, and 90 days. Submit results of these compressive strength tests but use only for quality control purposes. Submit all results of mixture proportioning studies at least 10 days prior to commencing concrete placement.

2.2 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 below, is used.
****

Submit certificate of compliance with all specification requirements for the following: Air-Entraining Admixture, Accelerators, and other Chemical Admixtures.

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.

****

Cementitious Materials are portland cement or portland cement in combination with pozzolan or GGBFS [or [_____]] 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 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 not meeting specifications from the site of work. Submit the manufacturer's certification of compliance, accompanied by mill test reports that materials meet the requirements of the specification under which they are furnished, for cementitious materials, including Cement and Pozzolan, [and GGBFS]. Certification and mill test reports must be from samples taken from the particular lot furnished.

2.2.1.1 Portland Cement

ASTM C150/C150M, Type I or II, except that the maximum amount of C3A in Type I cement must be 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 GGBFS provided the following requirement is met. The expansion of the proposed combination when tested in accordance with ASTM C441/C441M 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/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, Other than Silica Fume

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

2.2.1.3 Ground Granulated Blast-Furnace (GGBF) Slag

Provide ground granulated blast-furnace slag conforming to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.1.4 Blended Hydraulic Cement

Portland-Limestone cement must conform to ASTM C595/C595M, Type IL.

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 2.3.1.2 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, which matches 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 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 below. The sources listed at the end of this section were evaluated during the design phase of the project in [_____] and at that time were 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 stated in paragraph QUALITY below. A DM containing the results of the Government's 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 as an indication of the quality of all material from a source nor for the amount of processing required. Provide fine and coarse aggregates conforming to the grading requirements of ASTM C33/C33M. The nominal maximum size is as listed in subparagraph NOMINAL MAXIMUM-SIZE COARSE AGGREGATE of 1.3, 'c'.

2.2.2.2 Concrete Aggregate Sources

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

2.2.2.2.1 List of Sources

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

2.2.2.2.2 Selection of Source

After the award of the contract, designate in writing only one source or combination of sources from which he proposes to furnish aggregates. If the Contractor proposes to furnish aggregates from a source or from sources not listed at the end of this section, then designate only a single source or single combination of sources for aggregates. Regardless of the source, provide selected samples for acceptance testing as required by paragraph GOVERNMENT TESTING AND SAMPLING in PART 1. If a source for coarse or fine aggregates so designated by the Contractor does not meet the quality requirements stated in the paragraph below, 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.

2.2.2.3 Quality

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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 EM 1110-2-2000 for schedule of tests.

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.

A list of properties and test values are unique to each project and should be taken from the concrete materials DM. 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.

In selecting deleterious substances, it should be borne in mind that cutoff walls are to be treated as structures not exposed to weather.

****

Deliver aggregates to the mixer meeting the following requirements:

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Specific Gravity	[_____]	[_____]	ASTM C127 ASTM C128
Absorption	[_____]	[_____]	ASTM C127 ASTM C128
Clay Lumps 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]
Petrographic Examination	Listed unwanted deleterious materials and their limits		ASTM C295/C295M

TEST LIMITS			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TESTS
Coal and Lignite, less than 2.00 specific gravity	[_____]	[_____]	ASTM C123/C123M

2.2.2.4 Fine Aggregate Grading and Moisture Content

Determine the sieve analysis and fineness modulus of fine aggregate in accordance with ASTM C136/C136M and COE CRD-C 104, respectively. Determine the moisture content with an electric moisture meter in accordance with COE CRD-C 143. When in the Contracting Officer's opinion the electric moisture meter is not operating satisfactorily, determine the moisture content in accordance with either ASTM C70, ASTM C566, or COE CRD-C 112.

2.2.2.5 Coarse Aggregate Grading and Moisture Content

For each size group of coarse aggregate, determine the sieve analysis in accordance with ASTM C136/C136M. Determine the moisture content of each size group of the coarse aggregate in accordance with ASTM C566 or COE CRD-C 112.

2.2.3 Chemical Admixtures

Provide admixtures complying with the following.

2.2.3.1 Air-Entraining Admixture

Provide air-entraining admixture conforming to ASTM C260/C260M and consistently cause the concrete to have an air content in the specified ranges under field conditions.

2.2.3.2 Accelerating Admixture

Provide accelerators meeting the requirements of ASTM C494/C494M, Type C or E, except do not use calcium chloride or admixtures containing calcium chloride.

2.2.3.3 Flowing Concrete Admixtures

Provide other chemical admixtures for use in producing flowing concrete in compliance with ASTM C1017/C1017M, Type I or II. Use these admixtures only if the proposed admixture shows no deleterious effects when used with all other project materials during mixture proportioning studies.

2.2.4 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.

2.3 PLANT AND EQUIPMENT

Submit data on all placing equipment and methods for review by the

Contracting Officer.

2.3.1 Capacity

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NOTE: Experience has shown that to reduce problems associated with placement rates, the minimum capacity should be 77 cubic meters per hour 100 cubic yards per hour.
****

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

2.3.2 Batch Plant

Conform 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 to the Contracting Officer for review for conformance with applicable specifications.

2.3.2.1 Batching Equipment

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NOTE: Refer to the appropriate DM to choose the appropriate alternates.
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Provide batching controls that are [partially automatic], [semiautomatic], [or] [automatic]. [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 GGBFS. 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 GGBFS. If both cement and pozzolan or GGBFS are used, they may be batched cumulatively provided that the portland cement is batched first. If measured by mass, do not batch the mass of the water cumulatively with another ingredient. Provide interlocked 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 admixture. 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 so as to facilitate the inspection of all operations at all times. Provide suitable 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.

2.3.2.2 Scales

Provide equipment for batching by 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 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 TESTS AND INSPECTIONS, in PART 3, and in the presence of a Government inspector.

2.3.2.3 Batching Tolerances

Tolerances on determination of mass:

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials	-0 to +2
Aggregate	± 2
Water	± 1
Chemical admixture	-0 to +6

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

2.3.2.4 Moisture Control

Provide plant that is 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.]

2.3.3 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 in conformance with specified requirements.

2.3.3.1 Stationary Mixers

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

2.3.3.2 Truck Mixers

Provide truck mixers, the mixing of concrete, and concrete uniformity conforming to the requirements of ASTM C94/C94M. A truck mixer may be

used for complete mixing or to finish the partial mixing begun in a stationary mixer. 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.

2.3.4 Conveying Equipment

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NOTE: Experience has shown that to reduce problems associated with placement rates, the minimum conveying capacity should be 75 cubic meters per hour 100 cubic yards per hour.

****

Furnish conveying equipment with a capacity of at least [_____] cubic meters yards per hour. Convey concrete from mixer to trench as rapidly as practicable and within the time interval specified in paragraph PLACING, in PART 3, by methods that will prevent segregation or loss of ingredients. Pass any concrete transferred from one conveying device to another through a hopper that is conical in shape and do not drop vertically more than 1.5 m 5 feet, except where suitable equipment is provided to prevent segregation and where specifically authorized. Submit data on the conveying equipment and methods for transporting, handling, and depositing the concrete.

2.3.4.1 Buckets

Provide an interior hopper slope no less than 58 degrees from the horizontal; provide a clear gate opening with a minimum dimension of at least five times the nominal maximum-size aggregate and an area no less than 0.2 square meters 2 square feet. Maximum dimension of the gate opening greater than twice the minimum dimension is not permitted. Provide bucket gates that are essentially grout tight when closed and may be manually, pneumatically, or hydraulically operated except that manually operated buckets larger than 1.5 cubic meters 2 cubic yards are not acceptable. Provide means for positive regulation of the amount and rate of deposit of concrete in each dumping position.

2.3.4.2 Trucks

Furnish truck mixers operating at agitating speed or truck agitators used for transporting plant-mixed concrete conforming to the requirements of ASTM C94/C94M. Do not use nonagitating equipment for transporting concrete.

2.3.4.3 Chutes

When concrete can be placed directly from a truck mixer or agitator, 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.

2.3.4.4 Concrete Pumps

Concrete may be conveyed by positive displacement pump when approved. TProvide piston or squeeze pressure pumping equipment. Provide pipeline consisting of rigid steel pipe or heavy-duty flexible hose. Furnish pipe with an inside diameter that is at least three times the nominal

maximum-size coarse aggregate in the concrete mixture to be pumped, but no less than 100 mm 4 inches. Do not use aluminum pipe. Do not reduce the nominal maximum-size coarse aggregate to accommodate the pumps. The distance to be pumped must not exceed limits recommended by the pump manufacturer. Supply the concrete to the concrete pump continuously. When pumping is completed, eject concrete remaining in the pipeline without contamination of concrete in place. After each operation, thoroughly clean equipment, and waste flushing water outside of the forms.

PART 3 EXECUTION

3.1 PLACING

Concrete placement will not be permitted when, in the opinion of the Contracting Officer, weather conditions prevent proper placement. Deposit concrete in the tremie hopper with no vertical drop greater than 1.5 m 5 feet except where suitable equipment is provided to prevent segregation and where specifically authorized. Provide sufficient placing capacity so that concrete placement can be kept plastic and free of horizontal cold joints while concrete is being placed. Prior to placement, submit the method and equipment proposed for vertical construction joints cleanup and waste disposal, for review and approval by the Contracting Officer.

3.1.1 Time Interval Between Mixing and Placing

Place concrete within 30 minutes after mixing or agitating ceases. When concrete is truck mixed or when a truck mixer or agitator is used for transporting concrete mixed by a concrete plant mixer, deliver the concrete to the site of the work, and complete discharge within 45 minutes after introduction of the cement to the aggregates.

3.1.2 Placing Temperature

When deposited in the slurry, provide concrete with a temperature of no less than 5 degrees C 40 degrees F. Heating of the mixing water or aggregates is not be permitted until the temperature of the concrete has decreased to 7 degrees C 45 degrees F. Provide materials that are free from ice, snow, and frozen lumps before entering the mixer. Use placing equipment and methods that are subject to [approval] [review]. When heating is necessary to keep the concrete temperature above 5 degrees C 40 degrees F, regulate it so that the concrete temperature does not exceed 15 degrees C 60 degrees F. Do not exceed 32 degrees C 90 degrees F for concrete that is deposited in the slurry. Cooling of the mixing water and/or aggregates may be required to obtain an adequate placing temperature.

3.1.3 Concrete Deposited in Cutoff Trench

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NOTE: The hopper on top of the tremie pipe must be of a size capable of receiving and passing concrete into the tremie pipe at the capacity rate of the batching, mixing, and conveying equipment.

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.

****

Deposit concrete placed for the cutoff wall in a bentonite slurry-filled trench by a tremie or by a valved tremie. The methods and equipment used are subject to approval. Concrete buckets will not be permitted for placement of concrete in the slurry trench, although they may be used to transport concrete to the tremie hoppers. Provide watertight tremie that is sufficiently large to permit a free flow of concrete, and no less than 250 mm 10 inches in diameter. A funnel-shaped hopper of at least [_____] cubic meters yards in volume is required at the top of the tremie. Do not construct neither the tremie pipe nor the hopper of aluminum. Make hoisting equipment for raising and lowering the tremie pipe as the concrete is placed and tools for connecting the tremie pipe sections continuously available and on hand. In lieu of use of a tremie, concrete may be placed using a positive displacement pump and pump line provided the entire operation is approved in writing after a demonstration of its use.

3.1.4 Concrete Placement

Suitably secure tremie pipe sections together and use a gasket at each joint to prevent leakage. A retrievable traveling plug (go-devil) or a dry pipe with a plate and gasket wired to the bottom to prevent contact of the concrete and the slurry in the tremie is required to start each placement. Lower the tremie assembly to rest within 150 mm 6 inches of the bottom of the trench prior to beginning placement. During placement of the concrete, avoid any unnecessary movement of the pipe. Keep the bottom of the tremie pipe submerged in fresh concrete at all times to a depth that will produce the flat test surface slope that can practically be achieved. A depth less than 3 m 10 feet or more than 9 m 30 feet except when beginning placement at the bottom of a panel is not acceptable. Supply batches of concrete to the tremie pipe at a uniform rate for a continuous flow. Lift the tremie pipe during placement at a rate that will maintain the bottom of the pipe embedded in fresh concrete to a level that will produce the desired surface slope and rate of flow within the limits specified above. It may be necessary to reduce the amount of embedment as the differential head decreases between the concrete in the tremie pipe and the concrete in the panel. Minimize the repeated raising and lowering of the tremie pipe in the fresh concrete to facilitate placement. Proceed with placement without interruption until the concrete has been brought to the required height. Continuously measure and record the flow and slopes during placement with the use of a sounding line. Do not move the tremie horizontally during a placing operation, except that as the required height is reached, the tremie pipes may be moved to the corners and low areas between the tremie pipes to bring the lift to final elevation. Provide a sufficient number of tremies so that the concrete does not flow horizontally a distance of more than 2.1 m 7 feet from a tremie; i.e., place tremies a maximum of 4.2 m 14 feet on centers. Where more than one tremie pipe is used in the same placement simultaneously, maintain the concrete level at each pipe position nearly level with respect to the other. Take special care to ensure that the bottom of the tremie pipe is not lifted out of the fresh concrete. If this occurs, remove the tremie pipe, insert a dry pipe with a temporary bottom plug, and restart the placement. Also, as soon as practical, drill a NX-size core boring through the center of the cutoff wall to a depth of at least 3 m 10 feet below the depth where the bottom of the tremie pipe was lifted out of the fresh concrete. Repair unacceptable zones of concrete such as honeycombed, segregated, or uncemented zones found within the core boring immediately or remove and replace by an appropriate means. All cost incurred because of this failure, including the initial core boring and as many additional core borings as may be required to

delineate the limits of the unacceptable concrete and the repair of the cutoff wall, are borne by the Contractor and will not result in any additional cost to the Government. Submit a plan for repairing or removing and replacing the unacceptable concrete. Placement delays are not permitted for periods of time longer than 30 minutes.

3.1.5 Required Height of Concrete

Place concrete that is free of laitance, scum, slurry, or other contaminants at the top of the wall. Remove all scum, laitance, and contaminated concrete from the top of the concrete as the placement is nearing completion and dispose of in the spoil areas. Finish the top surface to grade by screeding spoil areas.

3.2 CURING AND PROTECTION

Moist cure exposed concrete for 14 days. Immediately after placement, protect 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 prior to the start of concrete placement. Protect 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. Submit the curing medium and methods to be used for review and approval.

3.3 TESTS AND INSPECTIONS

Submit statements asserting that the concrete testing technicians and the concrete inspectors meet the specified requirements; also test results and inspection reports daily and weekly as required.

3.3.1 General

Perform the inspection and tests described in the following paragraphs 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. Perform tests by onsite laboratory and in conformance with ASTM C1077. The individuals who sample and test concrete or the constituents of concrete as required in this specification will 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 will have demonstrated a knowledge and ability equivalent to the ACI minimum guidelines for certification of Concrete Construction Inspector, Level II. 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.

3.3.2 Testing and Inspection Requirements

3.3.2.1 Fine Aggregate

3.3.2.1.1 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.

3.3.2.1.2 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, report the fact immediately to the Contracting Officer.

3.3.2.1.3 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 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.

3.3.2.1.4 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.

3.3.2.2 Coarse Aggregate

3.3.2.2.1 Grading

At least once during each shift in which the concrete plant is operating, perform 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. 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 mixer to allow for degradation during handling.

3.3.2.2.2 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 concreting and take immediate steps to correct the grading.

3.3.2.2.3 Coarse Aggregate Moisture Content

Make a test for moisture content of each size group of coarse aggregate in accordance with ASTM C566 or COE CRD-C 112 at least once during a shift. 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.

3.3.2.2.4 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.

3.3.2.3 Quality of Aggregates

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

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

3.3.2.3.1 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. Test samples that were taken 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
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

FREQUENCY			
PROPERTY	FINE AGGREGATE	COARSE AGGREGATE	TEST
Organic 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 Particles	Not applicable	Every 6 months	COE CRD-C 130
Petrographic Examination	Every 6 months	Every 6 months	ASTM C295/C295M
Coal and Lignite, less than 2.00 specific gravity	Every 6 months	Every 6 months	ASTM C123/C123M or ASTM C295/C295M

3.3.2.3.2 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, rerun the test immediately. If the second test fails the quality requirement, report the fact to the Contracting Officer, and take immediate steps rectify the situation.

3.3.2.4 Deleterious Substances

3.3.2.4.1 Testing

When, in the opinion of the Contracting Officer, a problem exists in connection with deleterious substances in fine or coarse aggregates, make tests in accordance with ASTM C33/C33M at a frequency as directed, but no less than once per week. Report results of tests in writing.

3.3.2.4.2 Corrective Action for Deleterious Substances

When the results for a deleterious substance are out of the specification limit, resample and retest the aggregate for the deleterious substance that failed. If the second sample fails, report that fact to the Contracting Officer. When material finer than 75-µm (No. 200) sieve for coarse aggregate exceeds the specification limit, initiate immediate steps, such as washing or other corrective actions.

3.3.2.5 Scales

3.3.2.5.1 Accuracy

Checked 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. Make such tests as directed whenever there are variations in properties of the fresh concrete that could result from batching errors.

3.3.2.5.2 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 mass batched. Confirm that the calibration devices described in paragraph BATCH PLANT in PART 2 for checking the accuracy of dispensed admixtures are operating properly.

3.3.2.5.3 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.

3.3.2.6 Batch-Plant Control

Continuously control the measurement of quantities of all constituent materials batched including cementitious materials, each size of aggregate, water, and admixtures. Adjust the aggregate quantities 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 amounts per cubic meter yard, amount of water as free moisture in each size of aggregate, and the batch aggregate and water amounts per cubic meter yard for each class of concrete batched during plant operation. Submit the report to the Contracting Officer.

3.3.2.7 Concrete Mixture

3.3.2.7.1 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 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. 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 results plotted as tests are made. When a single test result reaches either the upper or lower action limit, make a second test immediatelye. Average the results of the two tests, and use this average as the air content of the batch to plot on the control charts for air content and 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 subparagraph 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 an 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 Contractor's 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 the air content at the mixer controlled as directed.

3.3.2.7.2 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, the air content is considered out of control and halt the concreting operation immediately until the air content is under control. Make additional air content tests when concreting is restarted. All this is at no extra cost to the Government.

3.3.2.7.3 Slump Testing

In addition to slump tests which are 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 when excessive variation in workability is reported by the placing foreman or Government's quality assurance representative. 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 slump test reaches or goes beyond either the upper or lower action limit, make a second test immediately 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 the control charts for percent air and for range and to determine 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 subparagraph SLUMP, and set upper and lower action limit lines 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 Contractor's 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.

3.3.2.7.4 Slump Corrective Action

Whenever points on the control chart for slump 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 water-cement ratio specified, based upon aggregates which are in a saturated surface-dry condition. When a single slump reaches the upper or lower action limit, deliver no further concrete 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, halt the concreting operation immediately, and take appropriate steps to bring the slump under control. Also, make additional slump tests as directed. All this is at no additional cost to the Government.

3.3.2.7.5 Compressive Strength

At least once during each shift, fabricate and cure, in accordance with ASTM C192/C192M, four 150 by 300 mm 6 by 12 inch test specimens. Test two specimens at 7 days and two at 28 days. If pozzolan or slag cement is used, fabricate six specimens and test two at 7 days, two at 28 days, and two at 90 days. Perform testing in accordance with ASTM C39/C39M. The results of compressive strength tests will not be used for acceptance. Results will be for record purposes and to evaluate the uniformity of concrete production. Average the results of each set of specimens tested at each age to produce one "test result". Plot these "test results" on control charts for each age. One control chart must consist of each "test result" plotted consecutively. One control chart must consist of the range from the "test result" for any one day to that of the next day. When the range exceeds 6.9 MPa 1,000 psi, notify the Contracting Officer and modify the operation to produce better uniformity.

3.3.2.7.6 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.

3.3.2.8 Placing

3.3.2.8.1 Preparation for Placing

Inspect each section of wall in sufficient time prior to concrete placement to certify to the Contracting Officer that it is ready to receive concrete. Report the results of each inspection in writing.

3.3.2.8.2 Placing

The placing foreman supervises all placing operations, determines that the correct quality of concrete is placed in each location as directed by the Contracting Officer, and is responsible for measuring and recording concrete temperatures, weather conditions, time of placement, quantity placed, method of placement, depths of tremie pipes and concrete at regular intervals, and loss of concrete. Submit a written report recording these data daily.

3.3.2.8.3 Placing Corrective Action

Do not continue 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.

3.3.2.9 Curing

3.3.2.9.1 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 the surface moisture condition.

3.3.2.9.2 Moist-Curing Correction 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.

3.3.2.10 Mixer Uniformity

Conform to the following:

3.3.2.10.1 Stationary Mixers

At the start of concrete placing and at least once every 6 months when concrete is being placed, determine uniformity of concrete. Perform tests in accordance with ASTM C94/C94M. Whenever adjustments in mixer or increased mixing times are necessary because of failure of any mixer to comply, retest the mixer after adjustment. Submit in writing the results of the initial mixer uniformity tests at least 5 days prior to the initiation of placing.

3.3.2.10.2 Truck Mixers

At 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. Select the truck mixers srandomly for testing. When satisfactory performance is found in one truck mixer, the performance of mixers of substantially the same design and condition of blades may be regarded as satisfactory. Report result of tests in writing.

3.3.2.10.3 Mixer Uniformity Concrete Action

When a mixer fails to meet mixer uniformity requirements, increase the mixing time or make adjustments to the mixer until compliance is achieved.

3.3.3 Reports

Report all results of tests and inspections as required. Include the updating of control charts covering the entire period from the start of the construction season through the current week in each report. 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.

3.3.4 Concrete Coring

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NOTES: The number of the test panels to be cored should be determined by each district office as necessary to give a representation of the work that was done. The core boring of these test panels should be done after the concrete has developed sufficient strength to allow cores of properly placed concrete to be retrieved.

The spacing and timing of the core borings of the concrete cutoff wall should be arranged to retrieve properly placed concrete cores. The concrete should be allowed to develop sufficient strength to allow cores of competent concrete to be retrieved. The spacing of the core holes should be representative of the particular job to give confidence in the work that was performed. The wall construction should not be allowed to get too far ahead of the core boring. This will allow problems discovered by the core boring to be corrected or changed and these changes incorporated in the cutoff wall construction that follows.

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3.3.4.1 Concrete Coring in Completed Panels

Drill one NX core boring (or one core boring approximately NX) through the concrete in each of the first [_____] test panels. Complete these borings during the installation of the first [_____] linear meters feet of cutoff wall and prior to commencement of the remainder of the wall. Thereafter, drill an NX boring through one panel selected by the Contracting Officer for every [_____] linear meters feet of wall, within [_____] days after completion of each [_____] meter foot section. Additional core borings may be directed by the Contracting Officer. Locate the borings in the center of each panel unless otherwise directed by the Contracting Officer. While coring the completed panels, prepare a log including the elevation of any drill fluid loss, soft zones, drill tool drops, or zones of core loss and provide the log to the Contracting Officer immediately after coring is complete. Do not backfill the core holes until approved by the Contracting Officer. [If the Contracting Officer decides to have falling head permeability tests or other tests conducted due to core results, do not use this as basis for a claim.] Fill core holes deviating through the side of the panel and drill a new core hole at no additional cost to the Government.

3.3.4.2 Method of Drilling

Drill cores by any approved standard and accepted method of rotary rock core wireline drilling using diamond-set coring bits by means of which continuous and complete cores of standard diameter for the specified bit size can be obtained.

3.3.4.3 Equipment and Supplies

Equipment to be furnished by the Contractor for core drilling includes diamond core-drilling machinery of a type or types approved by the

Contracting Officer, complete with all accessories for taking continuous cores of a diameter consistent with specified bit size to the depths specified. Provide core drill that is the product of one of the standard core drill manufacturing companies designed primarily for this type of work. Use a ball-bearing, swivel-type, double-tube NX core barrel or manufacturers' equivalent meeting standards established by DCDMA TM. Provide capacity of barrels not exceeding 4.6 m 15 feet of core, and equip with diamond-set core bits and standard core lifters. Include all casing, drill rods, core barrels, diamond-set coring bits, piping, pumps, water, tools, core boxes, and power required for drilling. Set bits with the proper size stones for drilling the concrete and bed rock.

3.3.4.4 Core Boxes

Use longitudinally partitioned wooden core boxes constructed of dressed lumber or other approved materials in general accordance with arrangement and dimensions shown in the drawing included at the end of this section of the specifications for all cores. Use as many core boxes as may be required in submitting each concrete or rock core or group of cores. Equip core boxes completely with all necessary partitions, covers, hinges, and hasps for holding down the cover. To prevent undue core breakage (while it is being placed in boxes) and to allow for ease of access to core in the specified core boxes, determine the maximum amount of core to be placed in any one box by the Government core drill inspector during the drilling operations. Normally, it is expected that an average of approximately 3.7 m 12 feet of core can be placed in each box. In addition to the spacer blocks shown in the drawing, provide, as required, lengths of 29 by 54 mm 1-1/8 by 2-1/8 inch wood, painted red on one side, cut into 100 mm 4-inch lengths, mark with appropriate depths, and insert in the proper positions in core boring samples to show the location and actual extent of voids and core losses. Mark all core boxes with the appropriate hole number, box number, and depths.

3.3.4.5 Disposition of Core Samples

Upon completion of core drilling and sampling operations for each hole, deliver core boxes containing cores to a storage facility to be designated at the project site. Deliver core boxes containing cores in accordance with schedules prepared by the Contracting Officer. All packing, handling, and transportation of samples are considered as subsidiary obligations of the Contractor.

3.3.4.6 Backfilling Core Holes

Upon completion of core sampling, backfill the holes under gravity pressure with portland cement grout or mortar as directed by the Contracting Officer. Pump the grout into the hole through drill rods or plastic hose set to within 1.5 m 5 feet of the bottom of the hole. The bottom of the core hole is defined as being a point in bedrock 900 mm 3 feet below the bottom of the panel or the point at which the boring deviates from the cutoff wall.

3.3.5 Evaluation and Acceptance

Concrete will be evaluated by examination of cores drilled by the Contractor from completed panels as specified in paragraph CORING CONCRETE IN COMPLETED PANELS in PART 1, and unacceptable concrete is defined in paragraphs QUALITY ASSURANCE and CONCRETE PLACEMENT. Repair or remove concrete determined to be unacceptable and replace as specified in

paragraph CONCRETE PLACEMENT above.

_____, 20__ LIST OF FINE AND COARSE AGGREGATE SOURCES		
LAT/LONG	PIT LOCATION, ADDRESS AND TELEPHONE NUMBER	MAIN OFFICE, ADDRESS AND TELEPHONE NUMBER
FINE AGGREGATE		
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
COARSE AGGREGATE		
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____
___/___	_____ _____ _____	_____ _____ _____

_____, 20__ LIST OF FINE AND COARSE AGGREGATE SOURCES		
LAT/LONG	PIT LOCATION, ADDRESS AND TELEPHONE NUMBER	MAIN OFFICE, ADDRESS AND TELEPHONE NUMBER
___/___	_____ _____ _____	_____ _____ _____

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