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## SECTION 02100

## DIVERSION AND CONTROL OF WATER

## PART 1 GENERAL

## 1.1 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES.

## SD-04 Drawings

Diversion and Control of Water; GA.

Within 10 days after receipt of Notice to Proceed, the Contractor shall submit a diversion and control of water plan showing the method that he proposes to use to divert water from each working area, in accordance with paragraph GENERAL.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

## 3.1 REQUIREMENT

## 3.1.1 General

All permanent construction shall be carried on in areas free from water. Water in varying quantities may be flowing in the detention basin as a result of either rainfall or flow from upstream of basin. Runoff from the watersheds is rapid and, during periods of rain, intermittent freshets may be expected. Within 10 days after receipt of Notice to Proceed, the Contractor shall submit a diversion and control of water plan showing the method that he proposes to use to divert water from each working area. The plan shall show sequence of the construction, complete layout of drainage facilities, temporary diversion dams, pumps, diversion channels, etc. Contractor's submitted plans, and diversion and control of water methods will in no way release the contractor from the fulfillment of his obligations or place the Government, in any manner, responsible for any losses due to failure or inadequacy of the diversion and control method used. The responsibility for damage to any part of the permanent work shall be as set forth in the CONTRACT CLAUSE: PERMITS AND RESPONSIBILITIES. Damage to all work (including temporary construction), utilities, materials, equipment, and plant shall be repaired to the satisfaction of the Contracting Officer at the Contractor's expense, regardless of the cause of such damage.

## 3.1.2 Diversion Requirements

The Red Rock Detention Basin is an on-line structure located at Red Rock natural wash. The Contractor is responsible for the diversion and control of all runoff entering the construction area. The runoff will include water originating from Red Rock wash and from upstream, urban runoff, adjacent drainages; and in addition any and all seepage and groundwater originating within the work. The work site may be inundated because of runoff. The Contractor shall be responsible for protection of work site during times of runoff by his own means and shall be approved by the Contracting Officer.

### 3.1.3 Drainage Ditches

The location and depth of any drainage ditch to be constructed under this contract shall be subject to the approval of the Contracting Officer. Special precautions shall be taken to avoid impairing the permanent subgrade. Damaged subgrade shall be replaced in accordance with SECTION 02250 FILLS AND SUBGRADE PREPARATION by and at the expense of the Contractor.

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## SECTION 02150

## CLEAR SITE AND REMOVE OBSTRUCTIONS

## PART 1 GENERAL

## 1.1 ENVIRONMENTAL PROTECTION

All work and Contractor operations shall comply with the requirements of Sections 01130 ENVIRONMENTAL PROTECTION and 02200 EXCAVATION.

## 1.2 BURNING

The use of burning at the project site for the disposal of refuse and debris will not be permitted.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

## 3.1 REQUIREMENTS

## 3.1.1 General

Except as otherwise specified, and/or indicated, areas to be cleared will be limited to actual excavation areas, and areas on which fills and/or structures are to be placed. The removal of trees, shrubs, turf, and other vegetation outside of these areas shall be held to a minimum and care shall be exercised not to damage any trees, shrubs, turf, or vegetation which can be left in place.

## 3.1.2 Existing Structures, Obstructions, and Stone Protection

The Contractor shall clear and grub, fill and excavation areas, and remove and dispose of existing structures, obstructions, and stone protection necessary for project construction, except for those structures which are identified to be protected in place as shown on the drawings. Obstructions, including stone protection, which are designated or specified to be removed but which are not designated or specified to be removed by others shall be removed by the Contractor. Except as otherwise specified, obstructions designated to be removed by others will be removed in sufficient time to preclude interference with the Contractor's operations.

## 3.1.3 Clearing

Trees smaller than 1-1/2 inches in diameter and other vegetation, except as specified, shall be cut off 6 inches below the indicated subgrade or ground level whichever is lower. Grasses, shrubs and weeds shall be cut off flush or slightly below the original ground surface. Clearing operations shall be conducted so as to prevent damage to trees, structures, and

installations under construction, or to remain in place, and to provide for the safety of employees and others. All rubbish, waste dumps, and debris areas shall be cleared.

#### 3.1.4 Grubbing

Grubbing shall consist of removing all trees, stumps, roots, logs, and other objectionable vegetable matter in the required fills, foundation areas, and all excavation areas. In grubbing out stumps and roots, all roots or other timber more than 1-1/2 inches in diameter shall be removed to 18 inches below the depth of the required excavation or existing ground level, whichever is lower. Trees and stumps shall be pulled, not cut off.

#### 3.1.5 Trash and Construction Debris

Surface trash and construction debris may be present at the project site. Surface trash and construction debris shall be removed from within the limits of the right-of-way and temporary construction easements.

#### 3.1.6 Environmental Assessment Requirement

The Contractor shall notify the Contracting Officer 14 Calendar days prior to the start of clearing and grubbing activities in accordance with Section 01200 GENERAL REQUIREMENTS.

#### 3.2 DISPOSAL OF CLEARED, GRUBBED, AND REMOVED MATERIAL

All material removed, except material specified and/or indicated to be salvaged, is designated as scrap, shall become the property of the Contractor, and shall be removed from the site. Disposal shall be in accordance with the requirements of Section 01130 ENVIRONMENTAL PROTECTION.

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## SECTION 02200

## EXCAVATION

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2487 (1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)

## ENGINEERING MANUALS (EM)

EM 385-1-1 (1996) U.S. Army Corps of Engineers Safety and Health Requirements Manual

## 1.2 SUBMITTALS

Government approval is required for all submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01300 SUBMITTAL PROCEDURES:

## SD-01 Data

Excavation Plan; FIO.

The Contractor shall submit his excavation plan to the Contracting Officer in conformance with paragraph GENERAL.

Haul Route Plan; GA.

The Contractor shall submit a haul route plan for removal of required excavated materials and for placing required fill materials.

## SD-04 Drawings

Shop Drawings; GA.

The Contractor shall submit for approval shop drawings showing proposed method of bracing which he intends to use to protect existing property.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

### 3.1 GENERAL

Excavation shall consist of the removal of every type of material encountered (except materials covered by the provisions of Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS in the designated areas or from areas directed. The material to be removed may include but is not limited to hardpan, silt, sand, gravel, cobbles and boulders, cemented silt/sand/gravel/cobbles/boulders with various degrees of cementations, caliche, asphalt, and other materials. The Contractor shall excavate the basin as shown on the project plans. Slope lines indicated on the drawings for temporary cuts do not necessarily represent the actual slope to which the excavation must be made to safely perform the work. Measurement for payment shall be made in accordance with Section 01250 MEASUREMENT AND PAYMENT. Excavation for permanent cuts shall be made to the slope lines indicated. Excavation may require ripping or other rock-excavation techniques and shall be performed in a manner which will not impair the subgrade. Except as otherwise specified, the finish surface of subgrades shall be smooth and shall not vary more than 1 inch from indicated grade, except at areas to receive concrete where finished surfaces of subgrade shall not vary more than 0.5 inches from indicated grade. Prior to commencing excavation, the Contractor shall submit his excavation plan to the Contracting Officer. All subgrade excavations will be inspected by the Contracting Officer prior to placement of any fill materials. Rock or cemented material from required excavation to be used in project fills shall be crushed or otherwise reduced in size to meet fill gradation requirements prior to placement or stockpiling. Suitable materials from required excavation to produce soil aggregates for Roller Compacted Concrete shall be crushed and processed to meet required gradations.

### 3.2 PRESERVATION OF PROPERTY

All excavation operations shall be conducted in such a manner that concrete structures, embankments, utilities or other facilities and improvements which are to remain in place permanently will not be subjected to settlement or horizontal movement. The Contractor shall furnish and install sheet piling, cribbing, bulkheads, shores, or whatever means may be necessary to adequately support material carrying such improvements or to support the improvements themselves and shall maintain such means in position until they are no longer needed. Temporary sheet piling, cribbing, bulkheads, shores or other protective means shall remain the property of the Contractor and when no longer needed shall be removed from the site. The Contractor shall submit for approval shop drawings showing proposed method of bracing which he intends to use. All shoring and bracing shall be designed so that it is effective to the bottom of the excavation, and shall be based upon calculation of pressures exerted by (and the condition and nature of) the materials to be retained, including surcharge imparted to the side of the trench by equipment and stored materials. Removal of shoring shall be performed in such manner as not to disturb or damage the finished concrete or other facility.

### 3.3 EXCAVATION

The excavation of the inflow channel and structure, and the roadside

channel shall be in accordance with lines and grades as shown on the drawings. The finished surface shall be reasonably smooth, free from irregular surface changes, and shall not vary more than 2 inches above or below the indicated grade, except that either extreme of such tolerance shall not be continuous over an area greater than 540 square feet.

The excavation within the detention basin shall be to the lines and grade shown on the drawings. The basin excavation area shall be regular in shape, graded smoothly and graded to drain.

Earth banks and facilities to remain in place shall be supported as necessary during excavation. In general, unless otherwise shown or specified, the actual side slopes shall be in accordance with EM 385-1-1.

#### 3.4 REMOVAL OF UNSATISFACTORY SOILS

The removal of soils which are unsatisfactory for foundation of the spillway/stilling basin or structures may be required in certain areas. Unsatisfactory materials include but are not limited to those materials containing roots and other organic matter, trash, debris and materials classified in ASTM D 2487, as Pt, OH, OL, CH, MH, and materials that are too wet to support construction equipment. The Contractor will be required to excavate any such areas to the depth directed and backfill the areas with compacted fill conforming to the requirements of the Section 02250 FILLS AND SUBGRADE PREPARATION.

#### 3.5 DISPOSITION AND DISPOSAL OF EXCAVATED MATERIALS

Excavated materials suitable for required fills or Roller Compacted Concrete shall be placed in temporary stockpiles or used directly in the work. Excess suitable excavated material not utilized as part of the construction shall be disposed of at the disposal site. Unsatisfactory material shall become the property of the Contractor and shall be removed from the site. No excavated material or waste of any kind shall be disposed of at any place beyond the limits of the work under this contract without the expressed authority of the Contracting Officer. Prior to placing material in fill areas and any approved stockpile area(s), the areas shall be cleared of trash and vegetation. Vegetation shall be cut off at the existing ground line. Clearing shall conform to the applicable requirements of Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS. Any stockpiles shall be placed in a manner to preclude ponding of water.

##### 3.5.1 Hauled Excavation Material

The Contractor shall have a haul route plan for removal of required excavated materials and for placing required fill materials. This haul route plan shall be submitted to the Contracting Officer for approval. The Contractor will be responsible for obtaining all permits and licenses necessary to haul material off-site. The Contractor will provide to the Contracting Officer three copies of the proposed street haul route plan for transport of all excess excavated material.

#### 3.6 OVERCUT

Except as otherwise specified or as may be ordered in writing, any overcut or excavation made outside the lines indicated on the drawings or directed shall be backfilled with compacted fill conforming to the Section 02250 FILLS AND SUBGRADE PREPARATION. All excavating, backfilling, and compacting of backfill occasioned thereby shall be by the Contractor at no additional cost to the Government.

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## SECTION 02241

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## SECTION 02241

## AGGREGATE BASE COURSE

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 128	(1997) Specific Gravity and Absorption of Fine Aggregate
ASTM C 131	(1996a) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	(1996a) Sieve Analysis of Fine and Coarse Aggregates
ASTM D 75	(1987; R 1997) Sampling Aggregates
ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2167	(1994) Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM E 11	(1995) Wire-Cloth Sieves for Testing Purposes

## 1.2 DEFINITIONS

### 1.2.1 Aggregate Base

Aggregate base as used herein is well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction.

### 1.2.2 Degree of Compaction

Degree of compaction is the ratio of the field dry density to the maximum dry density determined in the laboratory, expressed as a percentage of the maximum density. The field dry density shall be determined by ASTM D 1556.

The laboratory maximum density shall be determined by ASTM D 1557, Procedure C.

### 1.2.3 Moisture Content

Moisture content is the ratio of the weight of the water to the weight of the solid matter expressed as a percent and it is determined by ASTM D 2216.

## 1.3 GENERAL

The work specified herein consists of the construction of an aggregate base course. The work shall be performed in accordance with this specification and shall conform to the lines, grades, notes and typical sections shown in the plans. Sources of all materials shall be selected well in advance of the time that materials will be required in the work.

## 1.4 SUBMITTALS

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

### SD-01 Data

Plant, Equipment, Machines, and Tools; FIO.

List of proposed equipment to be used in performance of construction work including descriptive data.

### SD-09 Reports

Sampling and Testing; FIO.

Field Density; FIO.

Calibration curves and related test results prior to using the device or equipment being calibrated. Copies of field test results within 24 hours after the tests are performed. Certified copies of test results for approval not less than 30 days before material is required for the work.

### SD-18 Records

Waybills and Delivery Tickets; FIO.  
Coarse Aggregate; FIO.

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used. A notification stating which type of coarse aggregate is to be used.

#### 1.5 WAYBILLS AND DELIVERY TICKETS

Copies of waybills and delivery tickets shall be submitted during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all aggregates actually used in the construction.

#### 1.6 WEATHER LIMITATIONS

Base shall not be constructed when the atmospheric temperature is less than 35 degrees F. Base shall not be constructed on subgrades that are frozen or contain frost. If the temperature falls below 35 degrees F, completed areas shall be protected against any detrimental effects of freezing.

#### 1.7 PLANT, EQUIPMENT, MACHINES, AND TOOLS

##### 1.7.1 General Requirements

Plant, equipment, machines, and tools used in the work shall be subject to approval and shall be maintained in satisfactory working condition at all times. Other compacting equipment may be used in lieu of that specified, where it can be demonstrated that the results are equivalent. The equipment shall be adequate and have the capability of producing the results specified.

##### 1.7.2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be the self-propelled type weighing not less than 10 tons, with a minimum weight of 300 pounds per inch width of rear wheel. Wheels of the rollers shall be equipped with adjustable scrapers. The use of vibratory rollers is optional.

##### 1.7.3 Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have four or more tires, each loaded to a minimum of 30,000 pounds and inflated to a minimum pressure of 150 psi. The loading shall be equally distributed to all wheels, and the tires shall be uniformly inflated. Towing equipment shall also be pneumatic-tired.

##### 1.7.4 Sprinkling Equipment

Sprinkling equipment shall consist of tank trucks, pressure distributors, or other approved equipment designed to apply controlled quantities of water uniformly over variable widths of surface.

##### 1.7.5 Tampers

Tampers shall be of an approved mechanical type, operated by either pneumatic pressure or internal combustion, and shall have sufficient weight and striking power to produce the compaction required.

#### 1.7.6 Straightedge

The Contractor shall furnish and maintain at the site, in good condition, one 10-foot straightedge, for use in the testing of the finished surface. Straightedge shall be made available for Government use. Straightedges shall be constructed of aluminum or other lightweight metal and shall have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges shall have handles to facilitate movement on pavement.

#### 1.8 STOCKPILING MATERIALS

Materials, including approved material available from excavation and grading, shall be stockpiled in the manner and at locations designated. Before stockpiling of material, storage sites shall be cleared, and sloped to drain. Materials obtained from different sources shall be stockpiled separately.

#### 1.9 SAMPLING AND TESTING

##### 1.9.1 General Requirements

Sampling and testing shall be performed by an approved commercial testing laboratory or by facilities furnished by the Contractor. No work requiring testing shall be permitted until the facilities have been inspected and approved. The first inspection shall be at the expense of the Government. Cost incurred for any subsequent inspection required because of failure of the facilities to pass the first inspection will be charged to the Contractor. Tests shall be performed in sufficient numbers and at the locations and times directed to insure that materials and compaction meet specified requirements. Copies of test results shall be furnished to the Contracting Officer for approval within 24 hours of completion of tests.

##### 1.9.2 Test Results

Results shall verify that materials comply with this specification. When a material source is changed, the new material will be tested for compliance.

When deficiencies are found, the initial analysis shall be repeated and the material already placed shall be retested to determine the extent of unacceptable material. All in-place unacceptable material shall be replaced or modified as directed by the Contracting Officer.

##### 1.9.3 Sampling

Aggregate samples for laboratory tests shall be taken in accordance with ASTM D 75.

##### 1.9.4 Sieve Analysis

Before starting work, at least one sample of material shall be tested in

accordance with ASTM C 136 and ASTM D 422 on sieves conforming to ASTM E 11. After the initial test, a minimum of one analysis shall be performed during placement.

#### 1.9.5 Liquid Limit and Plasticity Index

One liquid limit and plasticity index shall be performed for each sieve analysis. Liquid limit and plasticity index shall be in accordance with ASTM D 4318.

#### 1.9.6 Laboratory Density

Tests shall provide a moisture-density relationship for the aggregate. Tests shall be conducted in accordance with ASTM D 1557.

#### 1.9.7 Wear Tests

Wear tests shall be performed in accordance with ASTM C 131. One test shall be run.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

##### 2.1.1 Aggregates

Aggregates shall consist of stone, crushed stone, crushed gravel, angular sand, or other approved material. Aggregates shall be durable and sound, free from lumps of clay, organic matter, objectionable coatings, and other foreign material. Material retained on a No. 4 sieve shall be known as coarse aggregate and that passing the No. 4 sieve shall be known as binder material.

##### 2.1.1.1 Coarse Aggregate

Only one type of coarse aggregate shall be used on the project. Coarse aggregates, consisting of angular fragments of uniform density and quality, shall have a percentage of wear not to exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131. The amount of flat and elongated particles shall not exceed 30 percent. A flat particle is one having a ratio of width to thickness greater than 3, and an elongated particle is one having a ratio of length to width greater than 3.

a. Crushed Gravel: Crushed gravel shall be manufactured from gravel particles 50 percent of which by weight are retained on the maximum size gradation sieve specified.

b. Crushed Stone: Crushed stone retained on each sieve specified shall contain at least 50 percent by weight of crushed pieces having two or more freshly fractured faces with the area of each face being at least equal to 75 percent of the smallest midsectional area of the piece. When two fractures are adjacent, the angle between the planes of the fractures must be at least 30 degrees to count as two fractured faces.

2.1.2 Liquid Limit and Plasticity Index

Liquid-limit and plasticity-index requirements shall apply to any component that is blended to meet the required gradation and shall also apply to the completed course. The portion of any component or of the completed course passing the No. 40 sieve shall be either nonplastic or have a liquid limit not greater than 29 and a plasticity index not greater than 5.

2.1.3 Gradation

Requirements for gradation specified shall apply to the completed base course. The aggregates shall have a 1 inch maximum size and shall be continuously graded within the following limits:

Sieve Designation	Percentage by Weight Passing Square-mesh Sieve (a) (b)	
1 in.	100	
3/4 in.	90-100	
#4	35-65	
#16	15-40	
#200	2-10	

(a) Particles having diameters less than 0.0008 inches shall not be in excess of 3 percent by weight of the total sample tested.

(b) The values are based on aggregates of uniform specific gravity, and the percentages passing the various sieves are subject to appropriate correction in accordance with ASTM C 127 and ASTM C 128 when aggregates of varying specific gravities are used.

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

When the base is constructed in more than one layer, the previously constructed layer shall be cleaned of loose and foreign matter by sweeping with power sweepers or power brooms, except that hand brooms may be used in areas where power cleaning is not practicable. Adequate drainage shall be provided during the entire period of construction to prevent water from collecting or standing on the working area. Line and grade stakes shall be provided as necessary for control. Grade stakes shall be in lines parallel to the centerline of the area under construction and suitably spaced for string lining.

3.2 OPERATION OF AGGREGATE SOURCES

Materials to be used for production of aggregates may be obtained from off-site sources. The contractor is responsible for selecting the source of materials such that all specified physical properties are met by the selected source.

### 3.3 SUBGRADE PREPARATION

Before constructing the aggregate base course, the subgrade shall be cleaned of foreign substances. The subgrade shall be moisture conditioned and proofrolled by 4 passes of the compaction equipment and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive the aggregate base. If subgrade is overexcavated, the subgrade shall be restored to grade and compacted to a density of 95 percent of laboratory maximum density in accordance with ASTM D 1557. Ruts or soft yielding spots in the subgrade shall be corrected by loosening and removing soft and unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to the density specified hereinbefore. The finished surface of the subgrade shall not vary more than 0.5 inch from the indicated grade at any point when tested with a 10-foot straightedge. The completed subgrade shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until base course is placed.

### 3.4 INSTALLATION

#### 3.4.1 Mixing and Placing

Materials shall be mixed by the stationary plant, traveling plant, or road mix method and placed in such a manner as to obtain uniformity of the aggregate base course material and at a uniform optimum water content for compaction. The Contractor shall make such adjustments in mixing or placing procedures or in equipment to obtain the true grades, to minimize segregation and degradation, to reduce or accelerate loss or increase of water, and to ensure a satisfactory base course.

#### 3.4.2 Edges of Base Course

Approved material shall be placed along edges of aggregate base course in such quantities as will compact to thickness of the course being constructed, or to the thickness of each layer in a multiple layer course, allowing in each operation at least a 1 foot width of the shoulder to be rolled and compacted simultaneously with rolling and compacting of each layer of base course.

#### 3.4.3 Compaction

Each layer of aggregate base course shall be compacted. Water content shall be maintained at optimum. Density of compacted mixture shall be at least 100 percent of laboratory maximum density. Where aggregate base course is used as structural foundation material and other areas as required, the density of compacted mixture shall be at least 95 percent of laboratory maximum density. Rolling shall begin at the outside edge of the surface and proceed to the center, overlapping on successive trips at least one-half the width of the roller. Alternate trips of the roller shall be slightly different lengths. Speed of the roller shall be such that displacement of the aggregate does not occur. Areas inaccessible to the rollers shall be compacted with mechanical tampers, and shall be shaped and finished by hand methods.

#### 3.4.4 Layer Thickness

Compacted thickness of the aggregate course shall be as indicated. No layer shall be in excess of 8 inches nor less than 3 inches in compacted thickness.

#### 3.4.5 Finishing

The surface of the top layer shall be finished to grade and cross section shown. Finished surface shall be of uniform texture. Light blading during compaction may be necessary for the finished surface to conform to the lines, grades, and cross sections. Should the surface for any reason become rough, corrugated, uneven in texture, or traffic marked prior to completion, such unsatisfactory portion shall be scarified, reworked, recompacted, or replaced as directed.

#### 3.4.6 Smoothness

Surface of each layer shall show no deviations in excess of 3/8 inch when tested with the 10 foot straightedge. Deviations exceeding this amount shall be corrected by removing material and replacing with new material, or by reworking existing material and compacting, as directed.

#### 3.4.7 Thickness Control

Compacted thickness of the base course shall be within 1/2 inch of the thickness indicated. Where the measured thickness is more than 1/2 inch deficient, such areas shall be corrected by scarifying, adding new material of proper gradation, reblading, and recompacting as directed. Where the measured thickness is more than 1/2 inch thicker than indicated, the course shall be considered as conforming to the specified thickness requirements. Average job thickness shall be the average of all thickness measurements taken for the job, but shall be within 1/4 inch of the thickness indicated.

### 3.5 FIELD QUALITY CONTROL

#### 3.5.1 Field Density

Field in-place density shall be determined in accordance with ASTM D 1556 or ASTM D 2167. Calibration curves and calibration test results shall be furnished within 24 hours of the conclusion of the tests. At least one field density test shall be performed upon completion of the work.

#### 3.5.2 Smoothness

Measurements for deviation from grade and cross section shown shall be taken in successive positions parallel to the road centerline with a 10 foot straightedge. Measurements shall also be taken perpendicular to the road centerline at 50 feet intervals.

### 3.6 TRAFFIC

Completed portions of the area may be opened to traffic, provided there is no marring or distorting of the surface by the traffic. Heavy equipment

shall not be permitted except when necessary for construction, and then the area shall be protected against marring or damage to the completed work.

### 3.7 MAINTENANCE

The aggregate base course shall be maintained in a satisfactory condition until accepted. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact.

### 3.8 DISPOSAL OF UNSATISFACTORY MATERIALS

Removed in-place materials that are unsuitable for the base course material that is removed for the required correction of defective areas, and waste material and debris shall be disposed of as directed.

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SECTION 02250

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## SECTION 02250

## FILLS AND SUBGRADE PREPARATION

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	(1963; R 1998) Particle-Size Analysis of Soils
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 2216	(1998) Laboratory Determination of Water (Moisture) Content of Soil and Rock
ASTM D 2487	(1998) Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 2922	(1996) Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

## 1.2 SUBMITTALS

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

SD-01 Data

Moisture-density relations; GA.

Moisture-density relations shall be determined by the Contractor, in accordance with the requirements in paragraph LABORATORY CONTROL.

SD-09, Reports

Field Density Tests; FIO.

Field density tests shall be performed by the Contractor. The Contractor shall submit reports as required in paragraph CONTROL.

PART 2 PRODUCTS (NOT APPLICABLE)

PART 3 EXECUTION (NOT APPLICABLE)

3.1 COMPACTION EQUIPMENT

Compaction shall be accomplished by tamping roller, rubber tired roller vibratory compactor or mechanical tampers. All equipment, tools, and machines shall be maintained in satisfactory working condition at all times. Compaction equipment shall be suitable for consistently producing uniform soil densities.

3.2 GENERAL REQUIREMENTS FOR COMPACTED FILLS AND COMPACTED BACKFILLS

3.2.1 Control

Moisture-density relations shall be established by the Contractor. The soil used for each maximum density test shall be classified in accordance with ASTM D 2487 and shall include a particle size analysis in accordance with ASTM D 422. At least one five point maximum density test shall be made for every 10 field density tests. Field density tests shall be performed by the Contractor at the frequency established in paragraph: FIELD CONTROL, and in such locations to insure that the specified density is being obtained. Moisture-density relations and field densities shall be reported on approved forms. One copy of density data less dry weight determinations shall be provided on the day each test is taken. The completed test reports shall be provided with the Contractor Quality Control Report on the work day following the test.

3.2.1.1 Laboratory Control

Moisture-density relations shall be established by the Contractor. One moisture-density relation shall be made for each classification, blend or change in classification of soil materials encountered. Approval of moisture-density relations shall be obtained prior to the compacting of any material in the work. The moisture-density relations shall be determined in a laboratory in accordance with ASTM D 1557.

- a. The desired amount of mixing water will be added for each compaction test specimen, mixed well, and the mixture will be placed in a container with an airtight cover and allowed to cure for 24 hours. A shorter curing time may be allowed where tests show that shortening the curing time will not affect the results.

3.2.1.2 Field Control

Field in-place density shall be determined in accordance with ASTM D 1556. The field moisture content shall be determined in accordance with ASTM D 2216. Determination of in-place densities using the nuclear method ASTM D 2922 may be used to supplement the sand cone density tests ASTM D 1556.

When ASTM D 2922 is used, the calibration curves shall be checked and adjusted using only the sand cone method as described in ASTM D 1556. At least one adjacent sand cone test shall be performed for every five nuclear density tests performed. If field density tests determined by the nuclear method vary by more than 3 pounds per cubic foot from comparison sand-cone tests, and are consistently high or low, adjustment of the calibration curve is necessary.

a. In-Place Densities

(1) One test per 1,000 cubic yards, for the first 10,000 cubic yards of material and one test for each 2,000 cubic yards thereafter, or fraction thereof, shall be made of each lift of fill or backfill areas compacted by other than hand-operated machines. At least one test shall be made in each 2.0 foot layer of compacted fill or backfill processed as a unit and not less than one test shall be made in each area.

(2) One test per 500 cubic yardss, or fraction thereof, shall be made of each lift of fill or backfill areas compacted by hand-operated machines.

3.2.1.3 Test Logs

The Contractors CQC shall maintain a log of all tests which will be updated and submitted to the Contracting Officer on a weekly basis. The test log shall include: Test number (if retest, shall include retest number), data, feature of work, station and offset, weight of wet soil, weight of dry soil, percent of compaction, optimum moisture content, maximum dry unit weight, soil classification, in-place density test methods either sand-cone or nuclear densimeter.

3.2.2 Settling of Fills or Backfills with Water

Settling of fills or backfills with water will not be permitted.

3.2.3 Fill Material

Fill material shall be obtained from the basin excavation, foundation excavation or stockpiles. Materials considered unsatisfactory for use as compacted fill include but are not limited to those materials containing roots and other organic matter, trash, debris, oversize chunks or clumps of cemented material. Fill material shall contain no stone whose greatest dimension is more than 3/4 the lift thickness. The contractor shall be expected to break-down, crush, or otherwise process the excavated material for use as fill material due to the cementation of in-situ soil. Materials classified in ASTM D 2487 as MH, CH, Pt, OH, and OL are also considered unsuitable for use as compacted fill.

3.2.4 Placement

Heavy equipment shall not be operated over pipes and buried structures until at least 2.0 feet of fill material has been placed and compacted over them. Material from the top of the pipe or buried structure to 2.0 feet

above pipe or buried structure shall be compacted by mechanical tampers or other equipment approved by the Contracting Officer. Compacted fill and backfill shall be placed with suitable equipment in horizontal layers which before compaction, shall not exceed 1.0 foot in depth for rubber-tired or vibratory rollers, 8 inches in depth for tamping rollers, and 4 inches in depth when mechanical tampers are used. The Contractor may vary the layer thickness within these limits for most efficient operations.

### 3.2.5 Moisture Content

Material shall have a uniform moisture content while being placed and compacted. Water shall be added at the source, if required, or by sprinkling each layer of material during placement. Uniform distribution of moisture shall be obtained by disking, harrowing, or otherwise manipulating the soil during and after time water is added. Material containing an excess of moisture shall be manipulated with suitable implements to facilitate maximum aeration and shall be permitted to dry to the proper consistency before being compacted. Fill shall have a maximum moisture content of not more than 2 percent above optimum and a minimum moisture content of not less than 2 percent below optimum.

### 3.2.6 Compaction

No layer of fill shall be compacted before the practicable uniform moisture content has been obtained. Scarified areas shall be compacted as specified for the fill placed thereon. Rollers will not be permitted to operate within 1.0 foot of outlet conduit or structure walls or over buried structures until the compacted fill over the top of the structures has reached a depth of 2.0 feet. Compaction equipment shall be so operated that structures are not damaged nor overstressed during compaction operations. Mechanical tampers shall be used for compaction of fill material adjacent to structures where rolling equipment is impracticable for use in compaction.

## 3.3 COMPACTED FILL

### 3.3.1 Compacted Fill

#### 3.3.1.1 Preparation for Placing

Before placing material for compaction, the surface shall be cleared of all existing obstructions, vegetation and debris. Material shall be removed in accordance with Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS and Section 02200 EXCAVATION. Unsatisfactory material not meeting the requirements for fill material shall be removed where directed. The existing surfaces shall be scarified to a depth of 6 inches and proofrolled by four passes of the compaction equipment before placing the fill. Sloped ground surfaces steeper than one vertical to four horizontal, on which fill or compacted backfill is to be placed, shall be stepped in such a manner that the compaction equipment will bear on the full depth of the layer.

#### 3.3.1.2 Compaction

Each layer of the materials shall be compacted to not less than 95 percent

of maximum density, per ASTM D 1557.

### 3.3.2 Filter Material

#### 3.3.2.1 Preparation for Placing

Foundation for the filter material shall be cleared of all existing obstructions, vegetation and debris. Any trash or debris shall be removed in accordance with Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS and Section 02200 EXCAVATION. Unsatisfactory material not meeting the requirements for fill material shall be removed where directed. The existing surfaces shall be scarified to a depth of 6 inches and proofrolled by four passes of the compaction equipment before placing the filter material. The subgrade for Filter Material shall be prepared in accordance with paragraph SUBGRADE PREPARATION.

#### 3.3.2.2 Material

Filter material and gradation shall be in accordance with SECTION 02600 STONE PROTECTION.

#### 3.3.2.3 Placement and Compaction

Filter material shall be spread by motor graders or other approved means in approximately horizontal layers to the lines and grades indicated on the plans, the thickness of the layers before compaction shall not be more than 1.0 foot, the entire surface of the layer shall be compacted by not less than four complete passes of the 9-ton vibratory roller. Each trip of the roller shall overlap the adjacent trip not less than 1.0 foot. The finished surface of the filter material shall not vary more than 0.5 inches above or below the indicated grades.

Filter material shall not be placed under 6 inch diameter riprap, only 18 inch diameter and 12 inch diameter riprap.

### 3.4 SUBGRADE PREPARATION

Subgrade preparation shall include subgrade preparation for areas to receive aggregate base course paving for access roads, maintenance roads and turnarounds. All trash and debris shall be removed in accordance with Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS and Section 02200 EXCAVATION. The entire subgrade for the area indicated above shall be moisture conditioned and proofrolled by 4 passes of the compaction equipment and trimmed to a uniform grade and smoothed with a steel-wheeled roller to make the subgrade ready to receive aggregate base. If the subgrade is disturbed by the Contractor's operations or is overexcavated, or is soft or yielding, the subgrade shall be restored to grade and compacted to a density of 95 percent of maximum density, per ASTM D 1557. The finished surface of the subgrade shall not be more than 0.5 inches from the indicated grade at any point when tested with a 10 foot straightedge.

### 3.5 SOIL STABILIZER

Soil Stabilizer shall be placed on all exposed excavation and fill surfaces

after construction is completed. The soil stabilizer shall be a mixture of plaster and natural cellulose fiber mulch. The cellulose fiber mulch shall be produced from grinding clean, whole wood chips, or fiber produced from ground newsprint with a labeled ash content not to exceed 7 percent. The plaster shall consist of natural occurring high purity processed gypsum and additives. The gypsum shall be produced from a mined or quarried source. The gypsum shall be processed to be composed of a crushed, dry calcium sulfate hemihydrate having a purity of not less than 88 percent. The soil stabilizer shall be mixed with color pigments to match existing soil color on site. Color can be matched by using the "Davis Colors" chart by Soil-Tech, Las Vegas, Nevada or equal. The gypsum and additives shall be furnished either in bags or bulk and be accompanied by bills of lading and shipping invoices. The shipping invoices for the gypsum shall state the gypsum's purity content, dry weight, and source of manufacture. Processed gypsum which has become partially air set, lumpy or caked shall not be used. The plaster/cellulose fiber mulch shall be applied at a rate of 3.0 tons of plaster mixed with 1.0 ton of fiber per acre. The plaster/cellulose fiber mulch stabilizer shall formulate a protective crust-like barrier within 4 to 8 hours after application. Application of the plaster/cellulose fiber mulch stabilizer will not be permitted when weather conditions are unsuitable for concrete placement in accordance with Section 03360 ROLLER-COMPACTED CONCRETE.

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SECTION 02600

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## SECTION 02600

## STONE PROTECTION

## PART 1 GENERAL

## 1.1 REFERENCES

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

American Society for Testing and Materials (ASTM)

ASTM C 33	(1999a) Concrete Aggregates
ASTM C 88	(1999a) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C 127	(1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate
ASTM C 295	(1998) Petrographic Examination of Aggregates for Concrete
ASTM C 535	(1996) Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM D 1141	(1980) Substitute Ocean Water
ASTM D 5519	(1994) Particle Size Analysis of Natural and Man-Made Riprap Materials
ASTM E 548	(1994) General Criteria Used for Evaluating Laboratory Competence

## 1.2 SUBMITTALS

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

SD-01 Data

Placing Method and Equipment; GA.

All placing methods and equipment shall be submitted for review by the Contracting Officer for conformance with paragraph PLACEMENT.

SD-09 Reports

Gradation Sampling and Testing; GA.

Copies of field test results within 24 hours after the tests are performed. Certified copies of test results shall be submitted for approval in accordance to paragraph GRADATION SAMPLING AND TESTING.

SD-14 Samples

Stone Quality; GA.

Stone quality samples shall be submitted at least 45 days prior to start of stone placement, in accordance with paragraph STONE QUALITY.

SD-18 Records

Waybills and Delivery Tickets; FIO.

Copies of waybills and delivery tickets during the progress of the work. Certified waybills and delivery tickets for all materials actually used as required in paragraph WAYBILLS AND DELIVERY TICKETS.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 Definitions

##### 2.1.1.1 Rounded Stone

Stone which is obtained from alluvial deposits and is nearly spherical and well rounded.

##### 2.1.1.2 Angular Stone

Stone which is obtained from bedrock deposits and is angular in shape.

#### 2.1.2 General

The Contractor shall make all arrangements, pay all royalties, and secure all permits for the procurement, furnishing and transporting of stone. The Contractor shall vary the quarrying, processing, loading and placing operations to produce the sizes and quality of stone specified. If the stone being furnished by the Contractor does not fully meet all the requirements of these specifications, the Contractor shall furnish, at no additional cost to the Government, other stone meeting the requirements of these specifications.

#### 2.1.3 Stone Sources

##### 2.1.3.1 Stone From Project Excavation

Stone conforming to these specifications may not be available from the required excavation in sufficient quantities of suitably large stone. Therefore, additional required stone may need to be obtained from offsite

sources. One offsite source is Sloan Quarry located about 16 miles to the southeast of the project site.

#### 2.1.3.2 Source Authorization

Before any stone is produced from a source for completion of the work under this contract, the source of stone must be authorized by the Contracting Officer's Representative. Authorization of a stone source shall not be construed as a waiver of the right of the Government to require the Contractor to furnish stone which complies with these specifications. Materials produced from localized areas, zones or strata will be rejected when such materials do not comply with the specifications.

#### 2.1.3.3 Source Development

Before a proposed source or sources of stone will be considered for sampling and testing, the Contractor must demonstrate that the source has sufficient stone to fulfill the contract requirements. If sufficient amounts of stone conforming to these specifications are not available from a source or sources used in the work, the Contractor shall submit stone from another source for authorization.

#### 2.1.3.4 Source Documentation

Authorization of a proposed stone source will be based on test results and/or service records. In general, current Corps of Engineers test results shall be required as outlined in paragraph: Quality Compliance Testing, below. In special cases, however, the Contracting Officer's Representative may elect to use either past Corps of Engineers test results, test results from other agencies or private laboratories, or service records. A service record is considered to be acceptable if stone from the proposed source has remained sound and functional after at least 10 years of exposure on a project similar to the one to be constructed under these specifications.

#### 2.1.4 Stone Quality

##### 2.1.4.1 Quality Compliance Testing

Samples for Corps of Engineers testing as specified in paragraph: Source Documentation shall be submitted a minimum of 45 days in advance of the time when the stone will be required in the work. Stone from a proposed source will be tested by the Government for quality compliance. The first test shall be at Government expense, however, if the stone fails the tests, or if the Contractor desires to utilize more than one source, additional testing will be performed by the Government at the Contractor's expense. The cost of additional testing will be deducted from payment due the Contractor in the amount of \$4,500 for each sample tested. All test samples (300 lb) shall be representative of the stone source and shall be obtained by the Contractor under the supervision of the Contracting Officer's Representative and delivered at the Contractor's expense to a testing laboratory specified by the Contracting Officer's Representative. The testing laboratory suggested by the Contractor and specified by the Contracting Officer's Representative shall be under the supervision of a

licensed Civil or Geotechnical Engineer or a licensed/registered Geologist.

#### 2.1.4.2 Stone Quality Testing Requirements

Stone shall be subjected to such tests as are necessary to demonstrate to the satisfaction of the Contracting Officer's Representative that the materials are acceptable for use in the work. At a minimum the stone shall meet the following test requirements.

<u>Test</u>	<u>Test Method</u>	<u>Requirement</u>
Specific Gravity (Bulk SSD)	ASTM C 127	2.60 minimum
Absorption	ASTM C 127	2.0% maximum
Wetting and Drying	SPD Test Procedure <sup>(1)</sup>	No fracturing <sup>(3)</sup>
Sulfate Soundness	ASTM C 88 <sup>(2)</sup>	10% max.loss <sup>(4)</sup>
Abrasion Loss	ASTM C 535	50% max.loss <sup>(4)</sup>

In addition to the above tests, the stone shall be subjected to a petrographic and X-ray diffraction analysis in accordance with ASTM C 295<sup>(5)</sup>. The stone must not contain any expansive clays. Stone for grouted stone protection shall not contain excessive amounts of deleterious minerals associated with alkali-silica or alkali-carbonate reactions as described in ASTM C 33.

NOTE: (1): Test procedure for wetting and drying test. The entire sample is carefully examined and representative test specimens are selected. The sample should be large enough to produce two cut slabs, 1 inch thick (+/- 1/4 in) with a minimum surface area of 30 square inches on one side. Two chunks approximately 3 by 4 inches are also chosen. The slabs and chunks are carefully examined under a low-power microscope and all visible surface features are noted and recorded. The specimens are then oven dried at 140 degrees F, for eight hours, cooled and weighed to the nearest tenth of a gram. The test specimens are photographed to show all surface features before the test. The chunks and slabs are then subjected to fifteen cycles of wetting and drying. One slab and one chunk are soaked in fresh tap water, the other slab and chunk are soaked in salt water prepared in accordance with ASTM D 1141. Each cycle consists of soaking for sixteen hours at room temperature and then drying in an oven for eight hours at 140 degrees F. After each cycle the specimens are examined with the low-power microscope to check for opening or movement of fractures, flaking along edges, swelling of clays, softening of rock surfaces, heaving of micaceous minerals, breakdown of matrix material and any other evidence of weakness developing in the rock. The cycle in which any of these actions occurs is recorded. After fifteen cycles, the slabs and chunks are again carefully examined and all changes in the rocks are noted and recorded. The test specimens together with all particles broken off during the test are oven dried, weighed and photographed.

NOTE: (2): The test shall be made on 50 particles each weighing 100 grams, +/- 25 grams, in lieu of the gradation given in ASTM C 88.

NOTE: (3): Weakening and loss of individual surface particles is permissible unless bonding of the surface grains softens and causes general

disintegration of the surface material.

NOTE: (4): Stone which has a loss greater than the specified limit will be accepted if the Contractor demonstrates that the stone has a satisfactory service record.

NOTE: (5): The test procedure for Petrographic and X-ray Diffraction is performed according to ASTM C 295, except for the following:

(a) A color, microscopic photograph shall be made of each stone type and the individual minerals within the stone shall be identified by labels and arrows upon the photograph.

(b) A very detailed macroscopic and microscopic description shall be made of the stone, to include the entire mineral constituents, individual sizes, their approximate percentages and mineralogical histories. A description of stone hardness, texture, weathering, and durability factors shall also be discussed.

(c) A written summary of the suitability of stone for use as riprap based on the Petrographic and X-ray tests and the results of ASTM C 535 shall be presented in the final laboratory report on stone quality.

#### 2.1.4.3 Stone Acceptance Criteria

Prior to placement, all stone shall be subject to acceptance by the Contracting Officer's Representative. Acceptance of any stone shall not constitute acceptance of all stone from a source. All accepted stone shall be:

- a. of the same lithology as the original stone from which test results or service records were taken as a basis for authorization of the source;
- b. sound, durable and hard, and free from laminations, weak cleavages, undesirable weathering, or blasting or handling-induced fractures (or fracture zones which subtend more than 1/3 of the total circumference of the stone along the plane of fracturing);
- c. of such character that it will not disintegrate from the action of air, water, or the conditions of handling and placing; and,
- d. clean and free from earth, clay, refuse, or adherent coatings.

In addition, to be accepted, the greatest dimension of any stone piece shall not be greater than 3 times its least dimension.

#### 2.1.4.4 Stone for Riprap

Stone for riprap protection shall be angular quarried material.

#### 2.1.5 Gradation

##### 2.1.5.1 General

All points on individual grading curves shall be between the boundary limits as defined by smooth curves drawn through specified grading limits plotted on a mechanical analysis diagram. The individual grading curves shall not exhibit abrupt changes in slope denoting skip grading or scalping of certain sizes. Specified grading of all material shall be met both at the source and as delivered to the project. In addition, material not meeting the required grading due to segregation or degradation during placement shall be rejected. If test results show that stone does not meet the required grading, the hauling operation will be stopped immediately and will not resume until processing procedures are adjusted and a gradation test is completed showing gradation requirement are met. All gradation tests shall be at the expense of the Contractor. For the size-weight relationships used during gradation tests, within-specification weights will be determined based on a stone specific gravity of 2.58 and stone sizes (diameters) that result for stone shapes midway between that of a sphere and a cube.

2.1.5.2 Stone Riprap

Stone Riprap shall be reasonably well-graded within the limits specified below, when tested in accordance with ASTM D 5519, Test Method A.

D<sub>50</sub> = 6" Stone Riprap,

	Min (in)	Max (in)
D <sub>100</sub>	6.7	9.0
D <sub>50</sub>	5.2	6.0
D <sub>15</sub>	3.4	4.6
D <sub>90</sub> (min)	6.5	
D <sub>30</sub> (min)	4.4	
Thickness, (min)	9.0	

D<sub>50</sub> = 12" Stone Riprap,

	Min (in)	Max (in)
D <sub>100</sub>	13.3	18.0
D <sub>50</sub>	10.5	12.0
D <sub>15</sub>	7.1	9.5
D <sub>90</sub> (min)	12.7	
D <sub>30</sub> (min)	8.8	
Thickness, (min)	18.0	

D<sub>50</sub> = 18" Stone Riprap

	Min (in)	Max (in)
D <sub>100</sub>	19.9	27.0
D <sub>50</sub>	15.8	18.0
D <sub>15</sub>	10.7	14.3
D <sub>90</sub> (min)	19.1	
D <sub>30</sub> (min)	13.2	

Thickness, (min) 27.0

2.1.5.3 Gradation Sampling and Testing

Testing shall be the responsibility of the Contractor and shall be performed at no additional cost to the Government. Tests shall be performed by an approved testing laboratory on samples selected by the Contracting Officer's Representative. Testing may be done by the Contractor, subject to approval by the Contracting Officer's Representative. If the Contractor elects to establish testing facilities, approval of such facilities shall be based on compliance with ASTM E 548, and no work requiring testing will be permitted, until the Contractor's facilities have been inspected and approved by the Contracting Officer's Representative. Testing shall be supervised by a registered Civil Engineer, experienced in rock-testing. The Government reserves the right to perform check tests and to use the Contractor's sampling and testing facilities to make the tests. One gradation test each shall be required for the 18" riprap, the 12" riprap, and the 6" riprap at the beginning of production prior to delivery of stone from the source to the project site. A minimum of one additional test each for the 18" riprap, the 12" riprap, and the 6" riprap shall be required for each 5,000 tons of stone placed, respectively. All sampling and gradation tests performed by the Contractor shall be under the supervision of the Contracting Officer's Representative.

Each sample shall consist of not less than 5.0 tons of stone, selected at random from the production run for the first test or from stone placed on grade or stockpiled on-site for required additional tests

2.1.6 Rejected Stone

Stone of unsuitable quality and/or size distribution as required by these specifications shall be rejected. Any rejected stone shall be promptly removed from the project at no expense to the Government. Any portions of the work covered by these specifications containing rejected stone will be considered incomplete.

2.1.7 Filter Material

2.1.7.1 Material

Filter material shall be processed from materials obtained from the required excavations or may be obtained from commercial sources. Filter material shall consist of natural sand, manufactured sand, or a combination of natural and manufactured sands.

2.1.7.2 Gradation

Filter material shall be reasonably well graded within the following limits:

Sieve Size	Percent by Weight Passing
3/8"	100
No. 4	85-95
No. 16	35-45
No. 100	0-20
No. 200	0-15

### PART 3 EXECUTION

#### 3.1 FOUNDATION PREPARATION

##### 3.1.1 General

Subgrade preparation for material placement shall conform to the provisions of SECTION 02250 FILLS AND SUBGRADE PREPARATION. Areas on which stone is to be placed shall be trimmed and dressed to conform to cross sections indicated or directed, within an allowable tolerance of plus or minus 1" from the theoretical slope lines and grades. Where such areas are below the allowable minus tolerance limit, they shall be brought to grade by filling with earth similar to the adjacent material and well compacted, or by filling with approved material, and no additional payment will be made for any material thus required. Immediately prior to placing the stone, the prepared base shall be inspected by the Contracting Officer's Representative and no material shall be placed thereon until that area has been approved.

#### 3.2 PLACEMENT

##### 3.2.1 General

Except as otherwise specified, the limits of stone in place shall follow, with reasonable variation, the indicated lines and slopes, without continuous under- or overbuilding. Templates shall be placed at adequate intervals, as determined by the Contracting Officer's Representative, to accurately delineate the surface of the work being placed. For all stonework, the Contractor shall submit the method of placement to the Contracting Officer's Representative for approval, before placement begins.

##### 3.2.2 Stone Riprap

Stone Riprap shall be placed in a manner to produce a reasonably well-graded mass with the minimum practicable percentage of voids, and shall be constructed to the lines and grades indicated or directed. Stone shall be placed to its full course thickness in one operation and in a manner to avoid displacing the underlying material. Material shall not be dropped from a height of more than 18". The placing method shall be submitted to Contracting Officer's Representative for approval prior to commencement of placement operations. The Contractor shall maintain the stone protection until accepted and any material displaced by any cause shall be replaced at the Contractor's expense to the lines and grades shown on the drawings. Self propelled equipment shall not be used on the slopes.

Hand placing, barring, or placing by crane will be required only to the extent necessary to secure the results specified. Placing stone by dumping into chutes or by similar methods likely to cause segregation will not be permitted. A tolerance of minus 1" to plus 2" from the indicated slope lines and grades will be allowed in the finished surface, except that either extreme of such tolerance shall not be continuous over an area greater than 25 square yards.

#### 3.3 DELIVERY

All stone delivered by rail or truck shall be weighed and the scale tickets certified by authorized weighers. All railroad cars and trucks used for delivering stone shall be plainly numbered.

### 3.3.1 Scales

Scales used for measurement shall, at the option of the Contractor, be either public scales or approved scales provided by the Contractor. Weighing shall be at the point nearest the work at which the public scale is available or at which it is practicable for the Contractor to provide a scale. Scales shall be standard truck scales of the beam type. The scales shall be of sufficient size and capacity to accommodate all trucks used in hauling the material. Scales shall be tested, approved, and sealed by an inspector of the State Inspection Bureau charged with scales inspection within the state in which the project is located. Scales shall be calibrated and resealed as often as the Contracting Officer's Representative considers necessary to insure continuous accuracy. The necessary number of standard weights for testing the scales shall be on hand at all times and, if an official inspection bureau of the state is not available, the scales will be tested by the Contracting Officer's Representative.

### 3.3.2 Waybills and Delivery Tickets

Copies of waybills or delivery tickets shall be submitted to the Contracting Officer's Representative during the progress of the work. The Contractor shall furnish the Contracting Officer's Representative scale tickets for each load of material weighed; these tickets shall include tare weight, identification mark of each vehicle weighed, date, time, and location of the loading. Tickets shall be furnished at the point and time individual loads arrive at the work site. A master log of all vehicle loading shall be furnished for each day of loading operation. The Contractor shall file with the Contracting Officer's Representative the master log of loadings, certified waybills and/or certified tickets within 24 hours of material delivery. Prior to the final payment, the Contractor shall furnish written certification that the material recorded on the submitted waybills and/or certified tickets was actually used in the construction covered by the contract.

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## SECTION 02832

## TEMPORARY TORTOISE FENCING

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 702	(1989; R 1994) Steel Fence Posts and Assemblies, Hot Wrought
ASTM A 740	(1986) Hardware Cloth (Woven or Welded Galvanized Steel Wire Fabric)
ASTM A 824	(1995) Metallic- coated Steel Marcellled Tension Wire for uses with Chain link fence
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM F 626	(1996a) Fence Fittings
ASTM F 900	(1994) Industrial and Commercial Swing Gates
ASTM F 1043	(1999) Strength and Protective Coatings on Metal Industrial Chain-Link Fence Framework
ASTM F 1083	(1997) Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures

## 1.2 SUBMITTALS

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

## SD-01 Data

Steel mesh hardware cloth, post, and accessories; GA.

Submit descriptions and product data on steel mesh hardware cloth, post, accessories, fittings, and hardware.

## SD-04 Drawings

Tortoise fencing and layout; GA.

Submit shop drawings showing details of tortoise fencing and gate layout, post foundation dimensions, bracing, hardware, and schedule of components for fence and gates.

#### SD-14 Samples

Steel mesh hardware cloth; GA.

Submit two samples of steel mesh hardware cloth 6.0 in x 6.0 in in size.

## PART 2 PRODUCTS

### 2.1 MATERIALS

Materials shall conform to the following requirements.

#### 2.1.1 Steel Mesh Hardware Cloth

Steel mesh hardware cloth shall be 0.5 inches mesh, galvanized steel and fabricated in accordance with ASTM A 740.

#### 2.1.2 Line Posts

Line Posts for temporary tortoise fence shall be T-post fabricated in accordance with ASTM A 702.

#### 2.1.3 Tension Wire

Tension wire shall be 11-gauge galvanized steel wire fabricated in accordance with ASTM A 824.

### 2.2 GATES

ASTM F 900. Gate shall be the type and swing shown. Gate frames shall conform to strength and coating requirements of ASTM F 1083 for Group IA, steel pipe, with external coating Type A, nominal pipe size (NPS) 2 inches. Gate frames shall conform to strength and coating requirements of ASTM F 1043, for Group IC, steel pipe with external coating Type A or Type B, nominal pipe size (NPS) 2 inches. Gate fabric shall be as specified for chain link fabric. Gate leaves shall have either intermediate members and diagonal truss rods or shall have tubular members as necessary to provide rigid construction, free from sag or twist. Gate fabric shall be attached to the gate frame by method standard with the manufacturer except that welding will not be permitted. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for the operation of the gate. Latches shall be arranged for padlocking so that the padlock will be accessible from both sides of the gate. Stops shall be provided for holding the gates in the open position. The steel mesh hardware cloth shall be attached to the gate frame as shown on the drawings. Latches, hinges, stops, keepers, rollers, and other hardware items shall be furnished as required for operation of the gate.

### 2.3 ACCESSORIES

ASTM F 626, ferrous accessories shall be zinc or aluminum coated. Truss rods shall be furnished for each terminal post. Tension rods shall be provided with turnbuckles or other equivalent provisions for adjustment.

### 2.4 CONCRETE

ASTM C 94/C 94M, using 0.75 inches maximum-size aggregate, and having minimum compressive strength of 2,000 psi at 28 days. Grout shall consist of one part portland cement to three parts clean, well-graded sand and the minimum amount of water to produce a workable mix.

## PART 3 EXECUTION

### 3.1 GENERAL

The temporary tortoise Fencing shall be installed after the Biologist survey of the construction site in accordance with Section 01130 ENVIRONMENTAL PROTECTION and prior to initial clearing, grubbing, trash removal, grading or other construction activities in accordance with Section 02150 CLEAR SITE AND REMOVE OBSTRUCTIONS. Temporary tortoise fencing shall be provided along the haul route from the work area to the disposal site in accordance with Section 02150 MEASUREMENT AND PAYMENT for Excavation. The Contractor shall maintain the fencing in good condition during the construction period and shall remove the fencing after completion of all construction activities. Install fencing in accordance with manufacturer's instructions and details shown. Fencing shall be adequately braced to support normal usage. Temporary tortoise fencing shall be installed along the portion of the project right-of-way AND construction site as shown on the drawings or as directed by the Contracting Officer. If required, ground surface irregularities shall be graded to maintain the top and bottom of the steel mesh fabric within a 2 inches tolerance of the dimensions shown on the drawings. Tortoise proof gates shall be installed across haul roads or access roads that cross the right-of-way at the indicated areas of fencing. Unless indicated otherwise on the drawings, all temporary tortoise fencing shall be of the same type and design. The temporary tortoise fencing shall be in place before construction and movement of heavy equipment is started and shall remain in place and maintained until all construction work is complete. Temporary tortoise fencing shall become the property of the contractor and shall be removed by the contractor upon completion of the project.

### 3.2 POSTS

Posts shall be set plumb and in alignment. Except where solid rock is encountered, line posts shall be installed a minimum of 36 inches below existing ground level at a maximum 10.0 feet center to center spacing. Gate posts shall be set in concrete to depth of 36 inches. Where solid rock is encountered with no overburden, posts shall be set to a minimum depth of 18 inches in rock. Where solid rock is covered with an overburden of soil or loose rock, posts shall be set to a minimum depth of 36 inches unless a penetration of 18 inches in solid rock is achieved before reaching

the 36 inches depth in which case depth of penetration shall terminate. All portions of posts set in rock shall be grouted. Portions of posts not set in rock shall be set in concrete from the rock to ground level. Line posts set in concrete shall be set in holes not less than 6 inches in diameter and gate post set in concrete shall be set in holes 12 inches in diameter.

### 3.3 TENSION WIRES

Stretch tension wire approximately 16 inches above ground and attach securely to line post and gate post as applicable. Tension wire shall be pulled taut and shall be free of sag.

### 3.4 STEEL MESH HARDWARE CLOTH

Installation of steel mesh hardware cloth shall be in accordance with one of the following options:

Option 1: Bottom of steel mesh hardware cloth shall be buried at least 12 inches below existing ground level.

Option 2: Bend steel mesh hardware cloth at ground level and extend bottom edge at least 18 inches towards the habitat side of fence. Cover flattened steel mesh hardware cloth with cobbles 6 inches in depth.

Steel mesh hardware cloth shall be installed on the habitat side of the post (side away from project area) with the top of the hardware cloth approximately 18 inches above the ground surface. The steel mesh hardware cloth shall be securely attached to the tension wire, with hog ties spaced at 12 inches and to the fence post with 11 gauge tie wires. The steel mesh hardware cloth shall be pulled taut to provide a smooth uniform appearance free from sag.

### 3.5 GATES

Gates shall be installed at haul road or access road crossings of the indicated temporary tortoise fencing locations. Hinged gates shall be mounted to swing as indicated. Latches, stops, and keepers shall be installed as required.

### 3.6 MAINTENANCE AND REPAIR

The Contractor shall maintain the temporary tortoise fencing in good condition during construction and shall promptly make repairs to any damaged sections that occur. The temporary tortoise fencing shall be removed after the completion of construction.

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## SECTION 03307

## CONCRETE FOR MINOR STRUCTURES

## PART 1 GENERAL

## 1.1 REFERENCES

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

## ACI INTERNATIONAL (ACI)

ACI 308	(1992; R 1997) Standard Practice for Curing Concrete
ACI 318/318R	(1999) Building Code Requirements for Structural Concrete and Commentary
ACI 347R	(1994) Guide to Formwork for Concrete

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 615/A 615M	(1996a) Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31/C 31M	(1998) Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(1999a) Concrete Aggregates
ASTM C 39/C 39M	(1999) Compressive Strength of Cylindrical Concrete Specimens
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete
ASTM C 143/C 143M	(1998) Slump of Hydraulic Cement Concrete
ASTM C 150	(1999a) Portland Cement
ASTM C 171	(1997a) Sheet Materials for Curing Concrete
ASTM C 172	(1999) Sampling Freshly Mixed Concrete
ASTM C 231	(1997) Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(1998) Air-Entraining Admixtures for Concrete
ASTM C 309	(1998a) Liquid Membrane-Forming Compounds for Curing Concrete

ASTM C 494/C 494M	(1999a) Chemical Admixtures for Concrete
ASTM C 618	(1998a) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 685	(1998a) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 881	(1999) Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 920	(1998) Elastomeric Joint Sealants
ASTM C 1107	(1999) Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM D 75	(1987; R 1997) Sampling Aggregates

CORPS OF ENGINEERS (COE)

COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
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## 1.2 DESIGN AND PERFORMANCE REQUIREMENTS

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

### 1.2.1 Strength

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

### 1.2.2 Construction Tolerances

A Class "C" finish shall apply to other exposed surfaces. A Class "D"

finish shall apply to all surfaces which will be permanently concealed after construction. The surface requirements for the classes of finish required shall be as specified in ACI 347R. A class "A" or "B" finish shall be required for vertical exposed surfaces of headwalls. A class "A" shall be required for walls inside junction structures.

### 1.2.3 Concrete Mixture Proportions

Concrete mixture proportions shall be the responsibility of the Contractor.

Mixture proportions shall include the dry weights of cementitious material(s); the nominal maximum size of the coarse aggregate; the specific gravities, absorptions, and saturated surface-dry weights of fine and coarse aggregates; the quantities, types, and names of admixtures; and quantity of water per cubic yard of concrete. All materials included in the mixture proportions shall be of the same type and from the same source as will be used on the project. The minimum specified compressive strength  $f'c$  shall be 3,500 psi at 28 days. The maximum nominal size coarse aggregate shall be 1-1/2 inches, in accordance with ACI 318/318R. The air content shall be between 4.5 and 7.5 percent. The slump shall be between 2 and 5 inches. The maximum water cement ratio shall be 0.45.

### 1.3 SUBMITTALS

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

SD-01 Data

Air-Entraining Admixture; FIO. Water-Reducing or Retarding Admixture; FIO. Curing Materials; FIO. Reinforcing Steel; FIO.

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

Batching and Mixing Equipment; FIO.

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

Conveying and Placing Concrete; FIO.

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

Nonshrink Grout; FIO.

Descriptive literature of the nonshrink grout proposed for use shall be furnished together with a certificate from the manufacturer stating that is suitable for the application for which it is being considered.

## SD-08 Statements

Formwork; FIO.

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

## SD-09 Reports

Aggregates; FIO.

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

Concrete Mixture Proportions; FIO.

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

## SD-13 Certificates

Cementitious Materials; FIO.

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

## PART 2 PRODUCTS

## 2.1 MATERIALS

## 2.1.1 Portland Cement

ASTM C 150, Type V, low alkali.

## 2.1.1.1 Pozzolan

Pozzolan shall conform to ASTM C 618, Class F, with loss on ignition limited to 6 percent.

## 2.1.2 Aggregates

Aggregates shall meet the quality and grading requirements of ASTM C 33, Class Designations 4M or better and shall be shown to be non-reactive nor contain any deleterious substances.

## 2.1.3 Admixtures

Admixtures to be used, when required or approved, shall comply with the

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

#### 2.1.3.1 Air-Entraining Admixture

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

#### 2.1.3.2 Accelerating Admixture

Accelerating admixtures shall meet the requirements of ASTM C 494/C 494M, Type C.

#### 2.1.3.3 Water-Reducing or Retarding Admixture

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

#### 2.1.4 Water

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

#### 2.1.5 Reinforcing Steel

Reinforcing steel bar shall conform to the requirements of ASTM A 615/A 615M, Grade 420. Details of reinforcement not shown shall be in accordance with ACI 318/318R, Chapters 7 and 12.

#### 2.1.6 Joint Sealants - Field Molded Sealants

Joint sealants - field molded sealants shall conform to ASTM C 920, Type M, Grade NS, Class 25, use NT for vertical joints and Type M, Grade P, Class 25, use T for horizontal joints. Bond-breaker material shall be polyethylene tape, coated paper, metal foil, or similar type materials. The backup material shall be compressible, nonshrink, nonreactive with the sealant, and a nonabsorptive material such as extruded butyl or polychloroprene foam rubber. Immediately prior to installation of field-molded sealants, the joint shall be cleaned of all debris and further cleaned using water, chemical solvents, or other means as recommended by the sealant manufacturer or directed.

#### 2.1.7 Formwork

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

#### 2.1.8 Form Coatings

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

### 2.1.9 Epoxy Resin

Epoxy resin for use in repairs shall conform to ASTM C 881, Type III, Grade I or II.

### 2.1.10 Curing Materials

Curing materials shall conform to the following requirements.

#### 2.1.10.1 Impervious Sheet Materials

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

#### 2.1.10.2 Membrane-Forming Curing Compound

ASTM C 309, Type 2.

### 2.1.11 Nonshrink Grout

Nonshrink grout shall conform to ASTM C 1107 and shall be a commercial formulation suitable for the application proposed. Grout strength shall be 3,500 psi in 3 days.

## PART 3 EXECUTION

### 3.1 PREPARATION

#### 3.1.1 General

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

#### 3.1.2 Embedded Items

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

#### 3.1.3 Formwork Installation

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

### 3.1.4 Production of Concrete

#### 3.1.4.1 Ready-Mixed Concrete

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

#### 3.1.4.2 Concrete Made by Volumetric Batching and Continuous Mixing

Concrete made by volumetric batching and continuous mixing shall conform to ASTM C 685.

#### 3.1.4.3 Batching and Mixing Equipment

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

### 3.1.5 Nonshrink Grout Application

Nonshrink grout shall conform to the requirements of paragraph Nonshrink Grout. Water content shall be the minimum that will provide a flowable mixture and fill the space to be grouted without segregation, bleeding, or reduction of strength. Mixing and placing shall be in conformance with the material manufacturer's instructions and as specified.

## 3.2 CONVEYING AND PLACING CONCRETE

Conveying and placing concrete shall conform to the following requirements.

### 3.2.1 General

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

joints will be prevented.

### 3.2.2 Consolidation

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

### 3.2.3 Cold-Weather Requirements

No concrete placement shall be made when the ambient temperature is below 35 degrees F or if the ambient temperature is below 40 degrees F and falling. Suitable covering and other means as approved shall be provided for maintaining the concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Salt, chemicals, or other foreign materials shall not be mixed with the concrete to prevent freezing. Any concrete damaged by freezing shall be removed and replaced at the expense of the contractor.

### 3.2.4 Hot-Weather Requirements

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

## 3.3 FORM REMOVAL

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

## 3.4 FINISHING

### 3.4.1 Chamfer

All exposed corners shall have 3/4 inch chamfer.

### 3.4.2 Finishing Formed Surfaces

All fins and loose materials shall be removed, and surface defects including tie holes shall be filled. All honeycomb areas and other defects

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

#### 3.4.3 Finishing Unformed Surfaces

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

##### 3.4.3.1 Float Finish

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

##### 3.4.3.2 Broom Finish

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

#### 3.5 CURING AND PROTECTION

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

accomplished by one of the following methods:

- a. Continuous sprinkling or ponding.
- b. Application of absorptive mats or fabrics kept continuously wet.
- c. Application of sand kept continuously wet.
- d. Application of impervious sheet material conforming to ASTM C 171.
- e. Application of membrane-forming curing compound conforming to ASTM C 309, Type 2 shall be accomplished in accordance with manufacturer's instructions.

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

### 3.6 TESTS AND INSPECTIONS

#### 3.6.1 General

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

#### 3.6.2 Inspection Details and Frequency of Testing

##### 3.6.2.1 Preparations for Placing

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

##### 3.6.2.2 Air Content

Air content shall be checked at least twice during each shift that concrete is placed for each concrete mix design delivered. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 231.

##### 3.6.2.3 Slump

Slump shall be checked twice during each shift that concrete is produced for each concrete mix design delivered. Samples shall be obtained in accordance with ASTM C 172 and tested in accordance with ASTM C 143/C 143M.

##### 3.6.2.4 Consolidation and Protection

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

### 3.6.3 Action Required

#### 3.6.3.1 Placing

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

#### 3.6.3.2 Air Content

Whenever a test result is outside the specification limits, the concrete shall not be delivered to the forms and an adjustment shall be made to the dosage of the air-entrainment admixture.

#### 3.6.3.3 Slump

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

### 3.6.4 Reports

The results of all tests and inspections conducted at the project site shall be reported informally at the end of each shift and in writing weekly and shall be delivered within 3 days after the end of each weekly reporting period. See Section 01440 CONTRACTOR QUALITY CONTROL.

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## SECTION 03360

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## SECTION 03360

## ROLLER-COMPACTED CONCRETE (RCC)

## PART 1 GENERAL

## 1.1 REFERENCES

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

## ACI INTERNATIONAL (ACI)

- ACI 305R (1991) Hot Weather Concreting  
ACI 347R (1994) Guide to Formwork for Concrete

## AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

- AASHTO M 182 (191; R 1996) Burlap Cloth Made form Jute or Kenaf

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM C 33 (1999a) Concrete Aggregates  
ASTM C 117 (1995) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing  
ASTM C 131 (1996a) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine  
ASTM C 136 (1996a) Sieve Analysis of Fine and Coarse Aggregates  
ASTM C 150 (1999a) Portland Cement  
ASTM C 171 (1997a) Sheet Materials for Curing Concrete  
ASTM C 172 (1999) Sampling Freshly Mixed Concrete  
ASTM C 174/C 174M (1997) Measuring Length of Drilled Concrete Cores  
ASTM C 566 (1997) Total Moisture Content of Aggregate by Drying

ASTM C 618	(1998a) Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
ASTM C 1040	(1993; R 2000) Density of Unhardened and Hardened Concrete in Place by Nuclear Methods
ASTM D 1556	(1990; R 1996) Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 1557	(1991; R 1998) Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2,700 kN-m/cu. m.))
ASTM D 3017	(1998; R 1996) Water Content of Soil and Rock in Place By Nuclear Method (Shallow Depth)
ASTM D 4318	(1998) Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 4791	(1999) Flat or Elongated Particles in Coarse Aggregate

## CORPS OF ENGINEERS (COE)

COE CRD-C 53	(1996) Consistency of No-Slump Concrete Using the Modified Vebe Apparatus
COE CRD-C 55	(1992) Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 100	(1975) Method of Sampling Concrete Aggregate and Aggregate Sources, and Selection of Material for Testing
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

## NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

NIST HB 44	(1997) NIST Handbook 44: Specifications, Tolerances, and other Technical Requirements for Weighing and Measuring Devices
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## NATIONAL READY-MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(1996) Concrete Plant Standards
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## 1.2 PRECONSTRUCTION TESTING AND MIXTURE-PROPORTIONING STUDIES

### 1.2.1 RCC Aggregate Sampling and Testing

Materials to be used for production of aggregates may be obtained from on-site or off-site sources. The CONTRACTOR is responsible for selecting the source of materials such that all specified physical properties are met by the selected source(s).

Samples from any off-site source selected, whether listed or not listed, consisting of not less than 150 pounds of each size of coarse aggregate and 75 pounds of fine aggregate, and taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 shall be delivered to a local materials testing laboratory selected by the Government within 15 days after Notice to Proceed. Should the Contractor elect to use on-site material, sampling and testing of the material shall not occur until at least 50 percent of the RCC aggregate is produced. Samples shall be taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100 and shall be delivered to a local materials testing laboratory selected by the Government within 45 days after Notice to Proceed. Quantities of materials required shall be determined by the Government. Sampling, shipment, and testing of samples shall be at the Contractor's expense. Sixty (60) days will be required to complete evaluation of the aggregates. All quality assurance testing will be performed by the Government in accordance with the applicable COE CRD-C or ASTM test methods. Tests to which aggregate may be subjected are specific gravity, absorption, soft particles, L.A. abrasion, and any test necessary to demonstrate that the aggregate is of a quality that is at least equivalent to those sources listed herein and meeting the requirements of ASTM C 33. The Government test data and other information on aggregate quality of on-site sources 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.

### 1.2.2 Cementitious Materials and Admixtures

At least 60 days in advance of submitting samples for mixture proportioning studies, the Contractor shall notify the Contracting Officer of the source, brand name, type, and quantity of all materials (other than aggregates) to be used in the manufacture and curing of the concrete.

### 1.2.3 Materials for RCC Mixture-Proportioning Studies

At least 60 days in advance of the time when placing of concrete is expected to begin, samples of representative materials proposed for this project and meeting all the requirements of this specification shall be delivered to the laboratory listed below by the Contractor at his expense.

US Army Engineer Waterways Experiment Station  
Structures Laboratory, Concrete Division  
3909 Halls Ferry Road  
Vicksburg, MS 39180

Samples of aggregates shall be taken under the supervision of the Contracting Officer in accordance with COE CRD-C 100, accompanied by test reports indicating conformance with grading and quality requirements

specified. Samples of materials other than aggregates shall be representative of those proposed for the project and shall be submitted accompanied by manufacturer's test reports indicating compliance with applicable specified requirements. Quantities of materials required shall be as follows:

MATERIAL	QUANTITY
Aggregate	4,500 lbs
Cement	900 lbs
Pozzolan	450 lbs

Mixture-proportioning studies will be made by the Government at its expense.

### 1.3 TESTING DURING CONSTRUCTION BY THE GOVERNMENT

#### 1.3.1 General

The Government will sample and test cementitious materials, admixtures, aggregates, and concrete during construction as considered appropriate to determine compliance with the specifications. The Contractor shall provide facilities and labor as may be necessary for procurement of representative test samples. Samples of aggregates will be obtained at the point of batching in accordance with COE CRD-C 100. Consistency of the RCC will be determined by the Government using the modified Vebe apparatus in accordance with paragraph CONSISTENCY OF RCC. Compression test specimens of batch RCC mixture and in-place RCC will be made and tested by the Government. Density of the compacted RCC will be checked by the Government as considered appropriate.

#### 1.3.2 Aggregates Sampling and Testing

Testing performed by the Government will not relieve the Contractor of his responsibility for testing under paragraph CONTRACTOR QUALITY CONTROL. During construction, aggregates will be sampled for acceptance testing as delivered to the mixer to determine compliance with specification provisions. The Contractor shall provide necessary facilities and labor for the ready procurement of representative samples under Government supervision. The Government will test such samples at its expense using the specified COE CRD-C and ASTM methods.

#### 1.3.3 Cementitious Materials

Cement or pozzolan will be sampled at the mill, shipping point, or site of the work by the Government. A list of prequalified cement sources and prequalified pozzolan sources is available from the Commander and Director, U.S. Army Engineer Waterways Experiment Station (CEWES-SC-MP), 3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199. If tests prove that a material which has been delivered is unsatisfactory, it shall be promptly removed from the site of the work. Cementitious materials that have not been used within 6 months after being tested will be retested by the Government at the expense of the Contractor when directed by the

Contracting Officer.

#### 1.3.4 Prequalified Cement Sources

Cement shall be delivered and used directly from a mill of a producer designated as a prequalified source for the type of cement being used. Samples of cement for quality-assurance testing will be taken at the project site or cement-producing plant by the Contracting Officer for testing at the expense of the Government. A copy of the mill tests from the cement manufacturer shall be furnished for each lot.

#### 1.3.5 Prequalified Pozzolan Sources

Pozzolan shall be delivered and used directly from a producer designated as a prequalified 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 copy of the test results from the pozzolan manufacturer shall be furnished for each lot.

#### 1.3.6 Nonprequalified Cement Sources

Cement, if not from a prequalified source, will be sampled and tested by or under the supervision of the Government at Government's expense. No cement shall be used 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 of the Contractor and at the Contractor's expense. The fill gate or gates of the sampled bin will be sealed and kept sealed until shipment from the bin has been completed. Sealing of the fill gate or gates and of conveyances used in shipment will be done by or under the supervision of the Government. Conveyances will not be accepted at the site of the work unless received with all seals intact. If tested cement is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of testing cement excess to project requirements will also be at the Contractor's expense and will be deducted from payments due the Contractor at a rate of \$1,750 per test.

#### 1.3.7 Nonprequalified Pozzolan Sources

Pozzolan, if not from a prequalified source, will be sampled at the source or at the site of the work and will be stored in sealed bins pending completion of acceptance tests. Pozzolan may be resampled at the site when determined necessary. All sampling and testing will be performed 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, 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 this basis will be contingent on continuing compliance with the other requirements of the specifications. If test results of a bin fail, the contents may be resampled and tested at the Contractor's expense. The Government will supervise or perform the unsealing and resealing of bins and shipping conveyances. If tested pozzolan is rehandled at transfer points, the extra cost of inspection will be at the Contractor's expense. The cost of

testing excess pozzolan in excess of project requirements will be at the Contractor's expense at a rate of \$1,650 per test. The amount will be deducted from payment to the Contractor.

#### 1.4 CONSTRUCTION TOLERANCES

##### 1.4.1 General

Tolerances shall be as below:

- a. The thickness of compacted lifts of RCC shall be within plus or minus 2 inches of that specified.
- b. The allowable variation of the elevation of finished surfaces of RCC lifts upon which subsequent RCC lifts are placed shall be minus zero (0) and plus 2 inches (in any direction), from the design elevation.

#### 1.5 SUBMITTALS

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

SD-01 Data

Batch Plant; GA.

Details and data on the concrete plant shall be submitted prior to plant assembly for review by the Contracting Officer for conformance with the requirements of paragraph BATCH PLANT. Final acceptance of any piece of plant is subject to satisfactory performance during operations.

Mixers; GA.

The make, type, capacity, and number of the concrete mixers proposed for use shall be submitted, prior to installation, for review by the Contracting Officer for conformance with the requirements of paragraph MIXERS.

Transporting and Conveying Equipment; FIO. Spreading and Remixing Equipment ; FIO. Compaction Equipment; GA.

A listing of the equipment proposed for transporting, handling, depositing, spreading, and compacting the concrete shall be submitted for review by the Contracting Officer before concrete placement begins. The data submitted shall include site drawings or sketches with locations of equipment and placement site.

SD-08 Statements

Aggregate and Concrete Production; GA.

Descriptions and details for all methods and operations proposed for aggregate and concrete operations including daily and weekly production rates, shall be submitted for review and approval for conformance with specifications.

Joint Cleanup and Waste Disposal; FIO.

The method and equipment proposed for joint cleanup and waste disposal shall be submitted for review by the Contracting Officer before concrete placement begins for conformance with paragraph JOINTS.

Curing; GA.

The curing media and methods to be used shall be submitted for review to the Contracting Officer before concrete placement begins for conformance with paragraph CURING AND PROTECTION.

Vertical Facings; FIO.

Details of the Contractors construction methods and equipment shall be submitted for review within 60 days after Notice to Proceed.

## 1.6 MATERIAL DELIVERY, STORAGE, AND HANDLING

### 1.6.1 Cementitious Materials

#### 1.6.1.1 Transportation

When bulk cement or pozzolan is not unloaded from primary carriers directly into weather-tight hoppers at the batching plant, transportation from the railhead, mill, or intermediate storage to the batching plant shall be accomplished in adequately designed weather-tight trucks, conveyors, or other means that will protect the material from exposure to moisture.

#### 1.6.1.2 Storage

Cementitious materials shall be furnished in bulk. Immediately upon receipt at the site of the work, all cementitious materials shall be stored in a dry, weather-tight, and properly ventilated structure. All storage facilities shall permit easy access for inspection and identification. Sufficient materials shall be in storage for at least two operating days to sustain continuous operation of the mixing plant while the RCC is being placed. In order that cement may not become unduly aged after delivery, the Contractor shall use any cement that has been stored at the site for 60 days or more before using cement of lesser age.

#### 1.6.2 Aggregate Storage

Fine aggregate and each size of coarse aggregate shall be stored in separate size groups, in free-draining stockpiles, adjacent to the batch plant and in such a manner as to prevent the intermingling of size groups or the inclusion of foreign materials in the aggregate. Aggregate shall remain in free-draining storage for at least 24 hours immediately prior to use. Sufficient fine and coarse aggregate shall be maintained at the site

at all times to permit continuous uninterrupted RCC placement.

## PART 2 PRODUCTS

### 2.1 CEMENTITIOUS MATERIALS

#### 2.1.1 Portland Cement

Portland cement shall conform to ASTM C 150, Type V, low alkali.

#### 2.1.2 Pozzolan

Pozzolan shall conform to ASTM C 618, Class F, with loss on ignition limited to 6 percent.

#### 2.1.3 Temperature of Cementitious Materials

The temperature of the cementitious materials as delivered to the site shall not exceed 150 degrees F.

### 2.2 CURING MATERIALS

Burlap shall conform to AASHTO M 182

### 2.3 WATER

Water for washing aggregates and for mixing and curing concrete shall be free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances and shall comply with COE CRD-C 400.

### 2.4 AGGREGATES

#### 2.4.1 Source of Materials

Borrow materials for production of RCC aggregates may be obtained from the required excavation or from off-site sources. The contractor shall make all arrangements, and secure all necessary permits for the procurement, furnishing and transporting aggregates from off-site sources.

#### 2.4.2 Particle Shape

The shape of the particles of the fine aggregate and of the coarse aggregate shall be generally spherical or cubical. The quantity of flat and elongated particles at a length-to-width or width-to-thickness ratio greater than 3 in the separated size groups of coarse aggregate, as defined and determined by ASTM D 4791, shall not exceed 25 percent in any size group.

#### 2.4.3 Deleterious Substances

The maximum plasticity index for RCC aggregate materials shall be limited to 3 when determined in accordance with ASTM D 4318.

#### 2.4.4 Resistance to Abrasion

Coarse aggregate, used in production of RCC, shall not show more than 45 percent loss after 500 revolutions when tested in accordance with ASTM C 131.

2.4.5 Fractured Faces

Coarse aggregate, used in production of RCC, will have a minimum 50 percent fractured faces when tested in accordance with State of Nevada, Department of Transportation (NDOT), Materials Testing Division, T230C (Rev C), "Method of Test for Determining the Percent of Fractured Faces."

2.4.6 Aggregate Gradation

Aggregate samples will be prepared for RCC mix design studies. The Government will use the specified gradations for use in preparation of mixture proportioning studies.

2.4.6.1 RCC Gradation

The aggregate base to be used for RCC construction, when tested in accordance with ASTM C 117 and ASTM C 136, shall conform to the gradation indicated below:

Standard Sieve Size	Percent Passing by Weight
1 inch	100
3/4 inch	90 - 100
#4	35 - 65
#16	15 - 40
#200	2 - 10

2.5 RCC MIXTURE PROPORTIONING

2.5.1 Composition

RCC mixture will be proportioned by the Contracting Officer. RCC shall be composed of cementitious materials, water, aggregates. The cementitious material shall be portland cement, or portland cement in combination with pozzolan.

2.5.2 Proportions

The proportions of all materials entering the RCC, as determined from the mixture proportioning studies, will be furnished to the Contractor by the Contracting Officer. The mixture proportions shall be changed by the Contractor during construction as directed by the Contracting Officer's representative. Adjustments will be made to the batch weights including cement, pozzolan, and water to maintain the necessary consistency to prevent segregation within the RCC and allow full compaction as determined.

Frequent changes to the batch weights shall be considered usual and can be expected to occur frequently during the course of each day's placement depending on such variables as humidity, wind velocity, temperature, and cloud cover. Such changes will be as directed. The Contractor will be

responsible for adjusting the aggregate weights to compensate for changes in aggregate moisture contents.

### 2.5.3 Cementitious Material Content

The total cementitious material content of the RCC will range from an approximate minimum of 9.4 pounds to an approximate maximum of 15.6 pounds per cubic foot, expressed as equivalent portland cement content (by absolute volume). If the contractor elects to use a pozzolan, it shall be furnished and will be proportioned to be between fifteen and thirty percent by absolute volume of the total cementitious material.

### 2.5.4 Consistency of RCC

The Contracting Officer will determine at the placement site on a continuing basis the proper consistency necessary for adequate hauling, spreading, and compacting and will direct all necessary changes to achieve the proper RCC consistency. Changes will be directed based on visual examination of the RCC during the spreading and compaction process and on the Vebe time when it varies outside the range considered ideal for compaction, as determined by the Government using the modified Vebe apparatus, in accordance with COE CRD-C 53.

## 2.6 BEDDING MORTAR

### 2.6.1 General

Bedding mortar is to be used for achieving bond between RCC lifts as indicated in paragraph JOINTS. No surfaces to receive a bedding mortar shall be covered with RCC until the prepared surface has been approved and that acceptance has been recorded on an approved checkout form. In no case will the bedding mortar be allowed to dry from the sun and wind.

### 2.6.2 Bedding Mortar Mix

The bedding mortar mix design will be developed by the government and will conform to the following general requirements. Aggregate for bedding mortar shall conform to the requirements of ASTM C 33, for washed concrete sand.

#### Parameter

Slump	8-10 inches
Cement Content	420-480 lb/yd <sup>3</sup>
Minimum Compressive Strength	(28 days) 2,000 psi

### 2.6.3 Installation

Bedding mortar shall be spread over the lift joint and other horizontal contact surfaces before placement of the next RCC lift. The bedding mortar shall be spread so that the maximum thickness of bedding does not exceed 1/2 inch, and the average thickness determined by dividing the volume used by the area covered is approximately 1/4 inch. Bedding mortar placements

shall be controlled to prevent bleeding of the mortar through the RCC. The bedding mortar shall be covered with the designated RCC mix within 15 minutes after placement of the bedding mortar. Consolidation of the bedding mortar will not be required. Serrated rakes creating small windrows of mortar or other approved devices shall be used for mortar application.

### 3. PART 3 EXECUTION

#### 3.1 STOCKPILING OF MATERIAL

##### 3.1.1 General

Whether obtained from the required excavation or off-site commercial sources, aggregates shall not be transported directly to the mixing plant. The aggregates shall be stockpiled on firm ground drained and leveled, free of debris, trash, organic materials, and other objectionable or deleterious material. Stockpiles shall be constructed in layers not exceeding 3 feet in thickness. Ramps formed for the construction of stockpiles shall be made of the same material as that being stockpiled, and will be considered a part of the stockpile. Aggregates taken from the stockpile for RCC production shall be removed from the stockpile in such a manner that material from several layers of the stockpile are combined in each sample and the gradation of the aggregate obtained is representative of that used in the mix design tests.

#### 3.2 EQUIPMENT

##### 3.2.1 Capacity

The concrete plant, conveying, placing, compaction, and cleanup systems shall have a capacity of at least 100 cubic yards per hour.

##### 3.2.2 Concrete Plant

The concrete plant shall be a batch or a continuous mixing plant.

##### 3.2.2.1 Location

The concrete plant shall be located on project site, subject to the approval of the Contracting Officer.

##### 3.2.2.2 Bins and Silos

Separate bins, compartments, or silos shall be provided for each size or classification of aggregate and for each of the cementitious materials. The compartments shall be of ample size and so constructed that the various materials will be maintained separately under all working conditions. All compartments containing bulk cement or pozzolan shall be separated from each other by a free-draining air space. The cement and pozzolan bins shall be equipped with filters which allow air passage but preclude the venting of cement or pozzolan into the atmosphere. All filling ports shall be clearly marked with a permanent sign stating the contents.

## 3.2.2.3 Batch Plant

The batch plant requirements should meet the following requirements.

- a. Batchers - Aggregate shall be weighed in separate weigh batchers with individual scales or may be batched cumulatively. Bulk cement and other cementitious materials shall each be weighed on a separate scale in a separate weigh batcher. Water shall be measured by weight or by volume. It shall not be weighed or measured cumulatively with another ingredient. Ice shall be measured separately by weight. Admixtures shall be batched separately and shall be batched by weight or by volume in accordance with the manufacturers recommendations.
- b. Water Batchers - A suitable water-measuring and batching device shall be provided that will be capable of measuring and batching the mixing water within the specified tolerances for each batch. The mechanism for delivering water to the mixers shall be free from leakage when the valves are closed. The filling and discharge valves for the water batcher shall be so interlocked that the discharge valve cannot be opened before the filling valve is fully closed. When a water meter is used, a suitable strainer shall be provided ahead of the metering device.
- c. Admixture Dispensers - A separate batcher or dispenser shall be provided for the admixture. The plant shall be equipped with the necessary calibration devices that will permit convenient checking of the accuracy of the dispensed volume of the particular admixture. The batching or dispensing devices shall be capable of repetitively controlling the batching of the admixtures to the accuracy specified. Piping for liquid admixtures shall be free from leaks and properly valved to prevent backflow or siphoning. The dispensing system shall include a device or devices that shall detect and indicate the presence or absence of the admixture or provide a convenient means of visually observing the admixture in the process of being batched or discharged. The system shall be capable of ready adjustment to permit varying the quantity of admixture to be batched. The dispenser shall be interlocked with the batching and discharge operations so that each admixture is added separately to the batch in solution in a separate portion of the mixing water in a manner to ensure uniform distribution of the admixtures throughout the batch during the required mixing period. Storage and handling of admixtures shall be in accordance with the manufacturer's recommendations.
- d. Moisture Control - The plant shall be capable of ready adjustment to compensate for the varying moisture content of the aggregates and to change the masses of the materials being batched.
- e. Scales - Adequate facilities shall be provided for the accurate measurement and control of each of the materials entering each batch of concrete. The weighing equipment and controls shall conform to the applicable requirements of NIST HB 44, except that the accuracy shall be within 0.2 percent of the scale capacity. The Contractor shall provide standard test weights and any other auxiliary equipment required for checking the operating performance of each scale or other

measuring device. Each weighing unit shall include a visible indicator that shall indicate the scale load at all stages of the weighing operation and shall show the scale in balance at zero load. The weighing equipment shall be arranged so that the concrete plant operator can conveniently observe the indicators.

f. Operation and Accuracy - The weighing operation of each material shall conform to requirements of NRMCA CPMB 100. The weigh batchers shall be so constructed and arranged that the sequence and timing of batcher discharge gates can be controlled to produce a ribboning and mixing of the aggregates, water, admixtures, and cementitious materials as the materials pass through the charging hopper into the mixer. The plant shall include provisions to facilitate the inspection of all operations at all times. Delivery of materials from the batching equipment shall be within the following limits of accuracy:

MATERIAL	PERCENT OF REQUIRED MASS
Cementitious materials .....	0 to +2
Water .....	+/- 1
Each individual aggregate size group.....	+/- 2

When water or chemical admixtures are measured by volume, they shall meet the same tolerance percent as stated in the chart.

g. Interlocks - Batchers and mixers shall be interlocked so that:

- (1) The charging device of each batcher cannot be actuated until all scales have returned to zero balance within plus or minus 0.2 percent of the scale capacity and each volumetric device has reset to start or has signaled empty.
- (2) The charging device of each batcher cannot be actuated if the discharge device is open.
- (3) The discharge device of each batcher cannot be actuated if the charging device is open.
- (4) The discharge device of each batcher cannot be actuated until the indicated material is within the allowable tolerances.
- (5) Admixtures are batched automatically and separately with the water.
- (6) The mixers cannot be discharged until the required mixing time has elapsed.

h. Recorder - An accurate recorder or recorders shall be provided and shall conform to the following detailed requirements:

- (1) The recorder shall produce a graphical or digital record on a

single visible chart or tape of the weight or volume of each material in the batchers at the conclusion of the batching cycle. The record shall be produced prior to delivery of the materials to the mixer. After the batchers have been discharged, the recorder shall show the return to empty condition.

(2) A graphical recording or digital printout unit shall be completely housed in a single cabinet that shall be capable of being locked.

(3) The chart or tape shall be so marked that each batch may be permanently identified and so that variations in batch weights of each type of batch can be readily observed. The chart or tape shall be easily interpreted in increments not exceeding 0.5 percent of each batch weight.

(4) The chart or tape shall show time of day at intervals of not more than 15 minutes.

(5) The recorder chart or tape shall become the property of the Government.

(6) The recorder shall be placed in a position convenient for observation by the concrete plant operator and the Government inspector.

(7) The recorded weights or volumes when compared to the weights or volumes actually batched shall be accurate within plus or minus 2 percent.

i. Batch Counters - The plant shall include devices for automatically counting the total number of batches of all concrete batched and the number of batches of each preset mixture.

j. Batch Plant Trial Operation - Not less than 7 days prior to commencement of placing the test section, a test of the batching and mixing plant shall be made in the presence of a representative of the Contracting Officer to check operational adequacy. The number of full-scale concrete batches required to be produced in trial runs shall be as directed, will not exceed 20, and shall be proportioned as directed by the Contracting Officer. All concrete produced in these tests shall be wasted or used for purposes other than inclusion in structures covered by this specification. All deficiencies found in plant operation shall be corrected to the satisfaction of the Contracting Officer prior to the start of concrete placing operations.

No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. Mixer uniformity testing, in accordance with paragraph CONTRACTOR QUALITY CONTROL, will be performed by the government near the end of this trial operation period. The Contractor shall notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

k. Protection - The weighing, indicating, recording, and control

equipment shall be protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

3.2.2.4 Continuous Mixing Plant

A continuous mixing plant(s) shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional batch plant and shall be capable of producing a uniform continuous product (at both maximum and minimum production rates) that is mixed so that complete intermingling of all ingredients occurs without balling, segregation, and wet or dry portions.

a. Operation and Accuracy - An electronic control system shall be provided. The control system shall have the capability of changing mixtures instantaneously, producing any of the mixtures at a variable rate, and tracking a mixture change to a hopper or a conveyor system. The control panel shall display for each ingredient the designed formula values and the instantaneous percentage values and shall record the instantaneous values at a preset time interval or on demand with a multiple copy printer/recorder. The recorder shall note formula changes and shall print total quantities of each ingredient and total amounts produced on command. There shall be weighing devices (belt scale or other) for continuous weighing of individual ingredients and total ingredients. The plant control shall not require manual devices to adjust the material flow. The plant shall be capable of total manual control operation for a single product at a limited production for short-time duration's in the event of loss of electronic control. The electronic control system shall incorporate modular replaceable components to reduce down time in the event of control system malfunction. An inventory shall be maintained of such replaceable components. The fine aggregate shall have a device that monitors its moisture content immediately prior to dispensing into the mixing plant dispensing system. The accuracy of the plant dispensing systems shall be within the following limits:

- Cementitious Materials..... 0 to +2 percent
- Water .....+/- 1 percent
- Each individual aggregate size group.....+/- 2 percent

The continuous feeders for each of the ingredients shall be calibrated as per the manufacturer's specifications. Devices and tools shall be maintained at the plant location to check the feeder's calibration at the Contracting Officer's request. A technician shall be provided that is skilled in calibration of the feed devices and the maintenance and repair of the plant control system. The technician shall be available within 30 minutes notice during all scheduled plant operations. The technician could be one or more of the Contractor's personnel.

b. Cement, Pozzolan, and Aggregate Feed - Cement, pozzolan, and aggregates shall be uniformly, continuously, and simultaneously fed (at the proper ratios and quantity for the mixture required) into the

mixer by belt, auger, vane feeder, or other acceptable method. The feed bins or silos for each ingredient shall be kept sufficiently full and shall be of sufficient size to ensure a uniform flow at a constant rate for a specific mixture. The feed bins shall have a low-level indicator that both warns the operator and can shut the plant down if insufficient material is available for a uniform and continuous flow.

c. Water and Admixture Dispensers - The liquid-dispensing devices shall be capable of metering and dispensing within the specified requirements. The liquid valves shall be free from leakage in the closed position. The dispensers shall have attachments and/or be installed in such a manner that will permit convenient checking of their accuracy. Plumbing shall be leak-free and properly valved to prevent backflow and siphoning. The dispenser shall be interlocked with the electronic plant control and shall warn the operator and shut down the plant if insufficient liquid is available. Separate nozzles for each liquid shall be properly located at the mixer to assure uniform distribution of each liquid to the materials entering the mixer.

d. Continuous Mixer(s) - The continuous mixer(s) shall have proper introduction of ingredients as specified by the manufacturer and shall not be charged in excess of the manufacturer's recommended capacity. Mixer(s) shall be capable of combining the materials into a uniform homogeneous mixture and of discharging this mixture without segregation. The mixer(s) shall operate at the blade speed designated by the manufacturer and shall be capable of changing retention time of the ingredients in the mixer. This should be accomplished by manually resetting the mixer(s) blade angles. Mixing time (ingredient retention time in the mixer) shall be predicated upon the uniformity, homogeneity, and consistency of the resultant mixture. Samples for uniformity testing shall be taken at 2-minute intervals and tested as per COE CRD-C 55. The mixer(s) shall be maintained in satisfactory operating condition and mixer blades shall be kept free of hardened concrete. Should mixer(s) at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired. Suitable facilities shall be provided for obtaining representative samples of concrete for testing. All necessary platforms, shelters, tools, labor, and equipment shall be provided for obtaining samples.

e. Segregation - A means shall be used to reduce and minimize segregation and waste which would otherwise result from the continuous stream of concrete being fed into the batch haul devices (concrete buckets, dump trucks, etc.). The equipment shall retain the concrete between tracks or other means of transport to prevent the need for stopping the mixer. These devices could include, but not be limited to, small-volume conveyor discharge hopper with a large gate that is automatically opened on a timed interval, thereby dumping a series of small batches into larger batch hoppers, trucks, or truck beds.

f. Trial operation - Not less than 7 days prior to commencement of concrete placing, a test of the plant shall be made in the presence of a representative of the Contracting Officer to check operational adequacy. The number of cubic meters required to be produced in trial

runs shall be as directed, but will not exceed 100 cubic yards and shall be proportioned as directed by the Contracting Officer. All concrete produced in these tests shall be wasted or used for purposes other than inclusion in structures covered by this specification. All deficiencies found in plant operation shall be corrected to the satisfaction of the Contracting Officer prior to the start of concrete placing operations. Mixer uniformity tests by the Government will be performed near the end of this trial period. No separate payment will be made to the Contractor for labor or materials required by provisions of this paragraph. The Contractor shall notify the Contracting Officer of the trial operation not less than 7 days prior to the start of the trial operation.

g. Protection - The weighing, indicating, recording, and control equipment shall be protected against exposure to dust, moisture, and vibration so that there is no interference with proper operation of the equipment.

h. Discharge Hopper - The pugmill mixer shall be equipped with a discharge hopper having a capacity of at least 20 tons. The hopper shall be equipped with dump gates to assure rapid and complete discharge without segregation.

### 3.2.3 Mixers

Mixers shall be stationary mixers or pugmill mixers. Mixers may be batch or continuous mixing. Each mixer shall combine the materials into a uniform mixture and discharge this mixture without segregation. Mixers shall not be charged in excess of the capacity recommended by the manufacturer on the nameplate. Excessive overmixing requiring additions of water will not be permitted. The mixers shall be maintained in satisfactory operating condition, and mixer drums shall be kept free of hardened concrete. Mixer blades or paddles shall be replaced when worn down more than 10 percent of their depth when compared with the manufacturer's dimension for new blades. Should any mixer at any time produce unsatisfactory results, its use shall be promptly discontinued until it is repaired or replaced.

#### 3.2.3.1 Pugmill Mixers

A batch or continuous mixing twin-shaft pugmill mixer shall be capable of producing RCC of the same quality and uniformity as would be produced in a conventional plant that meets all the requirements of these specification. All pugmill mixers shall meet the requirements of paragraph CONTINUOUS MIXING PLANT.

#### 3.2.3.2 Mixer Uniformity Requirements

All mixers shall be tested by the Government in accordance with this paragraph and in accordance with COE CRD-C 55. When regular testing is performed, the RCC shall meet the limits of any three of the four applicable uniformity requirements. When abbreviated testing is performed, the concrete shall meet only those requirements listed for abbreviated testing. The initial mixer evaluation test shall be a regular test and shall be performed prior to the start of concrete placement. The concrete

proportions used for the evaluation shall contain the largest size aggregate on the project and shall be as directed by the Contracting Officer. Regular testing shall consist of performing all tests on three batches of concrete. The range for regular testing shall be the average of the ranges of the three batches. Abbreviated testing shall consist of performing the required tests on a single batch of concrete. The range for abbreviated testing shall be the range for one batch. Mixer evaluations shall be performed by the Government. The Contractor shall provide labor and equipment as directed by the Contracting Officer to assist the Government in performing the tests.

PARAMETER	REGULAR TESTS ALLOWABLE MAXIMUM RANGE FOR AVERAGE OF 3 BATCHES	ABBREVIATED TESTS ALLOWABLE MAXIMUM RANGE FOR 1 BATCH
Coarse aggregate, percent	6.0	6.0
Compressive strength at 7 days	10.0	10.0
Water content, percent	1.5	1.5
Consistency, modified Vebe, second	7.0	--

A regular test will be performed before concrete production begins and when the Contractor requests a reduced mixing time. An abbreviated test shall be performed every 3 months when concrete is being placed. If a mixer fails the abbreviated test, a regular test will be performed. Cost of testing when the Contractor requests a reduced mixing time will be paid by the Contractor.

3.2.4 Sampling Facilities

3.2.4.1 Sampling Concrete

The Contractor shall provide suitable facilities and labor for obtaining representative samples of concrete in accordance with ASTM C 172 for Contractor quality control and Government quality assurance testing.

3.2.4.2 Sampling Aggregates

Suitable facilities shall be provided for readily obtaining representative samples of aggregates for test purposes immediately prior to the material entering the mixer.

3.2.5 Transporting and Conveying Equipment

The transporting and conveying equipment shall conform to the following requirements.

The concrete mixtures (RCC, bedding mortar) shall be conveyed from the plant mixer(s) to placement as rapidly and as continuously as practical by methods which limit segregation, contamination, and surface drying. The RCC shall be conveyed from the mixing plant to the structure by means of

main-line conveyor, end-dump truck, or a combination thereof.

### 3.2.6 Spreading and Remixing Equipment

The spreading and remixing equipment shall conform to the following requirements:

The primary spreading procedure shall be accomplished by track dozer. The dozers shall be equipped with well maintained grousers. The equipment shall be maintained in good operating condition. The equipment shall not leak or drip oil, grease, or other visible contaminants onto the RCC surface. All equipment used for spreading and remixing that leaves the surface of the structure for maintenance or repairs or, for any other reason, must be cleaned of all contaminants by an approved method before returning to the structure surface. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except to facilitate startup operations for each lift and by approved procedures.

### 3.2.7 Compaction Equipment

The compaction equipment shall conform to the following requirements.

#### 3.2.7.1 Primary Rollers

Self-propelled vibratory rollers shall be used for primary rolling and shall be double-drum. They shall transmit a dynamic impact to the surface through a smooth steel drum by means of revolving weights, eccentric shafts, or other equivalent methods. The compactor shall have a minimum gross mass of 20,000 lbs) and shall produce a minimum dynamic force of 4,000 lbf/ft of drum width. The operating frequency shall be variable in the approximate range of 1,700 to 3,000 cycles per minute. The amplitude shall be adjustable between 0.02 to 0.04 inches. The roller shall be capable of full compaction in both forward and reverse directions. The roller shall be operated at speeds not exceeding 2.3 ft/s. Within the range of the operating capability of the equipment, the Contracting Officer may direct or approve variations to the frequency, amplitude, and speed of operation which result in the specified density at the fastest production rate.

#### 3.2.7.2 Small Vibratory Rollers

Small vibratory rollers shall be used to compact the RCC where the larger vibratory rollers specified above cannot maneuver. The rollers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Small vibratory rollers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when small rollers are used, total lift thickness of the RCC layer or lift shall be reduced to not over 6 inches uncompacted thickness to permit adequate compaction. Rollers shall have independent speed and vibration controls and shall be capable of a wide range of speed adjustments.

#### 3.2.7.3 Tampers (Rammers)

The tampers shall compact the RCC to the required density and shall be so demonstrated during construction of the test section. Tampers cannot compact the RCC to the same density and thickness as the primary rollers; therefore, when tampers are used, thickness of each RCC layer that is to be compacted shall be reduced to not more than 6 inches uncompacted thickness to assure adequate compaction.

### 3.2.8 Nuclear Density Gauge

Tests to determine the density of both the uncompacted and compacted RCC shall be made by the Contractor using a two-probe nuclear density gauge supplied by the Contractor. The nuclear density gauge shall meet the applicable requirements of ASTM C 1040. The gauge shall be capable of taking readings along a horizontal path between the probes at 2 inch increments from 2 inches from the surface to 24 inches below the surface. The gauge and operator shall be made available to the Government until completion of all RCC production at no additional cost. The Contractor shall obtain all permits and certifications for the equipment and the operators.

### 3.2.9 Calibration

Nuclear gauges shall have been factory calibrated within 6 months of RCC placement. The Contractor shall construct, at no additional costs to the Government, three conventional concrete test blocks using RCC aggregate materials, and with dimensions 12 inches larger than the gauge dimensions. The concrete shall be formulated to have densities of approximately 131, 143, 162 lbs/ft<sup>3</sup> using the RCC materials and so far as possible, similar relative proportions. Completed blocks shall be weighed and measured to determine unit weight. Gauge calibration constants shall be adjusted for performance on these blocks at least 7 days prior to the evaluation of test strips. The Contractor shall remedy any inconsistencies in gauge performance prior to the start of RCC placement. After the start of RCC placement, gauges shall be field recalibrated against cast blocks every 24 hours.

## 3.3 SUBGRADE PREPARATION

Previously constructed underlying material shall be conditioned as specified in Section 02250 FILLS AND SUBGRADE PREPARATION. The existing subgrade, other than specified fills, shall be scarified, conditioned to optimum moisture content, and compacted to at least 90 percent of maximum density in accordance with ASTM D 1557 for a depth of least 12 inches. In all cases prior to placing RCC, deficiencies in the underlying material shall be corrected, and the surface shall be cleaned and moistened, as directed. The surface of the underlying material will be approved by the Contracting Officer.

## 3.4 PREPARATION FOR PLACING

### 3.4.1 Placing Schedule

Before starting RCC production, a detailed schedule shall be submitted

indicating intended daily and weekly production rates that, when followed, will meet the beginning and ending specified RCC production dates. After initiation of RCC production, the Contractor's schedule shall be updated and adjusted on a weekly basis for the duration of the RCC placement. If it becomes apparent for any reason that the Contractor is not pursuing a schedule that will meet the specified RCC production dates, actions necessary to increase the production rate shall be taken so that production is once again on schedule.

#### 3.4.2 RCC Orientation Session

Prior to or in conjunction with the construction of the RCC test section, supervisors and all other Contractor personnel which are expected to participate in the production of RCC for this job (including laborers, equipment operators, foremen, and QC and inspection staff) shall participate in a 2-hour orientation session organized by the Contracting Officer. The Contractor shall provide a facility suitable for slide and videotape presentation. The intent is to orient all individuals on the goals of the RCC placement process, provide clarification of specification requirements if requested, and be provided orientation as to what constitutes good construction practices. Additional orientation sessions will also be made available to, and shall be attended by, all new Contractor personnel who are subsequently hired and that will be involved with the production of the RCC.

#### 3.4.3 Aggregate Production Schedule

Aggregate production and initial stockpiling shall begin and shall be producing acceptable material by not later than 60 days in advance of the time when placement of the RCC test section is expected to begin. At least 50 percent of all RCC aggregates for each size group necessary for the completed RCC construction shall be manufactured and stockpiled prior to start of placement of RCC.

#### 3.4.4 RCC Test Section

Prior to placement of any RCC, the Contractor shall construct a test section at the job site. The purpose of the test section is to demonstrate the suitability of the Contractor's equipment, methods, and personnel. The test section shall consist of not less than two adjacent paving lanes, at least 66 feet in length. The section shall be constructed to at least the depth of 3 lifts. The lane width shall be 10 feet. The test section shall contain at least one fresh longitudinal construction joint, one cold transverse joint, one longitudinal cold construction joint which has stood overnight before completion, and one surface to be treated with bedding mortar. The site of the test section shall be approved by the Contracting Officer. After evaluation and assessment of the test section by the Contracting Officer, the Contractor shall dispose of the test section in an approved manner. Under no circumstances shall the test section be incorporated into or become a part of the permanent RCC structure. The test section shall demonstrate sustained plant production rates, and batching, mixing, transporting, spreading, compaction procedures, curing and preparation of construction joints. It shall also demonstrate the vertical face construction method along one side (formed), procedures for

foundation preparation, procedures for placement of bedding mortar, rolling pattern, joint preparation, rolling method for both fresh and cold construction joints, start-up and finishing procedures, testing methods, and plant operations. Variable amplitudes of the roller shall be used as approved in different areas to identify the optimum amplitude. Rolling pattern of the vibratory roller may be varied as approved to determine the best pattern. Variations in mixture proportions other than water shall be made if directed. The test section shall be placed in portions as directed by the Government. The Contractor shall vary the water content, as necessary, to arrive at the appropriate content, subject to the approval of the Contracting Officer's Representative. The mixing plant shall be operated and calibrated prior to placing the test section. The Contractor shall use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work. The Contractor shall not begin RCC operations for the main structure until testing and evaluations by the Government have been completed, and it has been demonstrated to the satisfaction of the Contracting Officer that all specification requirements were met. Following completion of test section construction, ten (10) calendar days shall be allowed for testing and evaluation. If the Contractor does not meet requirements as specified, an additional test section or sections shall be constructed at no additional cost to the Government. Test sections unacceptable to the Contracting Officer shall be removed at the Contractor's expense. The Contractor shall provide twelve (12) 6 inch diameter cores to the Government from points selected in the test section by the Government 7 days after completion of the test section. The date of the test section construction shall be provided at least 7 days in advance.

#### 3.4.5 Weather

If unusual adverse weather, such as heavy rain, severe cold, high winds, heavy snow, etc., occurs or is forecast to occur during placement, the placement operation shall be suspended until conditions improve.

##### 3.4.5.1 Placing During Cold Weather

Placement shall be discontinued when the air temperature reaches 41 degrees F and is falling and shall not be resumed until the air temperature reaches 36 degrees F and is rising. No RCC shall be placed on any surface containing frost or frozen material. Provision shall be made to protect the RCC from freezing during the specified curing period. Mixing water and/or aggregates shall be heated, as necessary, to produce RCC having a temperature between 50 degrees F and 86 degrees F as placed. Methods and equipment for heating shall be as approved. The aggregates shall be free of ice, snow, and frozen lumps before entering the mixer. Covering and other means shall be provided for maintaining the RCC at a temperature of at least 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. RCC damaged by freezing shall be removed and replaced as directed.

##### 3.4.5.2 Placing During Rain

RCC shall not be placed during rainfall of 0.2 in/hr or more. During periods of lesser rainfall, placement of RCC may continue if, in the

opinion of the Contracting Officer, no damage to the RCC is occurring. Work shall commence only after excess free surface water and contaminated paste or RCC have been removed and the surface has gained sufficient strength (no less than 4 hours after the RCC placement was suspended) to prevent rutting, pumping, intermixing of rainwater with the RCC, or other damage to the RCC. When the RCC surface has been contaminated or damaged in any manner, the RCC surface shall be washed to break up and remove laitance and/or mud-like coatings from the surface. Any undercut coarse aggregate shall be removed. All waste shall be removed and disposed of in an approved manner.

#### 3.4.5.3 Placing During Hot Weather

During periods of hot weather when the maximum daily air temperature is likely to exceed 86 degrees F; or when the combination of ambient conditions will produce evaporation rates of 0.2 lb/sq ft/hr or more, when calculated in accordance with Figure 2.1.5 of ACI 305R; the following precautions shall be taken. The underlying material shall be sprinkled with water immediately before placing the RCC. The RCC shall be placed at the coolest temperature practicable, and in no case shall the temperature of the RCC when placed exceed 90 degrees F. The aggregates and/or mixing water shall be cooled as necessary. The finished surfaces of the newly laid RCC shall be kept damp by applying a waterfog or mist, not streams of water, with approved spraying equipment until the RCC is covered by the curing medium. When heat or wind is determined excessive by the Contracting Officer, the Contractor shall immediately take such additional measures as necessary to protect the RCC surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately after placement. If these measures are not effective, placement shall be immediately stopped until satisfactory conditions exist.

#### 3.4.6 Surface Preparation

##### 3.4.6.1 Cleaning

All lift surfaces including any RCC or bedding mortar shall be cleaned prior to placing any additional concrete thereon. After cleaning, bedding concrete and bedding mortar are to be used specifically for achieving bond between different types of concrete eliminating and preventing segregation or voids along margins or RCC placements. No surfaces to receive bedding mortar shall be covered with RCC until the prepared surfaces have been accepted in writing and that acceptance has been recorded on an approved checkout form. All surfaces upon which RCC, structural concrete or any bedding mortar or bedding mix is placed shall be moist (but contain no visible free water). Prior to placing any concrete adjacent to the RCC and/or the ogee section, the surface shall be clean and free of loose, or unkeyed rock; all mud and silt accumulations; laitance; puddles or ponds of free surface water; coatings; and any other detrimental materials. High-pressure water jetting, and/or wet sandblasting, followed by mild high-volume, low-pressure washing, shall be used on all hardened RCC surface (cold joints) as necessary for the removal of laitance, coatings, stains, or other difficult-to-remove contaminants. High-volume low-pressure water washing and/or water jetting may be used for removal of

loose materials.

#### 3.4.6.2 High-Volume Low-Pressure Washing

Washing of loose materials can be accomplished with high-volume low-pressure water washing and/or air water jetting using equipment of similar design to that used in large-scale foundation cleanups. The air-water jets shall have 1-1/2 inch nozzles, a water supply of at least 30 gpm, and compressed air at the jet of 80 to 125 psi. The low-pressure water jets shall have 1 inch nozzles available and a capacity of at least 200 gpm for truck-mounted devices.

#### 3.4.6.3 High-Pressure Water Jet

A stream of water under a pressure of not less than 1,500 psi for RCC shall be used for cleaning all cold joint surfaces, or surfaces with laitance, mortar coatings, stains, or other difficult-to-remove contaminants. There shall be no undercutting of coarse-size aggregates. Aggregate particles that are undercut shall be removed.

#### 3.4.6.4 Wet Sandblasting

This method may be used when the RCC has reached sufficient strength to prevent undercutting of coarse aggregate particles. Wet sandblasting shall be continued until all accumulated laitance, coatings, stain, or other difficult-to-remove contaminants are removed. Wet sandblasting may be used in lieu of or in combination with the high-pressure water jet.

#### 3.4.6.5 Waste Disposal

Any waste water employed in cutting, washing, and rinsing of concrete surfaces, and any other surface water shall not stain, or affect exposed surfaces of the structure(s) or damage the environment of the project area.

### 3.5 PLACING

#### 3.5.1 Procedures

Placement of RCC shall be of such depth that when compacted, the surface will conform with cross section, grade, and contour indicated. Each lift shall be completed in its entirety across the full surface of the mass. As the advancing edge of the lift progresses, the exposed leading edges shall be kept "live" by progressively placing out from the advancing edge in a sloping and uniform fan-like manner. Placing of mixture shall be as nearly continuous as possible, with an absolute minimum of stops and starts; speed of placing shall be controlled, to permit proper rolling. The timing of placement shall be controlled so that RCC mixtures shall be placed and rolled within the time limit specified in paragraph COMPACTION. Placing shall be discontinued during rain except for light mists which do not cause intermixing of cement and water slurry on the surface. Placing shall be done in a pattern so that curing water from previous placements will not pose a runoff problem on the fresh surface. The contractor shall use care to minimize the production of cold joints.

### 3.5.2 Bedding Mortar

The bedding mortar shall be applied to the existing surface following any required cleanup. The bedding mortar shall be applied not more than 15 minutes ahead of RCC placement, unless otherwise approved. The bedding mortar shall be used between different RCC placements where cold joints occur, and other locations as directed or as shown in the drawings. The bedding mortar shall have an average thickness after application of between 1/4 and 1/2 inch and shall cover 100 percent of the lift area.

### 3.5.3 Lift Thickness

The total lift thickness after final compaction by the vibratory roller shall not exceed 8 inches.

### 3.5.4 Depositing, Spreading, and Remixing

After the RCC has been deposited, the RCC shall be spread by dozers into gently sloping layers, approximately 6 inches thick, that will, after final compaction of the several layers by the vibratory roller, result in the specified lift thickness. During the spreading process, the dozer operators shall continuously work the RCC surfaces with the dozer blade and grousers in a manner to remix any RCC that may contain pockets of segregated material and to compact the material. All surfaces of each layer shall receive at least two passes with the grousers. The dozers shall be operating continuously during the spreading process, even if this action results in more than two passes. In no case shall the RCC, or bedding mortar be allowed to dry. Under no conditions shall a dozer or other tracked vehicle be operated on other than fresh uncompacted RCC except at the start of each lift placement to facilitate startup operations, and then only by an approved procedure. No RCC shall be placed on a previous lift which has not met specification. Unacceptable material shall be removed.

## 3.6 COMPACTION

Compaction shall be accomplished by self-propelled, vibratory, steel-wheeled rollers and rubber-tired rollers. Rolling shall begin within 10 minutes of spreading and, except for fresh joints, rolling shall be completed within 45 minutes of start of mixing, except during hot or dry weather conditions, as described in paragraph Placing During Hot Weather. In hot or dry weather, rolling shall begin within 5 minutes of spreading and, except for joints, rolling shall be completed within 30 minutes of start of mixing. Delays in rolling freshly laid mixture will not be permitted. Rollers shall not be operated in the vibratory mode when not moving. The frequency and amplitude of vibration shall be varied, as needed or directed, within the range specified in paragraph EQUIPMENT. After initial vibratory rolling, preliminary tests and examination of density, grade, smoothness, and surface texture shall be made by the Contractor under the supervision of the Contracting Officer. Before rolling is continued, deficiencies shall be corrected so that the finished surface will conform to requirements for grade, surface texture, and smoothness specified herein. Further smoothness checks shall be as directed by the Contracting Officer. Rolling shall be continued with the

vibratory roller in vibratory mode, if necessary, until wet field density of not less than 95 percent of the "Target Density" is attained. Nuclear density testing shall be performed in accordance with paragraph CONTRACTOR QUALITY CONTROL. Surfaces of roller drums and wheels shall be kept clean at all times. Vibratory rolling beyond that specified above will not be permitted.

### 3.6.1 RCC Compaction

RCC layers shall be compacted to at least 95 percent of the Optimum Compaction Density (OCD). The Optimum Compaction Density (OCD) will be determined during placement of demonstration strips using the supplied mix design and Contractor supplied aggregates, materials, and equipment. Density shall be measured using a nuclear density meter and a sand cone. Nuclear density meter and sand cone tests shall be conducted in accordance with ASTM C 1040 and ASTM D 1556 respectively. Compacted RCC which indicates soft or yielding materials shall be tested immediately with the nuclear meter for moisture and density. If test results confirm that the RCC moisture content exceeds that specified, the soft or yielding area(s) will be removed and replaced by the Contractor at no additional cost to the Government. Upon completion of the OCD demonstration strip(s) the Government shall provide the Contractor with procedural placement requirements and the Contractor shall proceed with RCC production placement.

#### 3.6.1.1 Determination of Optimum Compaction Density (OCD)

The OCD method will be used to determine the requirement for achieving minimum density. All OCD determinations shall be performed by the Contractor in the presence of the Contracting Officer. The OCD will be invalid if material proportions, including water, are outside the designated ranges. OCD demonstration strip compaction will commence no later than 10 minutes after mixing of the RCC.

#### 3.6.1.2 Initial Determination of OCD

The initial OCD value will be determined during placement of RCC demonstration strip(s). The density of the RCC shall be determined for every one (1) or two (2) passes of compaction equipment, concurrently on the same demonstration strip in 2 locations. Compaction shall continue until the change in density decreases significantly. The OCD shall be the average maximum recorded density. A variation in OCD from the two locations of more than 2 lbs/ft<sup>3</sup> shall invalidate the test and require that another test set be performed. The number of roller passes to achieve OCD shall be a guide to the equipment operators of the required compaction necessary to achieve OCD.

### 3.6.2 Operation of Rollers and Tampers

Speed of rollers shall be slow enough at all times to avoid displacement of the RCC but in no case more than 1.6 mi/hr. Displacement of RCC resulting from reversing direction of roller or from any other cause shall be immediately corrected. Alternate passes of the roller shall be varied slightly in length and shall overlap sufficiently to provide full coverage over the surface. Additional rollers shall be furnished if RCC density

specified is not attained and/or if placing operations are getting ahead of rolling. In no case shall the Contractor allow placing operations be altered without approval of the Contracting Officer's Representative. Places inaccessible to large vibratory rollers shall be thoroughly compacted with walk-behind rollers and hand-tampers to the required density, using multiple thin lifts, as necessary. Additional field density tests shall be made for those areas by the Contractor and may also be made by the Government.

### 3.6.3 Rolling Pattern

Rolling shall commence at the outer edge of the lane abutting either a bulkhead, previously compacted RCC, or a construction joint. On subsequent placement, rolling shall begin at the previously compacted material. If there will be a subsequent lane placed along an edge and the joint will be constructed as a "fresh" joint, the roller shall go no closer to the outer edge until the subsequent lane is placed. If there will be a subsequent lane and the joint will be treated as a "cold" construction joint, or if the edge will be the final edge of the RCC, the outer 18 inches shall be rolled after rolling of the center of the lane. If the edge abuts a previously placed strip, either as a "fresh" joint or as a "cold" joint, the uncompacted joint area shall be rolled after the center of the lane. This joint area shall be given additional passes of the vibratory roller and rubber-tired roller, as necessary, to produce the specified compaction in the joint area. Approved hand-finishing operations shall be used as necessary to produce a tight surface at the joint. The rolling pattern shall be used consistently throughout production.

## 3.7 JOINTS

Joints shall conform to the details indicated and shall be perpendicular to the finished grade of the RCC. Joints shall be straight and continuous from edge to edge. Construction joints shall be made to ensure continuity in smoothness and grade between old and new sections of RCC, as specified hereinafter. All joints shall have the same texture, full-depth density, and smoothness as specified for other sections. Regardless of age, contact surfaces of previously constructed strips that have become coated with dust, sand, or other objectionable material shall be cleaned by brushing or cut back with approved power saw, as directed.

### 3.7.1 Lift Joints

The entire RCC shall be placed with sufficient continuity so that it hardens and acts as one monolithic structure without discontinuous joints or potential planes of separation. All lift joints shall be kept clean, uncontaminated, free from ponded water, and continuously moist until placement of the succeeding RCC. Regular lift-joint treatment and maintenance applies to subsequent lifts placed within 2 hours of the previous lift and shall include:

- a. Moisture Condition. Maintaining 100 percent of each compacted lift-joint surface continuously moist by application of water.
- b. Removing all loose contaminants or deteriorated RCC by low

pressure washing and vacuuming, and

c. Exception for Hot Weather Conditions. During periods of hot weather as defined in Paragraph: Placing During Hot Weather, the time period for regular lift joint treatment shall be reduced to 1-hour. After 1 hour, the requirements of 3.7.1.1 shall apply.

#### 3.7.1.1 Subsequent Lift Placed Within 2 to 4 Hours

If Lift joints that have not hardened or dried and are less than 4 hours old shall be given the regular lift-joint treatment:

a. Moisture Condition. Maintaining 100 percent of each compacted lift-joint surface continuously moist by application of water.

b. Air Jetting. Removing all loose contaminants or deteriorated RCC by high pressure, high volume air jetting and vacuuming. The air-jetting is intended is to be applied so that only the loose surface skin or mortar is removed and there is no undercutting of coarse-aggregate particles. The surface shall be completely free of all loose material and ponded water prior to placement of the subsequent lift.

c. Exception for Hot Weather Conditions. During periods of hot weather as defined in Paragraph: Placing During Hot Weather, the time period for regular lift joint treatment shall be reduced to 2-hours. After 2 hours, the requirements of 3.7.1.2 shall apply.

#### 3.7.1.2 Subsequent Lift Placed Within 4-8 Hours

When placement of the overlying lift does not occur within 4 hours the surface prior to placement shall be treated by air-water cutting.

a. The air pressure used in the jet shall be 90 to 110 psi, and the water pressure shall be just sufficient to bring the water into effective influence of the air pressure. After cutting, the surface shall be washed and rinsed until the wash water is no longer cloudy. Surfaces shall be inspected and approved by the Contracting Officer.

b. During periods of hot weather as defined in Paragraph: Placing During Hot Weather, the time period shall be reduced to 4-hours. After 4-hours the requirements of 3.7.1.3 shall apply.

#### 3.7.1.3 Subsequent Lift Placed More Than 8 Hours

When placement of the overlying lift does not occur within 8 hours the surface prior to placement shall be treated by air-water cutting as indicated in the paragraph: Subsequent Lift Placed 4-8 Hours Later and the application of a bonding layer. During periods of hot weather as defined in Paragraph: Placing During Hot Weather, the time period shall be reduced to 4-hours.

#### 3.7.2 Longitudinal Construction Joints

Any construction joints in which the edge of the initial strip has exceeded the time requirements given in paragraph PLACING shall be considered "cold joints" and shall be trimmed by sawing the edge of the hardened RCC with a power concrete saw, not earlier than 12 hours age. The sawcut shall be at least 6 inches from the original edge, and more if necessary to produce an acceptable joint. The sawcut shall be full depth of the RCC and shall produce a face within 15 degrees of vertical, free of all loose or uncompacted material. The outer portion shall be removed carefully to prevent any damage to the sawed face. If damage occurs, the edge shall be resawed.

### 3.7.3 Transverse Construction Joints

When a transverse construction joint is required, the roller shall pass over the end of the freshly placed RCC. In these cases, the previously placed materials shall be cut with a power concrete saw to full depth of the lift, as specified above, and the excess material removed. When necessary, the fresh mixture shall be hand finished at the joints. Additional rolling shall be used to assure that specified full-depth density and surface finish is attained.

## 3.8 CURING AND PROTECTION

### 3.8.1 General

Temporarily exposed surfaces of RCC that will be in contact with succeeding layers of RCC shall be kept continuously moist by moist curing method described hereinafter until placement of the subsequent layer. Curing of permanently exposed surfaces shall begin immediately after compaction and shall continue for at least 14 days. When wood or metal forms are left in place during curing, the forms shall be kept continuously wet. RCC shall be cured and protected from premature drying, extremes in temperature, rapid temperature change, freezing, mechanical damage and exposure to rain or flowing water. The Contractor shall have all equipment needed for adequate curing and protection on hand and ready to install before actual placement begins. The curing medium and method, or the combination of mediums and methods used, shall be approved by the Contracting Officer. The RCC shall be protected from the damaging effects of rain for 12 hours and flowing water for 14 days.

### 3.8.2 Moist Curing

RCC will be moist cured by maintaining all surfaces continuously, not periodically, wet for the duration of the entire curing period. Water for curing shall comply with the requirements of paragraph: WATER. If water is used which stains or discolors RCC surfaces which are to be permanently exposed, the surfaces shall be cleaned to the satisfaction of the Contracting Officer. Horizontal surfaces may be cured by covering with a minimum uniform thickness of 6 inches of continuously saturated sand. Temporarily exposed surfaces may not be cured by saturated sand. Horizontal construction joints may be allowed to dry for twelve hours immediately prior to the placing of the following lift.

### 3.8.3 Truck Applications

Water trucks shall be used, as necessary, to keep surfaces wet at all times until a sprinkler system, wet burlap covering, or final curing method is implemented. The water truck shall be supplemented, as necessary, by mists from hand-held hoses. The truck operator shall be positioned so he is capable of seeing the spray at all times. The spray shall be capable of easy direction, either by attachment to the front of the truck so it can be directed by steering the truck or by other approved means. All spray nozzles both on the trucks and the hand held hoses shall be of a type that produces a true fog spray without any concentrated streams of water. The mist shall not be applied in a channelized or pressurized manner that in any way erodes the surface of the RCC. It shall also be applied at a rate which does not cause ponding at the surface. Trucks shall not be allowed to drop visible oil or other contaminants on the surface. If trucks must leave the surface, the tires shall be washed free of dirt or other foreign material before returning to the surface. Water truck wheel loads shall not exceed 2000 kg (4409 lbs) and shall be such that no cracking or other damage to the RCC is caused.

#### 3.8.4 Sprinkler System

An approved sprinkler system consisting of pipe lines and rotating or other approved type of sprinklers may be used. Sprinklers shall deliver a fine mist of water and shall not cause any erosion to the surface of the RCC. The sprinkler system shall cover all portions of the RCC surface, and keep the surface wet at all times.

#### 3.8.5 Burlap

Burlap covers shall consist of two or more layers of burlap having a combined weight of 1 lb per square foot in a dry condition. Burlap shall be either new or shall have been used only for curing RCC or conventional portland cement concrete. Burlap strips shall have a length after shrinkage of at least 12 inches greater than necessary to cover the entire width and edges of the RCC. Mats shall overlap each other at least 6 inches. Mats shall be thoroughly wetted before placing and shall be kept continuously wet and in intimate contact with the surface and edges of the area for the entire specified curing period.

#### 3.8.6 Cure Water Runoff Control

Any water applied to the surface of the RCC or burlap during curing that is in excess of the amount needed to keep the surface of the RCC continuously wet shall be controlled from running onto the base course and causing ponding on the base course or saturation of the base or subbase material.

#### 3.8.7 Protection of RCC

After final rolling of the RCC, no vehicular traffic, except for pneumatic-tired water spray trucks or other curing equipment having wheel loads not exceeding 4,000 lbs shall be permitted on the RCC until the end of the curing period. No traffic or equipment shall be allowed on the surface that will cause any damage to the surface. Plastic sheeting meeting the requirements of ASTM C 171 shall be provided and kept readily

available to cover RCC less than 12 hours old if rainfall occurs.

### 3.9 FORMED VERTICAL FACINGS FOR RCC SPILLWAY

The vertical faces of the RCC spillway are to be constructed using a form similar to conventional concrete forms. The vertical facings system shall be demonstrated on one side of the RCC test section.

#### 3.9.1 Forms for Vertical Facing

Vertical and near-vertical facings shall be as shown in the drawings. The contract drawings are based on designs whereby all vertical and near-vertical faces are constructed at the same time and placement rate of each RCC lift. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the Contractor. The formwork shall be designed for loads, lateral pressure, and allowable stresses in accordance with Chapter 1 of ACI 347R. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the RCC and shall have sufficient rigidity to maintain specified tolerances. Vertical formwork shall be constructed such that forms are full wall height and shall be left in place (at a minimum) for all vertical layers/lifts of RCC for that wall section. The required sequence of construction operations after all forms and surface preparations have been approved is: place the uncompacted RCC (at the specified lift thickness) at full width against the forms; using dozer action, spread each thin RCC layer abutting against the forms, compact the RCC using the vibratory roller except the step edge shall be compacted with a hand-held tamper or vibrating plate compactor. Extreme care shall be taken to assure all time restrictions are met and to prevent the occurrence of any openwork, honeycombing, or voids at the formed RCC surface. The Contractor's construction techniques and equipment used including form anchor capability shall be satisfactorily demonstrated during construction of the test section.

### 3.10 FINISHING SURFACE FOR RCC

After compaction to the required lines and grades as shown in the drawings, RCC surfaces shall be reasonably smooth with no trimming allowed. Finishing of the RCC surface shall be conducted at the completion of each days production.

### 3.11 CONTRACTOR QUALITY CONTROL

#### 3.11.1 General

The following tests and inspections shall be the responsibility of the Contractor and shall be performed by an approved commercial testing laboratory or by approved Contractor personnel:

- a. Calibration of mixing plant.
- b. Sampling, gradation, and quality testing of aggregates during construction.

- c. Aggregate moisture tests.
- d. Moisture-density testing.
- e. Field density and moisture testing.
- f. Coring to provide specimens for the Government to determine RCC thickness, including filling the core holes as directed.
- g. Inspection during placing.

Based upon the results of these tests, the Contractor shall take the action and submit reports as required below, and any additional tests to ensure that the requirements of these specifications are met. Any test results requested by the Government for review shall be provided to the Government immediately, and all results of every test by the Contractor shall be furnished to the Government on a daily basis, not later than the day after the test or inspection is made. All core drilling shall be performed by skilled personnel experienced in such work. Verification tests of materials, RCC, and finished structural elements, if made by the Government, shall in no way relieve the Contractor from the testing requirements specified herein.

#### 3.11.2 Inspection Details and Frequency of Testing

The following number of tests will be the minimum acceptable for each type of operation:

##### 3.11.2.1 Calibration of Mixing Plant

- a. Batch-Mixing Plants: Accuracy of the batching equipment shall be checked for each type of cementitious material and aggregate at the beginning of operations and at least once for every 10 shifts in the presence of the Contracting Officer's representative. Such checks shall also be made whenever there are variations in properties of the fresh RCC which could be the result of batching errors. Standard test weights accurate to plus or minus 0.1 percent shall be provided for checking plant scales.
- b. Continuous-Mixing Plants: Accuracy of proportioning of the continuous-mixing plant shall be checked for each cementitious material every day at the beginning of operations and for each aggregate at the beginning of construction and after every 10 shifts. The accuracy of proportioning shall be checked by simultaneously securing timed samples of the cementitious materials and the combined aggregate as they are fed to the mixer and weighing each as appropriate.
- c. Mixing Time: Mixing time of the pug mill shall be checked at the direction of the Government. Unless otherwise required, determination of mixing time shall be by weight method using the following formula:

Mixing time in seconds = pug mill dead capacity in kg/pug mill; pug

mill output in kg per second

#### 3.11.2.2 Sampling, Sieve Analysis, and Quality of Aggregate

a. Sampling: Sampling and testing of aggregates during construction shall be performed by an approved commercial testing laboratory using appropriate Corps of Engineers and ASTM test methods.

b. Sieve Analysis: A sieve analysis on the fine and coarse aggregates as delivered to the mixer shall be made by the Contractor at the specified frequency. Before starting work, at least one sample of aggregate shall be tested in accordance with ASTM C 136 and ASTM C 117. The aggregate shall not be used unless results verify that the aggregate complies with the specified gradation and tolerances. After the initial test, a minimum of one analysis shall be performed for each 500 cubic yards or portion thereof of RCC material placed each shift. When deficiencies are found, the rate of testing shall be increased as directed. When two consecutive tests show the aggregate to be deficient in grading, the mixing operation shall be stopped until acceptable material is furnished for delivery to the mixer.

c. Aggregate Quality Tests: During construction, the Contractor shall test for quality the aggregates used for RCC construction. Tests shall consist of Los Angeles abrasion, clay lumps, and specific gravity determination. Tests for quality shall be performed at least once for each 5,000 cubic yards of placed RCC and otherwise when there may be a visual change in the aggregate.

#### 3.11.2.3 Aggregate Moisture Tests

At the beginning of the day and as otherwise directed by the Contracting Officer, the Contractor shall perform moisture content tests on the coarse and fine aggregates in accordance with ASTM C 566.

#### 3.11.2.4 Field Density Testing

a. Calibration Blocks for the Nuclear Density Gauge: Calibration blocks shall be fabricated by the Contractor with RCC materials and proportions representative of those to be used during construction. The blocks shall be used each day before paving begins to calibrate the full-depth readings of the nuclear density gauges used by the Contractor and the Government. The blocks shall be fabricated before the test section construction begins. The blocks size shall be a minimum of 18 in by 18 in by the maximum thickness of one lift, plus 1 inch. The blocks shall be compacted to between 98 and 100 percent of the maximum wet density, which will be determined by the Government in accordance with ASTM D 1557. The moisture content of the RCC used to fabricate the blocks may be increased just enough to facilitate compaction of the mixture, as long as the proportions of the dry materials remain constant and the required density is achieved. The blocks shall be measured and weighed to determine the actual density (unit weight) and shall be used to check the calibration of the nuclear density gauge. After drilling a hole in the block to accommodate the nuclear density gauge probe, three full depth nuclear

density gauge tests shall be performed in the direct transmission mode and the results averaged. This average nuclear density gauge reading shall be compared with the measured unit weight of the blocks and the difference used as a correction factor for all readings taken that day. All measuring and weighing of the test blocks and all calibration checking of the density gauge shall be performed in the presence of a representative of the Contracting Officer. Calibration checks of the density gauge shall be made at the beginning of construction every day. The calibration block shall be available for use by the Government as needed.

b. Field Density and Moisture Testing: Field density tests shall be performed on the RCC in accordance with ASTM C 1040 as soon as possible, but within 30 minutes, after the completion of vibratory rolling. Only wet density shall be used for evaluation. The test shall be performed using a two-probe nuclear density gauge operating in the direct transmission mode so density of the full depth of the RCC can be measured. Each test shall include readings at depths of 3, 6, 9 and 12 inches; however, only the deepest reading shall be used to evaluate the density. Both wet and dry densities shall be reported, and all individual readings shall be reported. The moisture content shall be determined in accordance with ASTM D 3017 at the same depths. The wet field density shall also be reported as a percentage of the "Target Density," maximum laboratory wet density as determined for that lot in accordance with ASTM D 1557. All holes left in the RCC as a result of nuclear density testing by both the Government and the Contractor shall be filled by the Contractor with a cement grout, as directed.

c. Frequency of Field Density and Moisture Testing: At least one field density test shall be performed for each 100 feet of paving lane of each layer of RCC and at least one for each 100 feet of longitudinal and transverse construction joint. Additional tests shall be made as directed, particularly during start-up and when problems with attaining required density occur.

#### 3.11.2.5 Coring Specimens to Determine Thickness

Cores shall be drilled by the Contractor from points in the RCC within 7 days after placement. A minimum of three cores per days placement will be taken from locations selected in a random fashion by the Contracting Officer. Cores shall be 6 inch diameter. Additional cores shall be drilled by the Contractor if required as specified in paragraph Thickness. Refilling of core holes shall be performed with portland cement mortar, using materials and procedures directed. Cores shall become the property of the Government and may be tested for strength determination or other properties as considered appropriate.

#### 3.11.2.6 Inspection During Placing

The Contractor's Quality Control organization shall supervise all placing operations and shall be responsible for measuring and recording RCC temperature, ambient temperature, weather conditions, time of placement, yardage placed, and method and location of placement.

a. Cold-Weather Placing: At least once during each shift, an inspection shall be made of all areas subject to cold-weather protection. Deficiencies shall be noted. During removal of protection, the RCC, and ambient temperature shall be measured at least hourly.

b. Hot-Weather Placing and Initial Curing at All Times: When the maximum daily air is likely to exceed 86 degrees F, the Contractor shall take and record the temperature of the RCC mixture at 30-minute intervals during hot-weather placement. The surface of the subgrade shall be inspected to assure that it is sprinkled with water immediately before the RCC is placed and any deficiencies noted. Regardless of ambient temperature, the finished RCC shall be inspected to assure that it is kept damp until the curing medium is applied and any deficiencies noted and immediately brought to the attention of the Contracting Officer's representative. Immediate steps shall be taken to correct any deficiencies.

c. Curing Operation: The curing operation shall be inspected to assure that the surface of the RCC is kept very moist (or wet) continuously until the end of the curing period.

### 3.11.3 Action Required

#### 3.11.3.1 Mixing Plant

Whenever it is found that either the weighing or the batching accuracy does not comply with specification requirements, the plant shall be shut down until necessary adjustments or repairs have been made. Discrepancies in recording shall be corrected immediately.

#### 3.11.3.2 Aggregate Grading and Quality

a. Grading: When the amount passing any sieve is outside the specification limits or tolerances, the aggregate shall be immediately resampled and retested. If the second sample fails on the same sieve, that fact shall be reported to the Contracting Officer and immediate steps shall be taken to correct the grading.

b. Quality: When the aggregate fails to meet the specification limits for Los Angeles abrasion, clay lumps and friable particles, lightweight pieces, other soft particles, and specific gravity, the Contracting Officer shall be notified immediately and approved corrective action shall be taken.

#### 3.11.3.3 Field Density and Moisture Testing

If any nuclear density gauge reading is below 95 percent, another test shall be performed within a 5 to 8 feet radius of the previous testing location. If this adjacent reading is also below the density requirements, the Contracting Officer shall be notified immediately, and additional vibratory roller passes shall be made across the full lane width between the last testing location that produced an acceptable reading and the

placement operations. If additional vibratory roller passes cause the density to decrease or cause the surface texture and appearance to deteriorate in the opinion of the Contracting Officer, the paving operation shall be discontinued until appropriate adjustments are made to the moisture content of the mixture, to placement operations, rolling procedures, or other operations to assure that the specified density and surface requirements can be achieved.

#### 3.11.3.4 Thickness Evaluation

The thickness of the RCC will be determined by the Contractor on the basis of measurements made on cores drilled by the Contractor from locations outlined in paragraph CONTRACTOR QUALITY CONTROL. Measurements of individual cores will be performed in accordance with ASTM C 174/C 174M. When the measurement of any core indicates that the RCC is deficient in thickness by 1/2 inch or more, additional cores shall be drilled by the Contractor at 25 ft intervals, on all sides of the deficient core until the cores indicate that the deficiency in thickness is less than 1/2 inches. When cores indicate a deficiency in thickness of less than 1/2 inch those, areas may be accepted provided the average thickness for the days placement, of the particular material, represented by the core is at least the specified thickness. When cores indicate a deficiency in thickness of 1/2 inch or more, the area represented by that core shall be removed and replaced with RCC of the specified thickness at no additional cost to the Government. If the Contractor believes that the cores and measurement taken are not sufficient to indicate fairly the actual thickness of the RCC, additional cores shall be taken and will be measured provided the Contractor shall bear the extra cost of drilling the cores.

#### 3.11.3.5 Inspection

a. Temperature Protection: The Contracting Officer shall be notified whenever the RCC temperature during the period of protection or protection removal fails to comply with the specifications, and immediate steps shall be taken to correct the situation. Regardless of the ambient temperature, when the temperature of the RCC mixture exceeds 90 degrees F, mixing and placing shall be stopped and the Contracting Officer notified.

b. Curing Operation: The Contracting Officer shall be notified when any RCC surface is allowed to dry before the end of the curing period, and immediate steps shall be taken to correct the situation.

c. Reports: All results of tests conducted at the project site shall be reported daily and shall be delivered to a designated representative of the Contracting Officer. During periods of cold weather protection, reports of pertinent temperatures shall be made daily. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Such reports of failure and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all Contractor quality control records at any time.

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## SECTION 05500

## MISCELLANEOUS METAL

## PART 1 GENERAL

## 1.1 REFERENCES

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

## AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 36/A 36M	(1997a) Carbon Structural Steel
ASTM A 53/A 53M	(1999b) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A 123/A 123M	(1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 276	(1998b) Stainless Steel Bars and Shapes
ASTM A 320/A 320M	(1999) Alloy Steel Bolting Materials for Low-Temperature Service
ASTM B 32	(1996) Solder Metal
ASTM C 94/C 94M	(2000) Ready-Mixed Concrete

## AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	(2000) Structural Welding Code - Steel
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## ASME INTERNATIONAL (ASME)

ASME B18.2.1	(1996) Square and Hex Bolts and Screws (Inch Series)
ASME B18.2.2	(1987; R 1993) Square and Hex Nuts (Inch Series)

## COMMERCIAL ITEM DESCRIPTIONS (CID)

CID A-A-1925	(Rev A; Notice 1) Shield, Expansion (Nail Anchor)
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## 1.2 SUBMITTALS

Government approval is required for submittals with a "GA" designation;

submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-04 Drawings

#### Miscellaneous Metal Items; FIO

Detail drawings indicating material thickness, type, grade, and class; dimensions; and construction details. Drawings shall include catalog cuts, erection details, manufacturer's descriptive data and installation instructions, and templates. Detail drawings for the following items: hand rail, access gates, and other miscellaneous metalwork.

### 1.3 GENERAL REQUIREMENTS

The Contractor shall verify all measurements and shall take all field measurements necessary before fabrication. Welding to or on structural steel shall be in accordance with AWS D1.1. Items specified to be galvanized, when practicable and not indicated otherwise, shall be hot-dip galvanized after fabrication. Galvanizing shall be in accordance with ASTM A 123/A 123M as applicable. Exposed fastenings shall be compatible materials, shall generally match in color and finish, and shall harmonize with the material to which fastenings are applied. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Thickness of metal and details of assembly and supports shall provide strength and stiffness. Joints exposed to the weather shall be formed to exclude water.

## PART 2 PRODUCTS

### 2.1 MATERIALS

#### 2.1.1 General

Materials indicated on the drawings or required in the work and not covered elsewhere by detailed requirements shall conform to the requirements of this section. In all cases not specifically covered in these specifications, the Contractor shall furnish approved highest grade commercial materials or products which are suitable for the intended use of the item.

#### 2.1.2 Structural Shapes and Plates

Steel structural shapes and plates shall conform to ASTM A 36/A 36M. Galvanized coatings where required, shall conform to ASTM A 123/A 123M.

#### 2.1.3 Steel Pipes

Steel pipe shall conform to ASTM A 53/A 53M, Type E or S, Grade A, galvanized nominal size and weight unless noted otherwise.

#### 2.1.4 Corrosion-Resisting Steel Bolts and Anchor Bolts

Corrosion-resisting steel bolts and anchor bolts shall conform to ASTM A 276, Class 304, Condition A, or the applicable requirements of ASTM A 320/A 320M, Grade B8.

#### 2.1.5 Bolts

Bolts shall conform to ASME B18.2.1.

#### 2.1.6 Nuts

Nuts shall conform to ASME B18.2.2. Nuts shall be galvanized.

#### 2.1.7 Expansion Anchors

Expansion anchors shall conform to the applicable requirements of CID A-A-1925. Anchors shall be multiple unit with inside thread.

#### 2.1.8 Concrete, Mortar and Grout

Concrete, mortar and grout shall conform to the requirements of Section 03307 CONCRETE FOR MINOR STRUCTURES.

### PART 3 EXECUTION

#### 3.1 WORKMANSHIP

Miscellaneous metalwork shall be well formed to shape and size, with sharp lines and angles and true curves. Drilling and punching shall produce clean true lines and surfaces. Welding shall be continuous along the entire area of contact except where tack welding is permitted. Steel with welds will not be accepted, except where welding is definitely specified or called for on the drawings. All bolts, nuts, and screws shall be tight. Work shall be accurately set to established lines and elevations and securely fastened in place. Anchorage shall be provided where necessary for fastening miscellaneous metal and wood items securely in place. Anchorage not otherwise specified or indicated shall include slotted inserts made to engage with the anchors, expansion shields, and power-driven fasteners when approved for concrete; machine and carriage bolts for steel; and lag bolts and screws for wood.

#### 3.2 FINISHING

In general, tolerances for machine-finished surfaces designated by nondecimal dimensions shall be within 0.156 inches. Sufficient machining stock shall be allowed on placing pads to insure true surfaces of solid material. Finished contacts of bearing surfaces shall be true and exact to secure full contact. All drilled holes for bolts shall be accurately located and drilled from templates.

#### 3.3 ZINC COATING (GALVANIZING)

Zinc coatings shall be applied in a manner and of a thickness and quality conforming to ASTM A 123/A 123M. All exposed ferrous metalwork, except

cast-iron and corrosion resistant steel and items to be completely embedded in concrete, shall be galvanized unless other protective coatings are specified. Metalwork, including completed railing assemblies, shall be galvanized after fabrication. In the event that any portion of galvanized metalwork is abraded or otherwise damaged to the extent that the base metal is exposed, such damaged or abraded portions shall be neatly covered with Grade 50B solder conforming to the requirements of ASTM B 32.

#### 3.4 WELDING

Welding shall conform to the provisions of AWS D1.1. Welders who have not been certified within two years of the date of commencement of work under this contract will not be allowed to perform the work.

#### 3.5 BOLTED CONNECTIONS

Bolt holes shall be reamed normal to the member and shall be truly cylindrical throughout. Unless otherwise specified, holes for bolts shall not be more than 0.0625 inches larger than the diameter of the bolt. Cutting bolt holes with a torch will not be permitted without the prior written approval of the Contracting Officer. Materials and parts necessary to complete each item, even though such work is not definitely shown or specified, shall be included. Poor matching of holes for fasteners shall be cause for rejection. Fastenings shall be concealed where practicable.

#### 3.6 EXCAVATION

Excavation for concrete-embedded items shall be of the dimensions indicated on the drawings. Holes shall be cleared of loose materials prior to placement of concrete.

#### 3.7 ACCESS GATE

Access gates shall be installed at the locations indicated on the drawings.

Access gates shall be fabricated in the shop from standard weight steel pipe conforming to ASTM A 53/A 53M. All access gate components shall be galvanized. Welded, cut, damaged, and deformed areas of galvanizing metal shall be neatly coated with Grade 50B solder conforming to ASTM B 32. The gate shall be installed in such a manner that they work freely. The Contractor shall examine the operation of all pipe gates not sooner than 30 days after installation for ease of operation. Any gates that cannot be operated by one person shall be repaired (including any required structural modifications) by the Contractor at no additional cost to the Government, and requirements for repair shall conform to the requirements for bolts for steel; and lag bolts and screws for wood.

#### 3.8 PIPE BOLLARDS

Pipe bollards shall be fabricated with heavy duty steel pipe conforming to ASTM A 53/A 53M, Type E or S, weight STD, black finish as indicated on the drawings. Pipe bollards shall be set vertically in concrete encasements. Concrete for encasements and pipe fill shall conform to ASTM C 94/C 94M, having a compressive strength of 3,500 psi.

-- End of Section --