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USACE / NAVFAC / AFCEC / NASA **UFGS-32 13 16.16 (November 2008)**

Preparing Activity: USACE **Superseding UFGS-32 13 16.16 (July 2007)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2014
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SECTION TABLE OF CONTENTS

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 13 16.16

ROLLER COMPACTED CONCRETE (RCC) PAVEMENT

11/08

-- End of Section Table of Contents --

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SECTION 32 13 16.16

ROLLER COMPACTED CONCRETE (RCC) PAVEMENT
11/08

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NOTE: This guide specification covers the requirements for roller compacted concrete (RCC) pavements for airfields, roads, streets, parking areas, repair yards, open-storage areas, and other utility grade pavements.

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

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

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

PART 1 GENERAL

****
NOTE: In preparing contract specifications for RCC pavement construction, the Contracting Officer will use Appendix D of UFC 3-250-04 for further guidance.

Insert name and location of project. Specification should be tailored for the specific site conditions, available materials, design requirements and construction practices.
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1.1 MEASUREMENT AND PAYMENT PROCEDURES

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NOTE: The Designer must carefully correlate and edit the bid items, measurement and payment paragraphs, and all the technical paragraphs so use of Portland cement, pozzolan, Portland-pozzolan cement, and ground granulated blast furnace slag will be well coordinated. Do not permit use of ground slag with pozzolan or Portland-pozzolan cement. Either use no separate pozzolan or use only a reduced amount if Portland-pozzolan cement is used.

Unit price bid items are recommended when the quantity of RCC and or the quantity of cementitious materials is not known or likely to be variable. If the quantity could range beyond 15 percent of the bid item, split bid items should be used. If quantities are known at the time of bidding, lump sum bid items are recommended.

****

1.1.1 Concrete Quantity

1.1.1.1 Measurement of Concrete Quantity

The quantity of concrete to be paid for will be the number of cubic meters yards, rounded to the nearest tenth of a cubic meter yard, placed in the completed and accepted pavements, including the accepted test section. Payment will not be made for wasted concrete, for concrete used for the convenience of the Contractor, or for concrete outside the neat lines shown on the drawing. Concrete will be measured in the completed and accepted pavements in accordance with the dimensions shown in the plan and cross section. No deductions will be made for rounded or beveled edges or the space occupied by pavement reinforcement, dowel bars, tie bars, or electrical conduits, nor for any void, drainage, or other structure extending into or through the pavement slab measuring 1 cubic meter 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with written instructions previously issued by the Contracting Officer.

1.1.1.2 Payment for Concrete Quantity

The quantity of concrete measured as specified above, will be paid for at the contract unit price when placed in completed and accepted pavements[or, where appropriate, at reduced prices adjusted in accordance with paragraph PAYMENT ADJUSTMENT]. The unit price will include the cost of labor and materials and the use of equipment and tools required to complete the work, except the cement, pozzolan, or ground granulated blast furnace slag that is specified for separate payment.

1.1.2 Cement Quantity

1.1.2.1 Measurement of Cement Quantity

The quantity of cement to be paid for will be the number of metric tons tons of cement used in the completed and accepted pavements. Payment will not be made for wasted cement or for cement used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg pounds of cement required by the mixture proportions per cubic m yard by the number of cubic m yards of the various mixtures placed and measured for payment, then dividing by 10002000 and rounding off to the

nearest tenth of a metric ton ton.

1.1.2.2 Payment for Cement Quantity

The quantity of cement, determined as specified above, will be paid for at the contract unit price, which includes all costs of handling, hauling, and storage at the site.[Adjustment in unit price because of requirements of paragraph PAYMENT ADJUSTMENT will not be made in the payment for Portland cement.]

1.1.3 Pozzolan Quantity

****
NOTE: This specification requires that pozzolan be used for all applications unless special circumstances exist. If pozzolan must be eliminated because it is not locally and readily available or the available quality is unacceptable, remove this paragraph and all further reference to the material.
****

1.1.3.1 Measurement of Pozzolan Quantity

The quantity of pozzolan paid for will be the number of metric tons tons used as a cementitious material in the completed and accepted pavements. Payment will not be made for wasted pozzolan or for pozzolan used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg/cubic meter pounds/cubic yard of pozzolan used as a cementitious material, and required by the mixture proportions by the number of cubic m yards of the various mixtures placed and measured for payment, then dividing by 1000 2000 and rounding off to the nearest tenth of a metric ton ton. Payment will not be made for pozzolan used strictly as a Contractor's option to compensate for lack of fines in the aggregate.

1.1.3.2 Payment for Pozzolan Quantity

The quantity of pozzolan, determined as specified above, will be paid for at the contract unit price, which includes costs of delivery, handling, and storage at the site.[Adjustment in unit price because of requirements of paragraph PAYMENT ADJUSTMENT will not be made in the payment for pozzolan.]

1.1.4 Ground Granulated Blast Furnace Slag (GGBFS)

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NOTE: If ground granulated blast furnace slag is not locally and readily available, remove this paragraph and all further reference to the material.
****

1.1.4.1 Measurement of GGBFS Quantity

The quantity of GGBFS to be paid for will be the number of metric tons tons of GGBFS used in the completed and accepted pavements. Payment will not be made for wasted ground iron blast furnace slag or for GGBFS used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg pounds of GGBFS required by the mixture proportions per cubic meter yard by the number of cubic meters yards of the various mixtures placed and measured for payment and then dividing

by 1,000 2,000 and rounding off to the nearest tenth of a metric ton ton.

1.1.4.2 Payment for GGBFS Quantity

The quantity of GGBFS, determined as specified above, will be paid for at the contract unit price, which includes costs of handling, hauling, and storage at the site.[Adjustment in unit price because of requirements of paragraph PAYMENT ADJUSTMENT will not be made in the payment for GGBFS.]

1.1.5 Portland-Pozzolan Cement

****
NOTE: If Portland-Pozzolan cement is not locally and readily available, remove this paragraph and all further references to the material.
****

1.1.5.1 Measurement of Portland-Pozzolan Cement Quantity

The quantity of Portland-pozzolan cement to be paid for will be the number of metric tons tons of Portland-pozzolan cement used in the completed and accepted pavements. Payment will not be made for wasted Portland-pozzolan cement or for Portland-pozzolan cement used for the convenience of the Contractor. The quantity to be paid for will be determined by multiplying the weight in kg pounds of Portland-pozzolan cement required by the mixture proportions per cubic meter yard by the number of cubic meters yards of the various RCC mixtures placed and measured for payment, then dividing by 1,000 2,000 and rounding off to the nearest tenth of a metric ton ton.

1.1.5.2 Payment for Portland-Pozzolan Cement

The quantity of Portland-pozzolan cement, determined as specified above, will be paid for at the contract unit price, which includes costs of handling, hauling, and storage at the site.[Adjustment in unit price because of requirements of paragraph PAYMENT ADJUSTMENT will not be made in the payment for Portland-pozzolan cement.]

1.1.6 RCC Lump Sum Contract

****
NOTE: For fixed-price contracts, inapplicable portions of the unit price paragraphs above should be deleted. It may be necessary to add features of the RCC pavement included in the lump sum bid item.
****

The quantity of RCC will be paid for and included in the lump-sum contract price. The lump sum payment will be for the completed RCC pavement in place at the location(s) as shown on the drawings and shall include all incidental work and materials necessary for the completed pavement.[If less than 100 percent payment is due based on the pay factors stipulated in paragraph: PAYMENT ADJUSTMENTS, a unit price of [_____] per cubic meter yard shall be used for purposes of calculating the payment reduction.]

1.2 PAYMENT ADJUSTMENT

****
NOTE: If Payment Adjustment is not used, the specification will have to be edited to delete

references to payment adjustment. In addition to other items, there will have to be inserted, at some appropriate location, the acceptance criteria to be used for surface smoothness and thickness, which are presently covered only in this paragraph.

If it is absolutely necessary to cut down a minor amount on acceptance testing, the acceptance testing for aggregate gradation during paving operations can be deleted, and this entire paragraph must be very carefully edited.

Do not, under any conditions, reduce the requirements for density, surface smoothness, surface texture, or thickness or the testing required for those items. Do not, under any conditions, reduce the requirements for daily calibration of the nuclear density meter with the cast block of RCC.

****

1.2.1 General Considerations

Adjustment in payment for individual lots of RCC pavement will be made in accordance with the following paragraphs[for all RCC pavement][the pavement sections listed]. The parameters to be measured are aggregate gradation, pavement thickness, density, surface smoothness, and surface texture. No adjustment in payment will be made for cementitious materials. Unless otherwise specified, testing shall be done as specified in paragraph: Contractor Quality Control. All tests shall be completed and reported within 24 hours after completion of construction of each lot.

[a. Location 1]
[b. Location 2]

1.2.2 Percent Payment/Acceptance of Lots

a. When a lot of material fails to meet the specification requirements for 100 percent payment as outlined in the following paragraphs, that lot shall be removed and replaced, or accepted at a reduced price, as specified herein. The lowest computed payment factor for any pavement characteristic (i.e., gradation, density, surface smoothness, thickness, and surface texture) discussed below will be the actual percent payment for that lot. Payment factors based on different criteria of the same lot will not be multiplied together to get a lower payment factor. The actual percent payment is applied to the bid price and to the quantity of RCC pavement placed in the lot to determine actual payment.

b. At the end of the project, an average of all lot pay factors will be calculated. If this average lot pay factor exceeds 95.0 percent and no individual lot has a pay factor less than 75.1 percent, then the percent payment for the entire project will be 100 percent of the unit bid price. If the average lot pay factor is less than 95.0 percent, then each lot will be paid for at the unit price multiplied by the lot's pay factor.

1.2.3 Density

1.2.3.1 Field Density

a. To evaluate field density for acceptance, 4 nuclear density gauge tests to determine wet density will be performed at random locations on the interior of the paving lane immediately behind final rolling operations, and 4 similar tests will be performed at random locations on fresh joints and 4 at random locations on cold joints, if such exist, for each sublot, and each set will be averaged for the sublot. Field density for each sublot will be compared with the target density for that lot. The locations of the tests on fresh joints will be alternated from side to side of the joint and will be between 75 and 130 mm 3 and 5 inches from the joint.

b. For cold joints, it is expected that the primary (originally placed) lane will be placed with one sublot and the secondary lane with another sublot. The cold joint evaluation for each of these sublots will be based on 4 density tests made for each sublot being evaluated on that sublot's side of the cold joint. These tests will be between 75 and 130 mm 3 and 5 inches from the proposed (sawed) joint line on the originally placed side of the cold joint and between 75 and 130 mm 3 and 5 inches from the actual joint on the secondary placement side.

1.2.3.2 Target Density

Determine, for each lot, the laboratory maximum wet density of an RCC sample tested in accordance with ASTM D1557 and as described for moisture-density testing in paragraph CONTRACTOR QUALITY CONTROL. This procedure for determining the target density will be repeated for each lot and as necessary whenever the mixture proportions or materials change. Since the "target density" for a lot will not be known until after the beginning of construction of the lot, the "target density" of the previous lot shall be used for quality control until the new "target density" is obtained.

1.2.3.3 Computed Percent Payment for Density

a. The average field densities for the sublots for lane interior and for each type of joint will in turn be averaged to determine the lot density for the lane interior, for fresh joints, and, if such exist, for cold joints. These lot average field densities will be compared with Table I and used to calculate the computed percent payment based on field density as described below.

b. First, the percent payment deduction for lane interior density, for fresh joint density, and for cold joint density will each be computed by subtracting the percent payment values found in Table I from 100.

c. Second, the weighted percent payment deduction for fresh joint density will be computed by multiplying the percent payment deduction for fresh joint density, as computed above, by the ratio of the total amount of RCC pavement in the fresh joint strip to the total amount of RCC pavement in the entire area of the lot. The area of fresh joint strip will be considered to be 3 m 10 feet wide times the length of completed fresh longitudinal construction joint in the lot, but not to exceed the total lot size.

d. Third, the weighted percent payment deduction for cold joint

density will be computed by multiplying the percent payment deduction for cold joint density, as computed above, by the ratio of the total amount of RCC pavement in the cold joint strip to the total amount of RCC pavement in the entire area of the lot. The area of cold joint strip will be considered to be 1.5 m 5 feet wide times the length of each half of the cold joint (each side of the joint) completed with the lot being evaluated, but not to exceed the lot size. (Although not probable, it could be possible that, for a full lot, both sides of a cold joint can be constructed in the same lot).

e. Finally, the percent payment reduction for the lane interior, the weighted percent payment deduction for fresh joint density, and the weighted percent payment deduction for cold joint density will be compared and the greatest value selected. This selected percent payment deduction will be subtracted from 100 to obtain the computed percent payment based on field density.

TABLE I - PERCENT PAYMENT FOR DENSITY

Average Lane Interior and Fresh Joint Density (16 Nuclear Density Gauge Readings Each)	Percent Payment	Average Cold Joint Density (16 Nuclear Density Readings)
98.0 and above	100.0	96.0 and above
97.9	99.5	95.9
97.8	99.0	95.8
97.7	98.2	95.7
97.6	97.0	95.6
97.5	95.0	95.5
97.4	86.5	95.4
97.3	81.0	95.3
97.2	72.0	95.2
97.1	65.0	95.1
97.0	58.0	95.0
96.9	52.0	94.9
96.8	47.0	94.8
below 96.8	reject	below 94.8

1.2.4 Surface Smoothness

a. After completion of the final rolling of a lot, test compacted surface for smoothness with a straightedge. Measurements will be made transverse to the paving lane at equal distances along the lane not to exceed 6 m 20 feet. These transverse measurements will be made completely across the paving lane and across the longitudinal construction joints. Measurements will be made longitudinal to the paving lane at separate intervals spaced not more than 6 m 20 feet apart longitudinally as well as across all transverse joints. Longitudinal measurements will be made at third points across the lane. Other areas having visually obvious deviations will also be tested. Location and deviation from straightedge for all measurements will be recorded.

b. When more than 5.0 percent of all measurements within a lot (across the joints and within the lane) exceed the tolerance specified in Table III, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. Regardless of the above, any separate joint or interior area

surface deviation which exceeds the tolerance given in Table III by more than 50 percent shall be removed or corrected to meet the specification requirements.

1.2.5 Thickness

a. The computed percent payment for thickness for the lot will be 100 percent if no core taken for that lot is deficient in thickness by 6 mm 1/4 inch or more.

1). When the measurement of any core indicates that the pavement is deficient in thickness by 6 mm 1/4 inch or more, additional cores shall be drilled parallel to the center line of the lane at 8 m 25 foot intervals on each side of the deficient core until the cores indicate that the deficiency in thickness is less than 6 mm 1/4 inch.

2). When the deficiencies in thickness for a series of cores are between 6 and 13 mm 1/4 and 1/2 inch, the average thickness will be established from an average of all core thicknesses, considering any core less than 6 mm 1/4 inch deficient as being full depth.

3). Any areas 13 mm 1/2 inch or more deficient in thickness shall be removed and replaced, recored and included in the measurements before the final calculation of computed percent payment for the lot is made.

b. The computed percent payment for thickness for the lot will then be determined as follows: the proportional part of the total lot area (expressed in percent) for Categories I and II in Table II will be multiplied by their respective percent payment from the table and the 2 products then added to obtain the computed percent payment for the lot.

c. The area of pavement for the percent payment calculations shall be considered to be the full paving lane width and midway between cores having thicknesses representing different categories. When any core shows a deficiency in thickness of 13 mm 1/2 inch or more, the area represented by that core shall be removed and replaced with pavement of the indicated thickness before any payment calculations are made. The area represented by the core shall be bound by the full paving lane width and a transverse line midway between the cores adjacent to the core in question, or the regularly scheduled transverse joint should such a joint fall between the cores.

d. If the Contractor believes that the cores and measurement taken are not sufficient to indicate fairly the actual thickness of the pavement, additional cores shall be taken and will be measured provided the Contractor will bear the extra cost of drilling the cores. When surface grinding is required that results in thickness deficiencies, the final surface will be considered in evaluation for thickness.

TABLE II - PERCENT PAYMENT FOR THICKNESS

Deficiency in Thickness
Determined by Cores

Percent Payment Category	mm	(or Action Required)
I	0.0 to 6.3	100
II	6.4 to 12.0	65
III	12.7 or greater	Remove and replace

TABLE II - PERCENT PAYMENT FOR THICKNESS

Deficiency in Thickness
Determined by Cores

Percent Payment Category	Inches	(or Action Required)
I	0.00 to 0.24	100
II	0.25 to 0.49	65
III	0.50 or greater	Remove and replace

1.2.6 Surface Texture

a. The surface texture of each lot will be visually examined by a representative of the Contractor's Quality Control immediately after construction to determine compliance with the surface texture requirements in paragraph RCC PAVEMENT PERFORMANCE REQUIREMENTS. The classification of the surface texture of any area of the pavement as acceptable or deficient will be made on the basis of comparison with a selected portion of the test section which has been chosen and marked as having an acceptable surface texture as determined by the Contracting Officer. The computed percent payment for surface texture requirements for the lot will be determined as shown in Table III.

b. Regardless of payment, any area of any size of extremely poor surface texture as determined by the Contracting Officer shall be removed and replaced full depth with suitable pavement at mo cost to the Government. No payment calculations will be made until all such defective material is removed and replaced.

TABLE III - PERCENT PAYMENT FOR SURFACE TEXTURE

Percent of Lot Area with Deficient Surface Texture	Percent Payment for Action Required
0.0 to 5.0	100
5.1 to 10.0	90
10.1 to 20.0	75
20.1 and above	Remove and replace

1.3 REFERENCES

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

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

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

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M 182	(2005; R 2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

ASTM INTERNATIONAL (ASTM)

ASTM C1040/C1040M	(2008; R 2013) Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, Including Roller Compacted Concrete, by Nuclear Methods
ASTM C1064/C1064M	(2011) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2014) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
ASTM C1157/C1157M	(2011) Standard Specification for Hydraulic Cement
ASTM C117	(2013) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2012) Standard Test Method for Lightweight Particles in Aggregate

ASTM C1260	(2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C127	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate
ASTM C128	(2012) Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate
ASTM C131	(2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	(2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C142/C142M	(2010) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C1435/C1435M	(2008) Standard Practice for Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer
ASTM C150/C150M	(2012) Standard Specification for Portland Cement
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C171	(2007) Standard Specification for Sheet Materials for Curing Concrete
ASTM C295/C295M	(2012) Petrographic Examination of Aggregates for Concrete
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2012) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39/C39M	(2014) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C40/C40M	(2011) Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C42/C42M	(2013) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

ASTM C494/C494M	(2013) Standard Specification for Chemical Admixtures for Concrete
ASTM C566	(2013) Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
ASTM C595/C595M	(2013) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2012a) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C78/C78M	(2012; E 2013) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C856	(2013) Petrographic Examination of Hardened Concrete
ASTM C87/C87M	(2010) Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
ASTM C989/C989M	(2013) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1557	(2012) Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)
ASTM D2995	(1999; R 2009) Determining Application Rate of Bituminous Distributors
ASTM D3665	(2012) Random Sampling of Construction Materials
ASTM D4791	(2010) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D6938	(2010) Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

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

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 300	(1990) Specifications for Membrane-Forming

	Compounds for Curing Concrete
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete
COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete

1.4 DEFINITIONS

The following DEFINITIONS apply to materials in Table VI:

a. Shale is defined as a fine-grained thinly laminated or fissile sedimentary rock. It is commonly composed of clay or silt or both. It has been indurated by compaction or by cementation, but not so much as to have become slate.

b. Limit for material finer than 0.075 mm (No. 200) sieve will be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale.

c. Clay ironstone is defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand. It commonly occurs as dull, earthy particles, homogeneous concretionary masses, or hard-shell particles with soft interiors. Other names commonly used for clay ironstone are "chocolate bars" and limonite concretions.

d. Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Other names commonly applied to varieties of chert are: flint, jasper, agate, onyx, hornstone, procellanite, novaculite, sard, carnelian, plasma, bloodstone, touchstone, chrysoprase, heliotrope, and petrified wood. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone.

e. Claystone, mudstone, or siltstone, is defined as a massive fine-grained sedimentary rock that consists predominantly of clay or silt without laminations or fissility. It may be indurated either by compaction or by cementation.

f. Shaly limestone is defined as limestone in which shale occurs as one or more thin beds or laminae. These laminae may be regular or very irregular and may be spaced from a few inches down to minute fractions of an inch. Argillaceous limestone is defined as a limestone in which clay minerals occur disseminated in the stone in the amount of 10 to 50 percent by weight of the rock; when these make up from 50 to 90 percent, the rock is known as calcareous (or dolomitic) shale (or claystone, mudstone, or siltstone).

1.5 SYSTEM DESCRIPTION

1.5.1 General Requirements

****
NOTE: Fill in the bracket with the name and location of the project.
****

a. The work covered by this section consists of furnishing all plant, material, and equipment, and performing all labor for the manufacturing, transporting, placing, compacting, finishing, jointing, and curing of roller-compacted concrete (RCC) pavement for [_____].

b. Provide access to the Contracting Officer at all times to all parts of the mixing and paving plant, placement site, and materials sources for inspection, sampling, and testing to assure compliance with the specifications.

1.5.2 Batching and Mixing Plant

****
NOTE: Time for this Submittal is intended to provide advance information to the field staff so that timely plant inspection can be done.
****

Submit details and data on the RCC mixing plant at least [60] [_____] days in advance of RCC test section construction and prior to plant assembly. Include:

a. Detailed layout of aggregate and RCC equipment.

b. Equipment manufacturer's literature on the:

1) Cementitious material storage, handling, and controls
2) Aggregate handling and controls
3) Water system and controls
4) Mixers and controls
5) Re-screening systems
6) Cooling systems
7) Plant conveyors, bins, and feeders.

1.5.2.1 Location of Plant

****
NOTE: The mixing plant should be on the construction site or as close as possible, but should be no further than 15 minutes haul time from the placing site. This is especially true if the project is on a military facility. The security delays at entrances are prohibitive.
****

Locate the mixing plant [onsite as indicated on the drawings][and][no more than 15 minutes haul time from the placing site].

1.5.2.2 Type of Plant

****
NOTE: Plant capacity should be governed by the laydown pattern or the size of the job to help eliminate or minimize cold joints.
****

Design and operate the mixing plant to produce an RCC mixture within the specified tolerances. The plant shall be a stationary-type plant having a twin-shift pug mill mixer and may be either weigh-batch type or continuous type and shall have a minimum rated capacity of [230][_____] metric tons [250][_____] tons per hour. The plant shall be equipped with positive means for controlling and adjusting the mixing time (amount of mixing), maintaining the time of mixing constant, and maintaining the speed of rotation of the pug mill shafts constant.

1.5.2.3 Cementitious Material Feed Unit

Suitable equipment, incorporating either weighing or volumetric measurements, shall be provided to separately batch or feed the required percentage of each cementitious material in the mixture within tolerances specified. Silos and feeders shall be equipped and operated so that no caking of material or variation in feed will occur, including use of any necessary air pressure or vacuum vents on the silos. Provision shall be made whereby each cementitious material can be readily sampled.

1.5.2.4 Aggregate Bins

Aggregate bins shall be provided for aggregate storage, one for each size group. Each bin shall be of sufficient capacity to supply the mixer continuously operating at full capacity. The bins shall be arranged to ensure separate storage of appropriate fractions of aggregate. Each compartment shall be provided with some means of preventing spilling of material into other bins. Unless the aggregate in the bin is readily visible to operating personnel, each aggregate bin shall be equipped with mechanical or electrical telltales to indicate when the aggregate in the bin is below level to permit accurate proportioning to mixing unit. Each bin shall be constructed or equipped so that a representative sample may be readily and safely obtained from each bin discharge during plant operations. When use of blending material is necessary, appropriate means shall be provided for separately storing, metering, and feeding into the mixer.

1.5.2.5 Water Control Units

Satisfactory means incorporating either weighing, metering, or volumetric measurements shall be provided to batch or feed the required quantity of water in the mixture within tolerances specified. Adjusting controls shall be convenient to and capable of easy and accurate operation by the mixer operator. When metering controls the quantity of water, provision shall be made whereby a fixed quantity of water delivered through the meter can be readily checked by weight or volume. A water storage tank shall be provided to prevent surge drawdown effect.

1.5.2.6 Batching or Feeding Tolerances

Batching or feeding shall conform to the mixture proportions directed within the following tolerances in Table IV. For batch-type plants, the

variation is in percent by weight from batch weight of each material based on the mixture proportions directed. For continuous feeding and mixing plants, the variation is in percent by weight from the mixture proportions of each material designed to be in a total timed sample obtained from a designated location in the plant.

TABLE IV - BATCHING OR FEEDING TOLERANCES

Material	Plant Tolerance, percent
Each cementitious material	plus or minus 2.0
Water	plus or minus 2.0
Admixtures	zero to plus 4.0
Each individual aggregate size group	plus or minus 2.0
Total aggregate	plus or minus 3.0

1.5.2.7 Additional Requirements for Batch-Type Mixing Plants

a. Plant Scales: Plant scales shall conform to requirements of NRMCA CPMB 100, with modifications as follows: Plant scales for any weigh box or hopper shall be of either beam or springless-dial type and shall be sensitive to 0.5 percent of maximum load required. Beam-type scales shall have a separate beam for each size aggregate, with a single pointer actuated for each beam and a tare beam for balancing hopper.

b. Weigh Box or Hopper for Aggregates: Weigh box or hopper for aggregates shall conform to requirements of NRMCA CPMB 100, with modifications as follows: Equipment shall include means for weighing each bin size of aggregate in a weigh box or hopper suspended on scales, ample in size to hold a full batch without running over. The gates on both the bins and the hoppers shall prevent leakage of aggregate when closed. On manually or semi-automatically operated plants, an interlocking device shall be provided to prevent opening more than one gate at a time. The interlocking device shall not be required on automatic plants designed for simultaneous weighing of all sizes of aggregate while the plant is operating under automatic control.

****
NOTE: Modify or delete GGBFS (bracketed) sentence.
****

c. Weigh Hoppers for Cementitious Materials: Weigh hoppers for cementitious materials shall conform to requirements of NRMCA CPMB 100, with modifications as follows: The weigh hopper shall have sufficient capacity to hold not less than 10 percent in excess of the weight of the cementitious material required for one batch. Portland cement and pozzolan may both be weighed cumulatively in the same hopper on the same scale, provided the Portland cement is weighed first, or the Portland cement and pozzolan may be weighed in separate hoppers on separate scales. The hopper shall be suspended on dial or beam scales equipped with a pointer so the tare weight of the hopper will be shown for each weighing; net weight of cementitious material shall be measured within 1 percent of the weight required.[Ground granulated blast furnace slag shall be [weighed on a separate scale][_____].]

d. Mixer Unit: The mixer for batch method shall be a stationary mixer of the twin pug mill-type capable of producing a uniform mixture within tolerances specified. The mixer shall have a time lock, accurate

within 5 seconds, to control operation of the complete mixing cycle by locking the weigh hopper gate after mixer is charged until closing of mixer gate throughout dry- and wet-mixing periods. The dry-mixing period is defined as the interval of time between the opening of the weigh hopper and the application of water. The wet-mixing period is the interval between application of water and the opening of the mixer gate. Control of mixing time shall be flexible and capable of being set at intervals of not more than 5 seconds throughout cycles up to 3 minutes. A mechanical batch counter shall be installed as part of the timing device and shall be designed to preclude register of dry batches or of any material run through during operation of pulling bins.

1.5.2.8 Additional Requirements for Continuous-Mixing Plants

****
NOTE: Delete the bracketed statement except for small or low-production jobs.
****

a. Aggregate Feed: Each bin shall have the feed rate controlled by a variable speed belt, [gate remotely operated from the central control panel,]calibrated to accurately deliver any specified quantity of material within the required tolerance. The feed rate from each bin shall be readily adjustable from the control panel to change aggregate proportions or to compensate for changes in moisture content. The feed rate controls shall automatically maintain the established proportions of aggregate from each bin when the combined aggregate delivery is increased or decreased. The combined aggregate belt feeding the mixer shall be equipped with an approved belt scale. The belt scale shall operate automatic controls, either electronic or mechanical, which will maintain the established proportion of each cementitious material and water as ratios of the total aggregate, with provisions for readily changing the proportions at the control panel. Approved means shall be provided for storing, metering, and feeding blend material as a separate material when use of blending material is necessary.

b. Cementitious Material Control: Approved means shall be provided to separately meter the required amount of each cementitious material in the mix within the tolerance specified. Metering shall be by readily adjustable vane feeders or other approved positive metering devices. Metering and feed shall be designed and controlled so that the cementitious material is uniformly fed into the mixer or into the stream of aggregate on the feeder belt, all with necessary controls to prevent loss of cementitious material as dust or in any other form. Control of the quantity of each cementitious material shall be automatically linked to the aggregate belt scales, as specified herein. Provision shall be made so the amount of each cementitious material delivered can be readily sampled and checked by weight.

c. Mixer Unit: The mixer for the continuous method shall be a stationary mixer of the twin-shaft pug mill type capable of producing a uniform and homogeneous mixture within tolerances specified. Blades shall be adjustable for angular position on shafts and reversible to retard flow of the mixture. The mixer shall bear a manufacturer's plate indicating net volumetric contents of mixer at several heights permanently inscribed on the wall and the rate of feed of aggregate per minute at plant-operating speed.

d. Discharge Hopper: The pug mill shall be equipped with a discharge

hopper having a capacity of at least one metric ton ton. The hopper shall be equipped with dump gates to assure rapid and complete discharge without segregation.

1.6 SUBMITTALS

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

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

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

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

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

SD-01 Preconstruction Submittals

Mixture Proportioning
Batching and Mixing Plant
Transporting and Placing Methods
Test Section
Placement Schedule
Contractor Quality Control

SD-03 Product Data

Placing and Spreading
Joints

Waybills and Delivery Tickets

1.7 QUALITY ASSURANCE

1.7.1 Sampling and Testing

The Government may sample and test aggregates and concrete during construction and inspect production and placement facilities and equipment to determine compliance with the specifications as specified herein and as otherwise considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing performed by the Government will not relieve the Contractor from the quality control testing requirements specified.

1.7.2 Allowable Variations

****
NOTE: Table V is a comprehensive listing of geometric and testing limits and corresponding allowable variations. Edit those values as appropriate for the project. Edit line items as appropriate. Where payment adjustment is not to be done, edit the exceedance action column to remove pay adjustment and add requirement.
****

Comply with the limits for parameters shown in Table V. The table identifies specified limits and allowable variations from these limits.

TABLE V - LIMITS AND ALLOWABLE VARIATIONS

Parameter	Specified Limit	Allowable Variation	Exceeding Action
Cementitious Material content	Conforming to mix design targets	Zero to plus 4% by weight	Remove and Replace if further quantity reduction required
Grade	As shown on the contract dwings	Plus or minus 13 mm (1/2 inch)	Remove and replace
Alignment	As shown on the contract dwings	Up to 13 mm (1/2 inch) variation	Remove and replace
Thickness	As shown on the contract drawings	Plus or minus 6 mm (1/4 inch)	[Pay adjustment up to 13 mm (1/2 inch, otherwise] remove and replace
Density in accordance with ASTM D1557	Laboratory test	98.0% interior 96.0% at joints	[Pay adjustment or] remove and replace
Smoothness	Checked with appr 4 m (12 ft) straight edge	Up to 10% of all measurements within specified limit	[Pay adjustment or] remove and replace
[Tank hardstands parking areas, open store areas]	Longitudinal Transverse	10 mm (3/8 inch) 10 mm (3/8 inch)	
[Roads and Str.]	Longitudinal	5 mm (3/16 inch)	

TABLE V - LIMITS AND ALLOWABLE VARIATIONS

Parameter	Specified Limit	Allowable Variation	Exceeding Action
	Transverse	6 mm (1/4 inch)	
Abrupt Offsets	Any direction	3 mm (1/8 inch)	[Grind to specified tolerance or] remove and replace
Surface Texture	Conforming to designated test patch on test section	Up to 5% of area less than test patch surface textures	[Pay adjustment or] remove and replace
Strength	Specified Strength	Not more than [10%] of strength results can be less than f'c	Remove and replace if more than [10%] of test results is less specified f'c

1.8 DELIVERY, STORAGE, AND HANDLING

1.8.1 Bulk Cementitious Materials

****
NOTE: Cement storage consists of dedicated plant silos for each cementitious material. In addition, higher capacity storage tankers (aka guppies, pigs) are often stored on site. Cementitious materials are usually truck hauled from the closest terminal or rail cars can be used as a temporary terminal. Dual silos must contain a clear air space between silo sidewalls to prevent cross contamination.
****

Furnish cementitious material in bulk. The temperature of the cementitious material, as delivered for storage at the site, shall not exceed 65 degrees C 150 degrees F. Provide separate facilities for unloading, transporting, storing, and handling of each type of cementitious material.

1.8.1.1 Transporting Cementitious Materials

When bulk cementitious material 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 completely protect the cementitious material from exposure to moisture. Submit copies of the Waybills and Delivery Tickets to the Contracting Officer, for cementitious material, during the progress of the work. Before the final payment is allowed, waybills and certified delivery tickets shall be furnished for all cementitious material used in the construction..

1.8.1.2 Storage of Cementitious Materials

Immediately upon receipt at the site of the work, store cementitious materials in a dry and properly ventilated structure. All storage facilities shall permit easy access for inspection and identification. To prevent cement from becoming unduly aged after delivery, use any cement that has been stored at the site for 60 days or more before using cement of lesser age.

1.8.2 Aggregate Materials

1.8.2.1 Storage

Aggregate shall be stored at the site of the mixing plant, avoiding breakage, segregation, or contamination by foreign materials. Each size of aggregate from each source shall be stored separately in free-draining stockpiles. Aggregate shall remain in free-draining storage for at least 24 hours immediately prior to use. At least [50] percent of the aggregate required for the [project][phase] shall be maintained at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time RCC is being placed.

1.8.2.2 Handling

Aggregate shall be handled preventing segregation or degradation. Vehicles used for stockpiling or moving aggregate shall be kept clean of foreign materials. Selective withdrawal and loader mixing of aggregates from the stockpile shall be done to blend materials prior to loading the bins.

PART 2 PRODUCTS

2.1 MATERIAL SOURCES

2.1.1 Aggregate Sources

****

NOTE: The specification provides in Table VI a complete list of material properties that the aggregate must have to be used on the project. It is the Contractor's responsibility to find sources that meet those requirements prior to the start of work and throughout the work.

Where complete testing has been done to determine acceptable sources, it may be expedient to list the sources that have been tested and are acceptable.

Where it is intended that a specific source or sources be used exclusively, they should be listed and so stated.

Performance testing of aggregate will require at least 90 days to perform the required freezing and thawing tests. Requirements for Contractor testing or design phase government testing of aggregate quality should be evaluated based on project schedule requirements.

Where service records are acceptable in lieu of performance testing, satisfactory service record for an aggregate will be determined based on the aggregate's ability to resist degradation under traffic and/or climatic conditions similar to that expected during its use. If performance data indicate that an aggregate is susceptible to one or more of the above mentioned problems, that source of aggregate will be rejected.

****

Locate and test the sources from which the aggregates are to be obtained. All aggregate for each nominal size group of aggregates shall be from a single aggregate source and shall meet specified quality requirements. Complete aggregate quality testing prior to performing mixture proportion studies.[The following sources are acceptable for RCC pavement construction:

a. Source a, name, location, owner, contact information.
b. Source [b][_____]]

2.1.2 Portland Cement Source

****
NOTE: Confirm that required portland cement is available in the required quantity from a single source.
****

Provide portland cement from sources actively producing portland cement that have a documented record of consistent physical and chemical properties meeting the specified provisions of [ASTM C150/C150M][ASTM C1157/C1157M]. Submit production tests for the past 2 years to verify acceptable performance. All portland cement for the project shall be from a single source. A second source of portland cement may be used if documentation is provided that the primary source cannot provide for the entire project needs. Test additional trial mixtures to confirm mixture performance.

2.1.3 Aggregate Samples

Provide facilities for the ready procurement of representative test samples for Government testing. Obtain samples of aggregates during paving at the point of batching. Additional tests and analyses of aggregates at various stages in the processing and handling operations may be made by the Government at the discretion of the Contracting Officer.

2.1.4 Pozzolan Source

****
Note: Confirm that required pozzolan is available in the required quantity from a single source.
****

Provide pozzolan from sources actively producing pozzolan that have a documented record of consistent physical and chemical properties meeting the specified provisions of ASTM C618. Submit production tests for the past 2 years to verify acceptable performance. All pozzolan for the project shall be from a single source.

2.1.5 Ground Granulated Blast Furnace Slag Source

****
NOTE: Confirm that required GGBFS is available in the required quantity from a single source.
****

Provide GGBFS from sources actively producing GGBFS that have a documented

record of consistent physical and chemical properties meeting the specified provisions of ASTM C989/C989M. Submit production tests for the past 2 years to verify acceptable performance. All GGBFS for the project shall be from a single source.

2.2 CEMENTITIOUS MATERIALS

2.2.1 Portland Cement

****
NOTE: The option of Type I or Type II portland cement should normally be specified, but only type II portland cement should be required when moderate resistance to sulfate attack is needed. Low alkali cements should be required when alkali reactive aggregates are used in the concrete. The false set requirement should be added if a history of false set exists for the area. Portland cement may also be specified using performance specification ASTM C1157/C1157M.
****

Portland cement shall conform to ASTM C150/C150M, Type [I][II][IV][, low alkali] [, including the false set requirement]. Low alkali cement shall be used if the proposed aggregates are found to have greater than 0.04 percent expansion when tested in accordance with paragraph: Alkali-Silica Reactivity. Portland cement shall conform to ASTM C1157/C1157M, Type [GU][MS][HS][MH][LH], including [Option R, Low Reactivity with Alkali-Reactive Aggregates][Optional Physical Requirements].

2.2.2 Pozzolan

****
NOTE: The supplemental requirements for limit on alkalies and limit on reactivity in brackets should be specified any time low alkali cement is specified or if class C pozzolan is permitted. Class C pozzolan should not be used if there is potential for sulfate attack. The supplemental requirements a-c should be used if there is potential for sulfate attack.
****

Fly ash shall conform to the requirements of ASTM C618, Class [F][C], including the optional requirements for drying shrinkage, uniformity, and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding [3][6] percent. Class F fly ash for use in mitigating Alkali-Silica Reactivity shall have a Calcium Oxide (CaO) content of less than 8 percent.

2.2.3 Portland-Pozzolan Cement

****
NOTE: The optional requirement for mortar expansion should be specified when the Portland-pozzolan cement will be used with alkali-reactive aggregate.

If portland-pozzolan cement is not locally and readily available, remove this paragraph and all

other references to the material in this specification.

****

Portland-pozzolan cement shall conform to the requirements of ASTM C595/C595M, Type IP or Type I(PM), including requirement for [mortar expansion][sulfate resistance] contained in Table III.

2.2.4 Ground Granulated Blast Furnace Slag

****

NOTE: If ground granulated blast furnace slag is not locally and readily available, remove this paragraph and all other references to the material in this specification. Select the appropriate grade of GGBFS.

****

Ground granulated blast furnace slag shall conform to the requirements of ASTM C989/C989M, grade [80][100][120].

2.3 WATER

Provide water conforming to the requirements of COE CRD-C 400 that is clean, fresh, and free from injurious amounts of oil, acid, salt, alkali, organic matter, and other substances deleterious to the hardening of concrete, subject to approval. Water that meets local drinking water standards and has no pronounced taste or odor may be used without testing.

2.4 CURING MATERIALS

a. Impervious-Sheet materials shall conform to ASTM C171. The type is optional.

b. Membrane-Forming curing compound shall conform to [ASTM C309, Type 1-D or 2][COE CRD-C 300] Nonpigmented compound shall contain a fugitive dye, and shall have the reflective requirements in ASTM C309 waived.

c. Burlap and cotton mat used for curing shall conform to AASHTO M 182.

2.5 AGGREGATES

****

NOTE: Modify the 90 percent limits if local information indicates that available aggregates cannot comply with this requirement and it is in the government's best interest to allow such a variation.

If the desire is to use State approved aggregates sources, revise the table values to match the state requirements and add supplemental line items as necessary.

****

Furnish, separately, both fine and coarse aggregates that meet requirements of these specifications. The coarse aggregate may consist of one or more nominal size groups each consisting of at least [90][_____] percent by weight of aggregate retained on the 4.75 mm No. 4 sieve, and the fine

aggregate and blending material, if used, shall have at least [90][_____] percent by weight of aggregate passing the 4.75 mm No. 4 sieve.

2.5.1 Coarse Aggregate

****

NOTE: Crushing the gravel tends to improve quality and bond characteristics and generally results in higher flexural strength of concrete and a more stable mixture under compaction. When mixture proportioning studies or local experience indicates that low flexural strength will be attained by using an uncrushed gravel, the possibility of attaining higher strength by crushing the gravel should be investigated. When desirable to require all the coarse aggregate to be crushed, modify the paragraph by deleting uncrushed gravel and adding the sentence in brackets.

If history of aggregate sources in the project area indicates lower concrete strengths are caused if dust and other coatings are not washed from the aggregate, then the option in brackets for washing aggregate should be considered if economically justified.

****

Coarse aggregate shall consist of crushed or uncrushed gravel, crushed stone, air cooled blast furnace slag, or a combination thereof.[Crushed gravel shall contain not less than 60 percent by weight of crushed particles size having at least one freshly fractured face, in each sieve.] Coarse aggregates shall consist of clean, hard, uncoated particles meeting the specified requirements.[Dust and other coatings shall be removed from the coarse aggregate by washing.] Particles of the coarse aggregate shall be generally spherical or cubical in shape. Coarse aggregate shall meet the test limits and requirements of TABLE VI - QUALITY LIMITS FOR AGGREGATE

2.5.2 Fine Aggregate

2.5.2.1 General Requirements

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two meeting the requirements of TABLE VI - QUALITY LIMITS FOR AGGREGATE. Where necessary to meet grading requirements, a fine blending material may also be used. Particles of the fine aggregate shall be generally spherical or cubical in shape.

2.5.2.2 Blending Material

To meet the specified gradation, additional fines (minus 0.150 and 0.075 mm No. 100 and No. 200 sieve size material), if necessary, shall be provided by adding to the aggregates a fine blending sand or pozzolan (fly ash). If pozzolan is used, it shall be the same material as furnished for cementitious material as required by paragraph CEMENTITIOUS MATERIALS. Pozzolan, if used for this purpose, shall be batched or fed together with pozzolan used as cementitious material and shall be furnished at the Contractor's expense. Blending sand, if used, shall be a clean, hard, siliceous material meeting all quality requirements specified herein for fine aggregate and shall be furnished to the mixer as a separate material.

TABLE VI - QUALITY LIMITS FOR AGGREGATE

Parameters	Test Method	Coarse Aggr E	Fine Aggr F
Characterization Tests:			
a Sieve Analysis	ASTM C136	(a)	(a)
b Specific Gravity & Absorption, BSSD	ASTM C127 & ASTM C128	(b)	(b)
Tests for Deleterious Materials (c) (d)			
c Materials finer than 0.075 mm (No. 200) sieve, max % by wt. (e)	ASTM C117	1.0	3.0
d Clay lumps, max % by wt.	ASTM C142/C142M	2.0	1.0
e Lightweight particles, max % by wt. (BSSD Sp. Gr.2.00) (f)	ASTM C123/C123M	1.0	0.5
f Chert and cherty stone, max % by wt. (BSSD Sp. Gr. <2.40)	ASTM C295/C295M	--	--
g Shale, max % by wt.	ASTM C295/C295M	--	--
h Clay ironstone, max by wt.	ASTM C295/C295M	--	--
i Claystone, mudstone, and siltstone, max % by wt.	ASTM C295/C295M	--	--
j Shaly and argillaceous limestone, max % by wt.	ASTM C295/C295M	--	--
k Other soft particles, max % by wt.	COE CRD-C 130	2.0	--
K Total of all deleterious substances, exclusive of material finer than 0.075 mm (No. 200) sieve, c through k, max % by wt.		5.0	--
Other Quality Tests:			
l Flat and elongated particles, max % by wt.	ASTM D4791	20	--
m Resistance to Freezing and Thawing using conventional concrete specimens if no service record of performance, min DFE	COE CRD-C 130	50	50
n Los Angeles Abrasion, max % loss by wt.	ASTM C131	40	NA
o Organic Impurities, max color number	ASTM C40/C40M	NA	3
p Effect of Organic Impurities, % of std.	ASTM C87/C87M	NA	pass
q Petrographic examination to assess potentially alkali-silica reactive constituents (f) (g)	ASTM C295/C295M	yes	yes
r Alkali Reactivity, max expansion at 16 days (f)	ASTM C1260	0.08	0.08

The following notes correspond to bracketed references (x) in Table VI:

a. The combined aggregate grading must meet the requirements of Table VI. Reference paragraph Aggregate Gradation.

b. Specific gravity and absorption are required for each aggregate size group for use in trial mixture proportioning.

c. Tests for deleterious materials require a petrographic analysis in accordance with ASTM C295/C295M for determining the presence of shale, clay ironstone, chert, cherry stone, claystone, mudstone, siltstone and shaly and argillaceous limestone.

d. The test sample size of coarse aggregate shall be at least 100 kg 220 lbs for nominal size groups greater than 19 to 38 mm 3/4 to 1-1/2 inch and 11.5 kg 26 lbs for the 5 to 19 mm No. 4 to 3/4 inch coarse aggregate. The minimum test sample for fine aggregate shall be 5 kg 11 lbs. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials shall be as follows:

1). Step 1: Test approximately one-fifth of sample for material finer than the 0.075 mm No. 200 sieve.

2). Step 2: Wash off material finer than the 0.075 mm No. 200 sieve from the remainder of the sample and recombine the remainder with material retained on the 0.075 mm No. 200 sieve from Step 1.

3). Step 3: Test remaining full sample for clay lumps and friable particles and remove.

4). Step 4: Test remaining full sample for lightweight particles and remove, and then for chert and/or cherty stone with SSD density of less than Sp. Gr. 2.40 and remove.

5). Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and/or argillaceous limestone, and remove. This work shall be done by a licensed petrographer.

6). Step 6: Test approximately one-fifth of remaining full sample for other soft particles.

e. The limit for material finer than 0.075 mm No. 200 sieve will be increased to 1.5 percent for crushed coarse aggregates and 5.0 percent for fine aggregates if the fine material consists of crusher dust and supplemental tests confirm that the material is essentially free from clay or shale. The separation medium shall have a specific gravity of 2.0. This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.

f. Determination of potential alkali reactivity of aggregates is a complex process that may involve additional testing if results of petrographic examination and ASTM C1260 tests indicate potential deleterious reactivity. See paragraph: Alkali-Silica Reactivity for requirements.

g. The petrographer meeting the requirements of ASTM C856 shall be subject to approval and at least 10 days before any individual is proposed to commence this type of work, submit a written resume of the individual's training and experience for approval by the Government. The Contractor will not be entitled to any extension of time or additional payment due to any delays caused by the testing, evaluation or personnel requirements specified herein.

2.5.3 Alkali-Silica Reactivity

****
NOTE: Use these paragraphs for regions where aggregates have a history of high alkali-silica reactivity. This requirement is more restrictive than the procedure required in Table III.
****

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity in accordance with ASTM C1260. Test both coarse aggregate size groups if from different sources. Evaluate the fine and coarse aggregates separately and in combination matching the proposed mix design proportioning. Test results of each individual group and combination must have a measured expansion less than 0.08 percent at 16 days after casting. Should the test data indicate an expansion equal to or greater than 0.08 percent, reject the aggregate(s) or perform additional testing in accordance with ASTM C1567 using one of the following options. If any of the above options does not lower the expansion to less than 0.08 percent at 16 days after casting, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance

2.5.3.1 Class F Flyash Option

Utilize the Contractor's proposed low alkali portland cement and Class F fly ash pozzolan in combination with the proposed aggregate percentage for the test proportioning. Use Class F fly ash pozzolan in the range of 25 percent to 40 percent of the total cementitious material by mass. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion to less than 0.08 percent at 16 days after casting.

2.5.3.2 GGBF Option

Utilize the Contractor's proposed low alkali portland cement and ground granulated blast furnace (GGBF) slag in combination with the proposed aggregate percentage for the test proportioning. Use GGBF slag in the range of 40 percent to 50 percent of the total cementitious material by mass. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion to less than 0.08 percent at 16 days.

2.5.4 Aggregate Gradation

****
NOTE: The combined aggregate grading is the property that must be evaluated and controlled. However, aggregates are stockpiled and handled in size groups that are typically fine aggregate (5 to 0 mm (No. 4 to 0), 19 to 5 mm (3/4-inch to No. 4), and 38 to 19 mm (1.5 to 3/4 inch)). This section requires that the Contractor designate the size groups, the gradings of each size group, and the proportion of each size group such that the combined grading is met. Typically the grading of each size group is monitored and controlled with little regard for the combined grading. This specification

requires that the combined grading also be monitored and controlled.

****

The combined aggregate shall consist of a minimum of at least two nominal size groups consisting of coarse and fine aggregate with blending material, if necessary, as previously described. Each nominal aggregate size group shall have a gradation such that the two or more materials can be combined in proportions that will produce a combined gradation within the specified limits. Each size group of aggregate and blending material shall be batched separately or otherwise fed separately to the mixer. The specified grading limits are determined in a 2 part process: 1) determining the initial combined aggregate grading and 2) determining the base grading limit.

2.5.4.1 Initial Combined Aggregate Grading Limits

Nominal aggregate size groups shall be combined to produce a uniform distribution of aggregate particles forming a smooth, well-graded curve. The Contractor's selected aggregate blend shall fall within the limits specified in the Table VII - Initial Combined Aggregate Grading Limits. Sieve analysis of fine and coarse aggregates (ASTM C136, ASTM C117) shall be performed to develop the Contractor's selected aggregate blend and initial grading.

TABLE VII - Initial Combined Aggregate Grading Limits

Sieve Size	Cumulative Percent by Weight Passing
25 mm	100
19 mm	85-100
12.5 mm	70-95
9.5 mm	55-85
4.75 mm	40-65
2.36 mm	30-55
1.18 mm	20-45
0.600 mm	15-35
0.300 mm	10-25
0.150 mm	5-15
0.075 mm	2-10

TABLE VII - Initial Combined Aggregate Grading Limits

Sieve Size	Cumulative Percent by Weight Passing
1 inch	100
3/4 inch	85-100
1/2 inch	70-95
3/8 inch	55-85
No. 4	40-65
No. 8	30-55
No. 16	20-45
No. 30	15-35
No. 50	10-25
No. 100	5-15
No. 200	2-10

2.5.4.2 Base Aggregate Grading Limits

After testing is completed and the aggregate blend meeting the initial combined aggregate grading shown in Table VII is selected, and after mix proportions and properties are determined using the selected blend, the base grading limits of each nominal size group of aggregate to be used during production shall be established. The base grading limit for each nominal aggregate size group, including any necessary blending material, shall be the grading used in the mix proportioning study with tolerances shown in Table VIII applied to each individual sieve size. The base grading limit for each aggregate size group will then be used for acceptance of aggregates entering the mixer.

TABLE VIII - Grading Limits for Each Aggregate Sieve Size

Sieves	Tolerance, plus or minus Percentage points
12.5 mm, 9.5 mm	5
2.36 mm, 1.18 mm, 0.600 mm	4
25 mm, 19 mm, 4.75 mm, 0.300 mm	3
0.150 mm, 0.075 mm	2

TABLE VIII - Grading Limits for Each Aggregate Sieve Size

Sieves	Tolerance, plus or minus Percentage points
1/2 inch, 3/8 inch,	5
No. 8, No. 16, No. 30	4
1 inch, 3/4 inch, No. 50, No. 4	3
No. 100, No. 200	2

2.6 ADMIXTURES

Water-reducing and retarding admixtures, if used, shall conform to ASTM C494/C494M, Type B or D.

2.7 EQUIPMENT

2.7.1 Paver Requirements

****
NOTE: This specification prohibits the use of traditional asphalt concrete pavers. Those are pavers that consolidate the material using a vibrating screed plate. The specified paver, also used for asphalt concrete, utilizes one or more tamping bars that compacts the material before exiting the machine. Much higher degree of compaction is attained by this type of machine.
****

Pavers shall be heavy-duty, track-equipped machines of the self-propelled type, similar to laydown machines (pavers) used for asphalt concrete or soil-cement construction. The pavers shall:

a. Be equipped with hoppers, distributing screws, vibrating screen and/or at least one tamping bar, adjustable screeds capable of being operated both manually and automatically, and equalizing devices.

b. Be of suitable weight and stability to spread and finish the concrete to the indicated thickness, smoothness, and surface texture requirements.

c. Confine edges of lanes to true lines without use of stationary side forms and shall place the concrete to the required thickness, free from segregation.

d. Shall be equipped with interchangeable side forms (shoes) which will form the edge of the pavement lane either vertically or 15 degrees from vertical.

e. Be designed to operate forward at variable speeds and in reverse.

2.7.2 Paver Control

The pavers shall automatically control both line and grade by means of electronic controls operating from stationary stringlines on both sides of the paver. However, as appropriate, a short ski riding on an adjacent paved lane may be used in lieu of one of the stringlines. Laser control devices may be used in lieu of a stringline provided the entire process is approved.

2.7.3 Compaction Equipment

2.7.3.1 Vibratory Rollers

Vibratory rollers shall be self-propelled, double-drum, steel-wheeled. Within the range of the operational capability of the equipment, the Contracting Officer may direct or allow variations within the specified range to the frequency, amplitude, and speed of operation which result in the required density and satisfactory surface texture at the fastest production rate. At least one self-propelled vibratory roller, in good operating condition and meeting these requirements, shall be used full time for each paver used full time. Any rollers that pick up material from the surface of the pavement shall be adjusted, modified, or replaced. The vibratory roller shall have the following features:

a. An average operating weight per drum of at least 2.7 kg/mm 150 pounds/lineal inch of drum.

b. A dynamic impact to the surface through the drums by means of revolving weights, eccentric shafts, or other equivalent methods.

c. A vibrating frequency of at least 1,500 cycles per minute.

d. An amplitude between 0.38 and 1.02 mm 0.015 and 0.040 inch at the operating frequency used.

e. Controls that permit ready variation of the amplitude at a minimum of two settings over at least 50 percent of the above range.

f. Drum diameter between 1219 and 1676 mm 48 and 66 inches and between 1676 to 2438 mm 66 to 96 inches in width.

g. Each drum equipped with an operating scraper and pad.

h. Equipped with a means of keeping the drums damp during operation.

2.7.3.2 Rubber-Tired Roller

The rubber-tired roller shall have the following features:

a. Smooth tires, nonoscillating wheels and a tire pressure adjustable between a minimum of 345 and a maximum of 620 kPa 50 and a maximum of 90 psi and with a total load between 1400 and 2000 kg 3,000 and 4,500 pounds per wheel.

b. 2 axles with at least 3 wheels per axle, offset so the front and back tires do not track in the same path.

2.7.3.3 Finish Roller

The smooth-wheeled tandem roller shall weigh 5 to 9 metric tons 5 to 10 tons. The vibratory roller may be used without vibration as a finish roller to remove surface blemishes.

2.7.3.4 Other Compaction Equipment

Light, walk-behind, or similar sized vibratory rollers and mechanical plate vibrators shall be furnished for use in compacting areas inaccessible to the large rollers.

2.7.4 Straightedge

Furnish one 3.6 meter 12 foot straightedge for each paving spreader for testing the finished surface. Straightedges shall be made available for Government use upon request. 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 the pavement.

2.7.5 Nuclear Density Gauge

One operable and properly calibrated nuclear density gauge shall be furnished for each paver. The nuclear density gauge shall be made available for Government use upon request. The nuclear density apparatus shall conform to ASTM C1040/C1040M, Method A, and shall be of a single-probe type.

2.7.6 Curing Equipment

Equipment for applying membrane-forming curing compound shall have the following features and configuration:

a. Mounted on a self-propelled frame that spans the paving lane.

b. The reservoir for curing compound shall be constantly mechanically (not air) agitated during operation and shall contain means for completely draining the reservoir.

c. A spraying system consisting of a mechanically powered pump which

will maintain constant pressure during operation and an operable pressure gauge.

d. Either a series of spray nozzles evenly spaced across the lane to give uniformly overlapping coverage or a single spray nozzle which is mounted on a carriage which automatically traverses the lane width at a speed correlated with the forward movement of the overall frame

e. All spray nozzles protected with wind screens.

2.8 MIXTURE PROPORTIONING

****
NOTE: Mixture proportioning studies include aggregate quality testing which may take considerable time. The mixture trial phase and follow up testing will require several months. Consider these time limits in selection when the submittal is required. Generally, mixture proportioning studies through 28-day test results require at least 60 days to perform. If later age strength results are necessary, more time is necessary.
****

The Contractor is responsible for all activities leading to development of a viable RCC pavement mix design. The work includes sampling aggregates, collecting materials, and laboratory testing and evaluations. The Contractor will be responsible for initial mixture proportions by the laboratory mixture proportioning trials. With approval of the Contracting Officer, the Contractor may make minor adjustments to the mixture proportions during construction as necessary to achieve the desired properties. At least [60] [_____] days in advance of RCC test section construction and prior to plant assembly submit the following:

a. Laboratory report on mixture design studies with [28] [90]-day strength test results.

b. Source information on all constituent materials.

c. Laboratory report of aggregate quality tests.

d. Manufacturer's literature including mill analysis and production test data on cementitious materials and admixture data.

2.8.1 Laboratory and Staff Qualifications

The laboratory and testing staff determining the RCC mixture proportions shall meet the same requirements specified in paragraph: CONTRACTOR QUALITY CONTROL.

2.8.2 Composition

****
NOTE: A typical range for most applications is 250 (min) to 350 (max) kg/cubic meter (400 (min) to 600 (max) lbs/cubic yard) of cementitious material and 15 to 25 percent pozzolan by absolute volume replacement of cementitious material. Add sentence

in last set of brackets on ground slag only if it will be used. Actual proportions will be determined by the testing laboratory.

****

RCC shall be composed of cementitious material, water, and fine and coarse aggregates, including any necessary fine blending material. The cementitious materials shall be portland cement in combination with pozzolan or, at the Contractor's option, cementitious material may be [portland-pozzolan cement] [portland cement in combination with ground granulated blast furnace slag]. A retarding admixture may be used, if ambient temperatures above [27][_____]degrees C [80][_____] degrees F are anticipated during placement. Other admixtures shall not be used unless demonstrated to be beneficial, approved in writing, and used in the mixture proportioning studies. Samples of all materials used in the mixture proportioning studies shall be representative of those proposed for use on the project.

2.8.3 Criteria for Mixture Proportions

****

NOTE: Pavement design is mostly based on the flexural strength of the mixture. Field control of mixtures is most easily done by evaluating compressive strength. One purpose of the mix design program is to correlate flexural strength and compressive strength of the mixture. It is important to not overspecify strength because that will result in mixtures that generate higher heat and may result in more cracking than would otherwise occur. Consequently overdesign strength values should be added to the extent required but not be excessive. It should be added to the specified strength and no separate provision made for computing overdesign strength. Suggest that 10 percent should be added to design compressive and flexural strengths.

****

The RCC mixture shall be proportioned based on the following criteria:

a. Workability of the mixture shall be appropriate for the paving machine to achieve the required density, thickness, grade, and finish texture.

b. The mixture shall attain a [28-day][56-day][90-day] [flexural][compressive strength] of [_____] psi.

c. The mixture shall be proportioned to minimize the volume of Portland cement.

d. The mixture [may][shall] contain pozzolan at a minimum replacement of [15 percent] of the volume of cementitious materials.

e. The mixture [may][shall] contain granulated ground blast furnace slag at a minimum replacement of [_____] percent of the volume of cementitious materials.

2.8.4 Mix Design Procedure

****

NOTE: There is no stardard guide for RCC pavement mixture. A previous guide, CRD C 161 in the Handbook of Cement and Concrete, is based on optimum moisture content and not considered as appropriate as the procedure outlined in Appendix C "RCC Pavement Mixture Proportioning Method" at the end of this Section.

****

Total mixture proportions shall be selected generally using the procedure detailed in Appendix C at the end of this Section. [Compressive][and][flexural] strength performance shall be determined for each trial mixture by testing [3 nominal 150 by 300 mm 6 by 12-inch cylinders][and][4 nominal 150 by 500 mm 6 by 6 by 20-inch beams] each at 7, 14, 28,[56,][and][90] days.

a. Strength. A minimum of three trial mixes shall be prepared at approximately 2 percent above and below the cementitious material content initially selected to meet the target project design [flexural][compressive] strength.

b. Workability. For each of the trial mixes, the paste volume shall be adjusted to produce workability approximately 10 seconds higher and 10 seconds lower than the target workability level. Subsequent moisture variations shall be based on observed performance during compaction of specimens.

c. Pozzolan. An additional 2 trial mixes shall be designed during the trial mix design study to establish the effect of pozzolan. Using the cementitious material content selected to meet the target project design, proportion two additional mixes using 15 and 25 percent pozzolan replacement by volume of cementitious material.[If ground granulated blast furnace slag is used the proportions will vary between 25 and 50 percent by absolute volume of the cementitious material, depending on the temperature during placing. No pozzolan or portland-pozzolan cement will be used if ground granulated blast furnace slag is used.]

d. Aggregate Fines. Using the cementitious material content selected to meet the target project design, proportion two additional mixes with fines content (materials passing 0.075 mm No. 200 sieve) at 2 percent above and below the target blend.

e. Select the final mixture proportions from the performance data of the trial mixtures that best meets the mix performance criteria. The Contracting Officer may direct further adjustments to the mix proportions before and during placement.

PART 3 EXECUTION

3.1 PRE-PLACEMENT ACTIONS

Complete the following activities prior to the commencement of pavement placement.

3.1.1 Calibration Block for the Nuclear Density Gauge

a. General. A calibration block shall be fabricated with concrete materials and proportions representative of those to be used during construction. The calibration block shall be available for use by the Government as needed. The calibration may be either a fabricated block or a test section area.

b. Fabricated Block. The block shall be fabricated before the test section construction begins. The block size shall be 456 by 456 mm 18 by 18 inches by the maximum thickness of one lift, plus 25 mm 1 inch. The block shall be compacted to between 98 and 100 percent of the maximum wet density, which will have been determined during mixture design trials. The moisture content of the concrete used to fabricate the block may be increased just enough to facilitate compaction of the mixture (normally 0.1 to 0.5 percent), as long as the proportions of the dry materials remain constant and the required density is achieved. Drill a hole in the block to accommodate the nuclear density gauge probe. The block 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.

c. Test Section. In lieu of a fabricated block, designate a portion of the test section or test strip to be the calibration area. The gage location shall be identified and a probe hole maintained for repeated testing. Six 100 mm 4-inch diameter full depth cores shall be removed from the perimeter of a 1219 mm 4-foot diameter circle around the probe hole. The cores shall be trimmed 25 mm 1 inch on each end and density of each core determined. The average of the 6 cores shall be used provided that the density range is not more than 32 kg/cubic m 2 lbs/cf. The calibration area shall not be disturbed or damaged during the construction of any RCC.

d. Daily Calibration. The block 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. Three sets of full depth nuclear density gauge tests shall be performed in the direct transmission mode and the results for each depth averaged. This average nuclear density gauge reading shall be compared with the measured unit weight of the block and the difference used as a correction factor for all readings taken that day.

e. Verification. All measuring and weighing of the test block and all calibration checking of the density gauge shall be performed in the presence of the Contracting Officer.

3.1.2 Test Strips

Place at least [4][_____] test strips in the vicinity of the plant. These strips shall be one paver width wide and 9-12 m 30-40 feet in length. The test strips allow evaluation of the placing characteristics of the mixture and to make necessary adjustments prior to placing the test section. The strips may be demolished within 3 hours after placing.

3.1.3 Test Section

****

NOTE: For noncritical pavement areas, the test section may be included into the actual pavement

area. For critical areas, the test section should be constructed in a separate area near the jobsite, with similar conditions and pavement section to the actual construction site.

The requirement of building the test section 10 days before the main construction begins may be lengthened or shortened in the project specifications, depending on the confidence of the designer in the ability to obtain the design flexural strength in the test section.

If the test section will be included into the actual pavement area, this paragraph should be modified to state that the test section will be removed if it is unacceptable.

The test section should demonstrate ALL the required elements specified and should be done after calibration of the mixing plant.

****

Submit a detailed plan of the proposed test section layout, location, and placement sequence at least 14 days prior to placement of the test section. At least 10 days but not more than 60 days prior to construction of the pavement, construct a test section near the job site at the location designated on the contract plans. The Contracting Officer shall be notified at least 5 days in advance of the date of test section construction. The test section shall be placed in portions as directed by the Government. Test sections unacceptable to the Contracting Officer shall be removed at the Contractor's expense.

a. Timing. Two separate days shall be used for construction of the test section. The test section will provide the Contractor the opportunity to develop and demonstrate that the proposed techniques of mixing, hauling, placing, compacting, finishing and curing, and the preparation of the construction joints meet the contract requirements. The mixing plant shall be fully operational and calibrated, and uniformity testing completed prior to placing the test section.

b. Features. Use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work. Base course preparation, concrete production, placing, compacting, curing, construction of joints, and all testing shall be in accordance with applicable provisions of this specification. The test section shall:

1). Be no less than two adjacent paving lanes each 30 m 100 feet long.
2). Be constructed to the designated thickness and number of lifts.
3). Use the same lane width proposed for use in the project.
4). Include at least one fresh longitudinal construction joint
5). Include at least one cold transverse joint.
6). Include one longitudinal cold construction joint that is at least 12 hours old before placing the adjacent lane.

c. Operational Demonstration. Demonstrate the ability to meet the specified requirements for:

1). Plant operations and paving start-up procedures.
2). The RCC laydown method and production rate.
3). The rolling pattern and method for the mat, and fresh and cold construction joints.
4). Cold joint preparation.
5). Saw-cutting and joint sealant installation.
6). RCC testing and evaluation methods.

d. Adjustments During Test Placement. Be prepared to make adjustments to various aspects of the test section placement as directed by the Contracting Officer. Adjustments include:

1). Varying the amplitude and frequency of the roller to identify the optimums.
2). Varying the rolling pattern of the all rollers to determine the best pattern
3). Varying the mixture proportions other than water.
4). Varying the water content, as necessary, to arrive at the appropriate content.

e. Testing. Remove twelve [150][100] mm [6][4]-inch diameter cores and six beams 150 by 810 mm 6 by 32 inches, by full depth, from points selected in the test section by the Contracting Officer 5 days after completion of the test section. Trim the beams to dimensions directed by the Contracting Officer and test the cores and beams in accordance with ASTM C42/C42M. Perform testing at 7, 28, and 90 days of age.

f. Acceptance. The test section shall meet all specified performance factors, density, thickness, strength, surface smoothness, and surface texture. Failure to construct an acceptable test section will necessitate construction of additional test sections at no additional cost to the Government. Remove test sections after completion of the test section evaluations.

3.1.4 Subgrade Preparation

****
NOTE: Designer will include the title of the applicable specification section used for base course or subgrade, and delete inappropriate sections.
****

Previously constructed material underlying the RCC pavement shall be conditioned as specified in Section [32 11 27 BITUMINOUS-STABILIZED BASE COURSE, SUBBASE, OR SUBGRADE][32 11 26.16 PORTLAND CEMENT-STABILIZED BASE OR SUBBASE COURSE][32 11 36.13 LIME-STABILIZED BASE COURSE, SUBBASE, OR SUBGRADE][32 11 33 BITUMINOUS BASE COURSE][32 11 16.16 SUBBASE COURSES][32 11 24 GRADED, CRUSHED AGGREGATE BASE COURSE]. In all cases prior to placing concrete, deficiencies in the underlying material shall be corrected, and the surface shall be cleaned and moistened, as directed. The Contracting Officer will inspect and approve the surface of the underlying material prior to placing RCC pavement.

3.1.5 Grade Control

Establish and maintain lines and grades shown on contract drawings for each pavement category of the contract by means of line and grade stakes. Finished pavement gradelines and elevations shown shall be established and

controlled at the site of work in accordance with bench mark elevations shown on the contract drawings. The surface of the underlying material shall be finished to the necessary grade such that when the required thickness of RCC is placed, the pavement surface will meet the indicated grade. Finished and completed RCC pavement shall conform to the lines, grades, cross section, and dimensions indicated.

3.2 TRANSPORTING AND PLACING METHODS

****
NOTE: The submittal is to be reviewed in advance of the test section construction. The test section is where the Contractor demonstrates the proposed processes. The processes may change as a result of the test section and the resubmittal documents that change.
****

Perform initial submittal [60] [_____] days in advance of the test section construction. A resubmittal shall be done after completion of a successful test section at least [14] [_____] days in advance to the RCC pavement placement. Include narrative, equipment, crew list, and manufacturer's literature for the following operations for normal and adverse weather conditions:

1) Transporting RCC from plant to placement area
2) RCC feeders to the laydown equipment
3) Laydown equipment
4) Grade and alignment control
5) Compaction
6) Curing

a. Submit instructions on adjustments and operating procedures including corrective action(s) necessary to assure a tight, smooth surface on the RCC pavement, free of tears and other surface imperfections, including surface pitting.

b. Haul concrete from the mixer to the placing site in dump trucks [equipped with protective covers]. The trucks shall dump directly into the hopper of the paver or into an approved secondary material distribution system which deposits material into the paver hopper. RCC shall not be dumped onto the prepared subgrade or adjacent areas.

c. Schedule deliveries so that concrete will be spread and rolled within the time limit specified in paragraph COMPACTION and spreading and rolling of all mixture prepared for 1 day's run can be completed during daylight unless artificial lighting is provided. Loads that have become visibly contaminated or have become wet by rain will be rejected.

d. Hauling over freshly placed concrete will not be permitted[, except as approved by the Contracting Officer on the lower compacted lift of multilift-pavements]. RCC not meeting these specifications shall be removed from the plant or placement area and disposed of [as specified in Section [_____]][at a location designated by the Contracting Officer].

3.3 BATCHING AND MIXING

Operate the plant to produce a uniform and homogeneous mixture. The proportions shall be as developed during the mixture proportioning process and otherwise approved. All materials used in the mixture shall be batched or fed separately, except that fly ash used as aggregate fines shall be batched or fed with fly ash used as cementitious material.

3.3.1 Mixing

The aggregates, cementitious materials, water, and admixtures shall be conveyed to the mixer in proportions, as required. In batch mixing, aggregates and cementitious materials shall be charged into the mixer and dry-mixed at least 15 seconds. Water shall be added, and mixing shall be continued as required to obtain a homogeneous mixture. The paddles of the pug mill shall be adjusted, as necessary, to provide the required mixing time and to provide a thorough mixing. Shaft speed of the pug mill shall be maintained at the speed recommended by the manufacturer. RCC shall not extend above the tips of the paddles of the pug mill mixer when paddles are in vertical position. Mixer and mixer paddle surfaces shall be kept free of hardened concrete and other contamination. The dimensions of mixer paddles worn down more than 10 percent from new paddles of the same type and manufacture shall be replaced. New paddles shall be available onsite for comparison.

3.3.2 Water Content

****

NOTE: Mixture workability is a major factor in achieving the required density and the most desirable surface texture. Periodic water content adjustments are necessary to compensate for stockpile moisture variations or variable aggregate properties. Typically these adjustments are minor and it is normal that the Contractor have the latitude to make the adjustments as required. Otherwise a timely response to an observed condition cannot be made.

****

The initial or start-up water content will be approved by the Contracting Officer based on results of the mixture proportioning trials. After startup, the total water content of the mix shall be controlled as necessary to meet all requirements stated herein. The water content shall be varied at frequent intervals, as necessary and as considered appropriate, because of placing and compacting operations and shall in general be based on: 1) the action of the vibratory roller on the freshly placed concrete; 2) the field density test results attained in the pavement; and 3)the texture of the RCC surface being produced.

3.3.3 Mixture Uniformity Testing

Evaluation of mixture uniformity consists of 2 separate test series and each shall be performed to evaluate: 1) the performance of the drum mixer and 2) the uniformity of the batching and mixing process. Mixture uniformity testing shall be done prior to the production and placement of any RCC. The RCC proportions used for testing shall be as that proposed for use on the project. All mixture uniformity testing shall be performed in accordance with COE CRD-C 55 as modified herein and paragraph CONTRACTOR

QUALITY CONTROL.

3.3.3.1 Mixer Performance Test

a. Perform mixer performance tests when a reduced mixing time is proposed. The test is performed on three separate samples representing each of the three thirds of a single full-production batch of concrete. For continuous mix plants, take samples during full plant production at 1 minute intervals.

b. Before uniformity data are available, the mixing time for each batch after all solid materials are in the mixer, and provided that all of the mixing water is introduced before one-fourth of the mixing time has elapsed, shall be at least 75 seconds.

c. The RCC shall meet the limits of the five mixer performance requirements listed in Table IX below. The testing shall consist of performing all five tests on a single batch of concrete. The range for determining acceptability shall be the range of test results for each of the three samples representing the single batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, etc., the results of tests on one of the mixers shall apply to the others, subject to the approval of the Contracting Officer.

3.3.3.2 Process Uniformity Test

Process uniformity testing shall consist of performing all five tests on three separate batches of concrete. The range for determining acceptability shall be the range of test results for each of the three samples representing the three full-production batches. For continuous mix plants, samples shall be taken at approximately 3 hour intervals during full plant production.

TABLE IX - UNIFORMITY REQUIREMENTS--STATIONARY MIXERS

Parameter	Process Uniformity Test Allowable Maximum Range for Average of 3 Batches	Mixer Performance Test Allowable Maximum Range for 1 Batch
Unit weight of (Air-free) mortar	32 kg/cubic m (2.0 lbs/cubic ft)	24 kg/cubic m (1.5 lbs/cubic ft)
Coarse aggregate	6.0 percent	6.0 percent
Compressive strength at 7 days	10.0 percent	10.0 percent
Water Content	1.5 percent	1.0 percent
Unit Weight of Concrete (full mix including air)	24 kg/cubic m (1.5 lbs/ft)	16 kg/cubic m (1.0 lbs/ft)

3.4 PLACING AND SPREADING

If concrete is to be placed in or exposed to hot or cold weather conditions, submit a description of the placing and protection methods proposed, prior to construction of the test section. Unless otherwise directed or approved, placing shall begin along the low side of sloped areas.

3.4.1 Placing

****
NOTE: This requirement may be deleted if it is duplicated in the overall project schedule.
****

a. Timing. Place mixture in accordance with the Placement Schedule and as nearly continuous as possible, with an absolute minimum of stops and starts; control speed of placing to permit proper rolling. Submit schedule of paving operations, at least [28] [_____] days prior to start of paving unless otherwise specified. The timing of placement shall be controlled so that all RCC mixture shall be placed and rolled within the time limit specified in paragraph COMPACTION. Except as specified below, for certain extremely small odd-shaped isolated areas, all concrete shall be placed and spread with the paver.

b. Charging. The level of concrete in the paver hopper shall not be allowed to approach empty between loads, and concrete shall be maintained above the auger shaft during paving.

****
NOTE: If the total pavement thickness is greater than 250 mm (10 inches), use the first statement in brackets regarding lift thickness; otherwise, the second statement should be used.
****

c. Setup. The paver shall be adjusted and the speed regulated to prevent segregation, meet the surface requirements, and of such depth that, when compacted, the surface will conform to cross section, grade, and contour indicated. [No layer shall be in excess of 250 mm 10 inches or less than 100 mm 4 inches in compacted thickness.][The entire depth of pavement shall be placed as one layer.]

d. Edges. Each edge of each lane shall be constructed with a sloped face of 15 degrees from vertical configuration, as directed. The edge shoe shall be constructed so that it is within 19 mm 3/4 inch of the compacted base surface.

e. Lanes. Mixture shall be placed in consecutive adjacent lanes having a minimum width of 3 m 10 feet and a maximum width of6 m 20 feet. A wider lane may be approved to prevent edge lanes less than 3 m 10 feet in width. If more than 60 minutes should elapse between placements in adjacent lanes, the construction joint shall be considered a "cold joint" and treatment as specified herein for cold joints shall be provided. Not more than 60 minutes shall elapse between placement of lifts on multilift construction. During extremely hot weather, both of these limits will be decreased by the Contracting Officer as specified in paragraph: Placing During Hot Weather or as otherwise considered appropriate. Each lane placed before a succeeding lane shall be of such length that, where practical, the succeeding lane can be placed without the use of a cold joint.

f. Joints. Pavers shall be used in sufficient numbers and operated in staggered formation to assist in achieving the above requirement and to produce multilane construction in one construction operation to minimize cold construction joints. Otherwise, the joint shall be constructed as a cold joint. In multilift construction, a separate

paver shall be required for placement of each lift of pavement. The length of a lane that is to be followed by another lane shall be approved and shall be decreased or increased as required by air temperatures, wind, and other climatic conditions existing at the time of placement. Longitudinal joints and edges shall be constructed to true line markings. Lines parallel to the centerline of an area to be paved shall be established, and stringlines shall be placed coinciding with established lines for the spreading machine to follow.

g. Control of Water. Placing shall be discontinued during rain except for light mists that 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 or base course.

3.4.2 Placing Adjacent Lanes

Fresh longitudinal construction joints between separate lanes of concrete pavement shall be completed within the time limitations in the paragraph PLACING AND SPREADING. Other longitudinal joints shall be treated as "cold joints." Joints shall be made to assure continuous bond between old and new sections of pavement. Extra passes of the vibratory roller and other compaction and hand finishing shall be used as necessary to assure specified full depth compaction and surface finish.

3.4.3 Special Requirements for Placing Lanes Succeeding Initial Lanes

For longitudinal construction joints the screed of the paver shall overlap the previously placed lane 25 to 50 mm 1 to 2 inches and shall be sufficiently high so that compaction will produce a smooth, dense joint, without offset. The concrete placed on the edge of the previously placed lane by the paver shall be carefully pushed back by hand by using a lute to the edge of the lane being placed, so none will remain on the surface of the previously placed lane. If necessary, when the quantity of concrete on the edge of the previously placed lane plus uncompacted material in the lane being placed exceeds that required to produce a smooth, dense joint, the excess concrete shall be removed by approved methods and wasted.

3.4.4 Handwork

Any paving operations that require significant handwork, other than as specified above, shall be stopped and the problems corrected before restarting. Broadcasting or fanning of concrete mixture over areas being compacted will not be permitted. When segregation occurs in the concrete during placement, the spreading operation shall be suspended until the cause is determined and corrected. Segregated coarse aggregate shall be removed from the surface prior to compaction. Irregularities in alignment of the pavement left by the mechanical spreader shall be corrected by hand trimming directly behind the spreader before rolling. Distortion of pavement during edge trimming will not be permitted.

3.4.5 Placing Odd-Shaped Areas

In isolated instances involving very small, odd-shaped areas where use of machine spreading is impractical, concrete shall be spread by hand. Spreading shall be in a manner to prevent segregation. Mixture shall be spread uniformly with shovels in a loose layer of thickness that, when compacted, will conform to density, grade, thickness, and surface texture requirements.

3.4.6 Placing During Cold Weather

Placement shall be discontinued when the air temperature reaches 5 degrees C 40 degrees F and is falling and shall not be resumed until the air temperature reaches 2 degrees C 35 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 concrete from freezing during the specified curing period. Mixing water and/or aggregates shall be heated, as necessary, to produce concrete having a temperature between 10 and 30 degrees C 50 and 85 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 10 degrees C 50 degrees F for not less than 72 hours after placing and at a temperature above freezing for the remainder of the curing period. Concrete damaged by freezing shall be removed and replaced as directed.

3.4.7 Placing During Hot Weather

During periods of hot weather when the maximum daily air temperature is likely to exceed 30 degrees C 85 degrees F, the following precautions shall be taken:

a. The maximum period between placing succeeding lifts or lanes shall be 45 minutes.

b. The underlying material shall be sprinkled with water immediately before placing the concrete.

****

NOTE: The maximum placing temperature at which concrete should be placed is dependent on the minimum temperatures that can occur in the region. For simplicity 3 regions have been established based on average ambient air temperatures (AAAT). When air temperatures during RCC placement in these regions exceeds 30 degrees C (85 degrees F), one of the following maximum concrete temperatures should be required:

AAAT.<40 degrees, concrete temperat. <70 degrees F
AAAT <50 degrees, concrete temperat. <80 degrees F
AAAT <60 degrees, concrete temperat. <90 degrees F

****

c. Place the concrete at the coolest temperature practicable, and the temperature of the concrete when placed shall not exceed [_____] degrees CF.

d. The finished surfaces of the newly laid pavement shall be kept damp by applying a waterfog or mist, not streams of water, with approved spraying equipment until the pavement is covered by the curing medium.

When the Contracting Officer determines heat or wind excessive, immediately take additional measures, as necessary, to protect the concrete surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective, paving operations shall be immediately

stopped until satisfactory placement conditions exist.

3.5 COMPACTION

****
NOTE: Do not, under any conditions, reduce the requirements for use of vibratory rollers operating in the vibratory mode or for use of electronic controls and stringlines or lasers.
****

Accomplish compaction by self-propelled, vibratory, steel-wheeled rollers and rubber-tired rollers. 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. Surfaces of roller drums and wheels shall be kept clean at all times.

3.5.1 Timing

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. 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.

3.5.2 Initial Rolling

Initial rolling shall consist of a minimum of 4 complete vibratory passes of the vibratory roller. In no case shall this requirement for vibratory rolling be relaxed. Initial static passes may be necessary before the vibratory rolling to "set" the pavement surface before vibratory compaction is started. A round trip over the same material shall count as 2 complete passes (i.e., from point A to point B and return to point A by the same route are 2 complete passes).

3.5.3 Deficiency Evaluation

After initial vibratory rolling, preliminary tests and examination of density, crown, grade, smoothness, and surface texture shall be made 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.

3.5.4 Vibratory Rolling and Testing

Rolling shall be continued with the vibratory roller in vibratory mode, if necessary, until the specified wet field density as a percentage of the "Target Density," maximum wet density is attained in the lane interior, at fresh joints, and at cold joint. Nuclear density testing shall be performed in accordance with paragraph CONTRACTOR QUALITY CONTROL.

3.5.5 Final Rolling

Once at least 4 passes of the vibratory roller, operating in the vibratory mode, have been made and the specified density is attained, rolling with the steel wheeled vibratory roller shall stop. Vibratory rolling beyond

that specified above will not be permitted. All additional rolling beyond 4 vibratory passes required to produce the specified field density shall be at the Contractor's expense. As soon as rolling with the vibratory roller is complete, the pavement surface shall receive at least 2 complete passes of the rubber-tired roller with tire pressure and loading per wheel at the midpoint of the range previously specified, unless otherwise directed. These passes shall be followed by 2 complete passes of the finish roller.

3.5.6 Operation of Rollers and Tampers

Speed of rollers shall be slow enough at all times to avoid displacement of the concrete but not more than 2.5 km/hr 1.5 mph. Displacement of concrete resulting from reversing direction of roller or from any other cause shall be immediately corrected. Alternate passes of roller shall be varied slightly in length and shall overlap sufficiently to provide full coverage over the surface. Additional rollers shall be furnished if pavement density specified is not attained and/or if paving operations are getting ahead of rolling. Paving operations shall not be altered to accommodate a lack of rollers. 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.

3.5.7 Rolling Pattern

a. Rolling shall commence at the outer edge of the lane, followed by the other edge, and then the center. On subsequent adjacent lanes, rolling shall begin at the outer edge. The first pass along each edge shall extend to within approximately 450 mm 18 inches of the edge except as otherwise approved or directed.

b. 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.

c. 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 pavement, the outer 450 mm 18 inches shall be rolled after rolling of the center of the lane.

d. 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.

e. Approved hand-finishing operations shall be used as necessary to produce a tight surface at the joint, meeting the specified surface tolerances in Table III. The rolling pattern shall be used consistently throughout production.

3.6 JOINTS

Submit a detailed plan of the proposed paving pattern showing all planned construction joints and curing water runoff control. Joints shall conform to the details indicated and shall be perpendicular to the finished grade of the pavement. The joint area is considered the RCC material within 12 inches of the joint. Joints shall:

a. Be straight and continuous from edge to edge of the pavement.

b. Be made to ensure continuity in smoothness and grade between old and new sections of pavement, as specified hereinafter.

c. Have the same texture, full-depth density, and smoothness as specified for other sections of pavement or as specified for joints.

d. Be cleaned by brushing or cut back with approved power saw, as directed, regardless of age, contact surfaces of previously constructed strips that have become coated with dust, sand, or other objectionable material.

3.6.1 Longitudinal Construction Joints

Any construction joints in which the density fails to meet the specified limits shall be trimmed by sawing the edge of the hardened concrete with a power concrete saw, not earlier than 12 hours age.

a. The sawcut shall be at least 150 mm 6 inches from the original edge, and more if necessary to produce an acceptable joint.

b. The sawcut shall be full depth of the pavement and shall produce a face within 15 degrees of vertical, free of all loose or uncompacted material.

c. The outer portion shall be removed carefully to prevent any damage to the sawed face. If damage occurs, the edge shall be resawed.

d. If necessary, additional rolling shall be used to assure that full depth density and surface texture is attained.

3.6.2 Transverse Construction Joints

a. When a transverse construction joint is required, the roller shall pass over the end of the freshly placed concrete.

b. The tapered end of the strip and adjacent unacceptable material shall be cut with a power concrete saw to full depth of the lift, as specified above, and the excess material removed.

c. In continuing placement of the strip, the paver shall be positioned on the transverse joint so that sufficient fresh concrete will be spread to obtain a joint, after rolling, which will conform to required full-depth density and smoothness specified. 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.

3.6.3 Joints in Multilift Construction

****
NOTE: Delete this paragraph if only one course construction is to be used in the project. Delete bracketed statement if all lift joints are to receive bedding mortar.
****

a. The top layer shall be placed so that longitudinal joints in that layer will coincide with joints in the lower layers of the pavement.

b. Transverse joints in the top layer shall coincide with transverse joints in the lower layers of the pavement.

c. All portions of the lower layer that are to be covered by the upper layer shall be covered with a bedding mortar layer 6 to 10 mm 1/4 to 3/8 inch thick immediately before placing the upper layer[if the time between successive layers exceeds 30 minutes].

d. Bedding mortar shall be a mixture of cement, fine aggregate and water of the proportions directed and shall be spread evenly over the lower layer.

3.6.4 Slip Joints

Slip joints shall be constructed between roller-compacted and conventional concrete where no expansion joint is required and as shown on the contract drawings. The edge of the initial placement, either RCC or PCC, shall be coated with a bituminous product a minimum of 3 mm 1/8 inch thick prior to placing the next material. If RCC is placed prior to conventional concrete, the RCC shall be sawcut full depth at the joint line and excess RCC removed.

3.6.5 Sawing of Contraction Joints

****
NOTE: Sawing of transverse contraction joints is recommended because of appearance and ease of sealing. However, in the past much RCC pavement has been allowed to crack naturally without benefit of sawing. These natural cracks normally occur at 12 to 20 m (40 to 70 ft) spacing. Delete this paragraph if sawed joints are not being used and modify paragraph Sealing Joints and Cracks accordingly. The bracketed statement should be included if longitudinal construction joints are to be sawed and sealed. In the past, longitudinal construction joints have had no treatment except for routing and sealing if they open up to form a crack 3 mm (1/8 inch) or more in width. In general this has been a satisfactory approach.
****

a. Transverse contraction joints shall be sawed at 12 m 40 ft spacing or as otherwise indicated. [Longitudinal construction joints between lanes shall be sawed to form a reservoir for joint sealant in the same manner as specified above.]

****
NOTE: Very early age sawing is commonly done for conventional concrete pavements. It is also appropriate for RCC pavements where sawn joints is desired. Specialized equipment is necessary for sawcutting to be done at very early ages so that damage to the joint and pavement is prevented.
****

b. Timing for Sawing. Initial joint sawing shall be accomplished where indicated by using a 3 mm 1/8 inch blade to the depth indicated. The time of sawing shall vary depending on existing and anticipated weather conditions and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing the concrete without chipping, spalling, or tearing. The sawing operation shall be carried on, as required, during both day and night regardless of weather conditions. Water-curing, if required, shall be discontinued only in small areas to facilitate sawing.

c. Cracking. Before sawing a joint, the concrete shall be examined closely for cracks, and the joint shall not be sawed if a crack has occurred within 3 m 10 feet from the planned joint location. Sawing shall be discontinued when a crack develops ahead of the saw cut.

d. Spacing and Alignment. The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. A chalkline or other suitable guide shall be used to mark the alignment of the joint. The saw cut shall not vary more than 13 mm 1/2 inch from the true joint alignment from edge to edge of the pavement area, and shall have no abrupt offsets.

e. Undercutting. The sawed faces of joints will be inspected for undercutting or washing of the concrete due to the early sawing, and sawing shall be delayed if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint.

****
NOTE: Installation of the final joint seal or sealant, if required, should be done after completion of the curing period. To minimize costs, it is always preferable that the sealing subcontractor be able to install all the seals or sealant at one time rather than to mobilize several times. Sealing as soon as practical is desirable so that continued construction operations don't damage or contaminate joints.
****

f. Joint Widening. After expiration of the curing period and no later than [_____] days, the upper portion of the groove shall be widened by sawing to the width and depth indicated to form a reservoir for the joint sealer.

g. Cleaning Joint. Immediately after initial and final sawing of the joint, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint.

h. Equipment. The sawing equipment shall be adequate in the number of units and the power to complete the sawing at the required rate. An ample supply of saw blades shall be available on the job before concrete placement is started, and at least one standby sawing unit in good working order shall be available at the jobsite at all times during the sawing operation.

3.6.6 Routing Cracks

Thirty to 45 days after placement of concrete, all cracks which have been opened to 3 mm 1/8 inch or more shall be routed to the dimensions shown. Routing shall be done minimizing spalling, using a vertical spindle type rotary router mounted on a rigid chassis so that the spindle will caster.

3.6.7 Sealing Joints and Cracks

Joints and cracks shall be sealed immediately following routing of cracks or sawing of joint reservoir or as soon thereafter as weather conditions permit. Joints and cracks shall be sealed as specified in Section 32 01 19 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS.

3.7 CURING AND PROTECTION

****
NOTE: Curing of RCC surfaces is difficult. It is not practical to moist cure surfaces where water runoff may effect adjacent construction operations. In most cases it is preferable that RCC surfaces be cured by a membrane curing compound. The relatively rough surface texture of RCC would requires a high dosage of curing compound (often double) to minimize voids in the membrane.
****

3.7.1 General

a. Concrete shall be continuously protected against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready for use before actual concrete placement begins. If any selected method of curing does not afford the proper curing and protection against concrete cracking, the damaged pavement shall be removed and replaced, and another method of curing shall be employed as directed.

b. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in paragraph: Membrane Curing. Any hand-operated sprayers allowed by paragraph: Membrane Curing shall be compressed air supplied by a mechanical air compressor. If the curing equipment fails to apply an even coating of compound at the specified rate, it shall immediately be replaced.

3.7.2 Membrane Curing

a. Timing. A uniform coating of white-pigmented, membrane-forming, curing compound shall be applied to the entire exposed surface of the concrete and the edge surfaces as soon as the free water has disappeared from the surface. Concrete shall not be allowed to dry before the application of the membrane. If any drying has occurred, the surface of the concrete shall be moistened with a fine spray of water, and the curing compound applied as soon as the free water disappears.

b. Coverage. The curing compound shall be applied to the finished surfaces by means of an approved automatic self-propelled spraying machine. The curing compound shall be applied with an overlapping

coverage that will give two-coat application coverage of 93 square m/L 400 square feet/gallon per coat, plus or minus 5.0 percent for each coat. A one-coat application may be applied provided a uniform overlapping application and coverage of 47 square m/L 200 square feet/gallon, plus or minus 5.0 percent is obtained.

c. Manual Application. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs and on concrete surfaces exposed by the removal of forms. When the application is made by hand-operated sprayers, a second coat shall be applied in a direction approximately at right angles to the direction of the first coat. If pinholes, abrasions, or other discontinuities exist, an additional coat shall be applied to the affected areas within 30 minutes.

d. Protection. Concrete surfaces to which membrane-curing compounds have been applied shall be adequately protected during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

e. Membrane Damage. Concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied shall be resprayed by the method and at the coverage specified above. Areas where the curing compound is damaged by subsequent construction operations within the curing period shall be immediately resprayed.

3.7.3 Burlap

Burlap covers shall consist of 2 or more layers of burlap having a combined weight of 4746 gm or more/sq m 14 ounces or more/square yard in a dry condition. Burlap shall be either new or shall have been used only for curing concrete. Burlap strips shall have a length after shrinkage of at least 305 mm 1 foot greater than necessary to cover the entire width and edges of the pavement. Mats shall overlap each other at least 150 mm 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 pavement area for the entire curing period.

3.7.4 Protection of Pavement

After final rolling of the pavement, no vehicular traffic, except for approved curing equipment having wheel loads not exceeding 2000 kg 4,500 pounds, shall be permitted on the RCC pavement 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 C171 shall be provided and kept readily available to cover pavement less than 12 hours old if rainfall occurs.

3.8 TREATMENT OF DEFECTIVE PAVEMENT

Defective pavements shall be removed and replaced unless the deficiency is subject to payment adjustments. RCC mixtures that are improperly proportioned or become contaminated are considered defective and shall be removed. Skin patching of an area that has been rolled will not be permitted. No additional payment will be made for the repair or removal and replacement of defective pavement. Except as noted below, the following defects will require complete removal and replacement[or pay adjustment. A defect greater than allowed for pay adjustment shall be

removed and replaced].

a. Reduced thickness of pavement.
b. Surface texture.
c. Smoothness.
d. Density.
e. Horizontal Alignment.

3.8.1 Pavement Removal and Replacement

Defective areas to be replaced shall be delineated by sawing full depth of the pavement around the perimeter of the defective area. The delineated area shall be removed for the full pavement depth of the course without damaging the adjacent pavement. Delineated areas shall have a length or width no less than 3 m 10 feet, and no adjacent slab or portion of a slab that remains in the pavement abutting the replacement area shall have a length or width less than 2.5 m 8 feet when measured from a joint or edge. The edge of the existing concrete shall form a clean, vertical face to pave against. Conventional concrete or RCC may be used at the Contractor's option to fill the void. The new slab shall conform to all requirements of smoothness, surface texture, density, thickness, and concrete quality, as stated herein. Longitudinal and transverse joints shall be established in the new slab in accordance with the original plans and shall be sealed, if required for the adjacent slab.

[3.8.2 Cracks in Pavement

Joint sawcutting shall be modified to prevent the repeated occurence of cracks. Pavement sections shall be removed and replaced when cracks exceed [_____] mm inch in width or when spaced closer than [_____] m feet.[Cracks determined to be repairable shall be repaired as specified.]

]3.8.3 Mix Proportion Variations

Variation in aggregate grading of pavement shall be subject to pay adjustment. Grading variations greater than allowed for pay adjustment shall be removed and replaced. Pavement sections shall be removed and replaced for variations in other mixture constituents beyond the specified tolerances.

3.8.4 Voids

Holes the full thickness of course shall be cut so that the sides are perpendicular and parallel to the jointing pattern and the edges are vertical.

3.8.5 Grade Variations

High spots indicated by the testing edge in excess of applicable tolerance shall be marked plainly and removed or reduced by rubbing with a Carborundum brick and water. Rubbing shall be discontinued as soon as contact with the coarse aggregate is made. If high spots cannot be removed in the above manner because of disturbing the coarse aggregate, the high portion of the pavement shall be corrected by an approved surface-grinding machine after the RCC is 14 days old or the defective pavement shall be removed and replaced. When grinding of 13 mm 1/2 inch or more would be required, the pavement shall be removed and replaced.

3.9 CONTRACTOR QUALITY CONTROL

****
NOTE: This submittal requires verification that the laboratory has passed COE laboratory validation. Such validation does not preclude specific facility and staff qualifications specified.
****

The Contractor is responsible for sampling and testing aggregates, cementitious materials, and RCC to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Furnish sampling platforms and belt templates to obtain representative samples of aggregates from charging belts at the concrete plant. Obtain samples of RCC at the point of delivery to the paver. Perform the inspection and tests described below, and based upon the results of these inspections and tests, take the action required and submit reports as required. Perform this testing regardless of any other testing performed by the Government, [either for pay adjustment purposes or for any other reason]. Submit a detailed plan of the proposed facility, equipment, procedures and qualifications at least [14] [_____] days prior to placement of the test section. Include:

a. Qualifications of Contractor CQC Staff
b. Laboratory accreditation documents and staff certifications
c. Equipment list and calibration certificates
d. Nuclear gage license and calibration curves.

3.9.1 Contractor Quality Control Staff

All Contractor Quality Control personnel assigned to concrete construction shall be American Concrete Institute (ACI) certified in the following grade (or shall have written evidence acceptable to the Contracting Officer of having completed similar qualification programs):

a. CQC personnel responsible for inspection of concrete paving operations: ACI Concrete Transportation Inspector.

b. Field Testing Technicians: ACI Concrete Field Testing Technician, Grade I.

c. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and Laboratory Testing Technician, Grade I or II.

3.9.2 Laboratory Accreditation

Laboratory and testing facilities shall be provided by and at the expense of the Contractor. The laboratories performing the tests shall be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation shall be current and shall include the required and optional test methods, as specified throughout this Section.

a. Aggregate Testing and Mix Proportioning: Aggregate testing and mixture proportioning studies shall be performed by a commercial laboratory.

b. Contractor Quality Control: All sampling and testing shall be performed by an approved, onsite, independent, commercial laboratory, or for cementitious materials and admixtures, the manufacturer's

laboratory.

c. Laboratory Inspection: The Government will inspect the laboratory equipment and test procedures prior to the start of concreting operations for conformance to ASTM C1077. The laboratory shall maintain these certifications for the duration of the project.

3.9.3 Reports

All results of tests conducted at the project site shall be reported on the same day tested and shall be delivered to the Contracting Officer. 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.

3.9.4 Lots and Sublots

****
NOTE: The lot size can be specified on the basis of time (i.e., 4 hours, 1 shift, etc.) or amount of production (i.e, 500 cu m (665 cu yd), 1000 cu m (1333 cu yd), etc.). If the lot size is based on the amount of production, it normally should be selected to be approximately equal to the amount of RCC expected to be produced in 1 shift of operation. The lot size should not exceed 1500 cu m (2000 cu yd) of RCC. When a lump sum contract is used, the lot size becomes the total job; thus, the percent payment is applied to the contract price. The following paragraphs will be edited accordingly.

Delete this paragraph if the project is small or control based on lots is not appropriate. Revise QC table where lots and sublots are identified.
****

Areas to be tested[and quantities for which payment is to be adjusted] will be based on pavement areas subdivided into lots and lots subdivided into sublots. A lot will be that quantity of construction that will be evaluated for compliance with specification requirements. A lot will be equal to [[375][_____] cu m [500][_____] cu yd] [[8][_____] hours production] [1 shift production]. Sublots are designated and defined for the specific parameter to be tested. Thickness, surface smoothness, and surface texture determinations will be made on the lot as a whole. In order to evaluate field density, each lot will be divided into 4 equal sublots. All samples and test locations will be selected randomly, using commonly recognized methods of assuring randomness conforming to ASTM D3665 and employing tables of random numbers or computer programs.

3.9.5 Additional Sampling and Testing

****
NOTE: Add bid items for requirements that may need additional testing.
****

The Contracting Officer will request additional samples and tests for any

area that appears to deviate from the specification requirements. The Contractor will pay for the cost of any additional testing if tests verify deficient material. If tests verify that materials conform to the specifications, payment will be made under the appropriate bid item. Testing in these areas will be in addition to the lot testing, and the requirements for these areas will be the same as those for a lot.

3.9.6 Testing and Evaluation

****
NOTE: In Table X modify testing items and frequency of testing to fit project specific conditions.
****

Based upon the results of these tests, take the action and submit reports as required in Table X, and any additional tests to ensure that the requirements of these specifications are met.

TABLE X - CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit/Corrective Action
CEMENTITIOUS MATERIALS SAMPLING		
1 Sample per 500 tons	none	2.2 kg (5 lb) samples to be collected, labeled, stored and delivered to the CO after completion of the project.
FINE AGGREGATE GRADATION AND FINENESS MODULUS		
1 500 tons of aggregate during production	ASTM C136 Sample at stock-pile.	Outside limits on any sieve: retest 2nd failure: stop, repair, retest
1 per sublot during RCC placement	ASTM C136 Sample at discharge belt from plant	Outside limits on any sieve: retest 2nd failure: stop, repair, retest
COARSE AGGREGATE GRADATION		
1 500 tons of aggregate during production	ASTM C136 Sample at stock-pile.	Outside limits on any sieve: retest 2nd failure: stop, repair, retest
1 per sublot during RCC placement	ASTM C136 Sample at discharge belt from plant	Outside limits on any sieve: retest 2nd failure: stop, repair, retest
AGGREGATE DELETERIOUS MATERIALS		
Initially and when visual change	See paragraph: AGGREGATES	Stop production, retest, replace aggregate. 2nd failure: stop, evaluate problem, notify CO for corrective action
AGGREGATE MOISTURE		
Daily	ASTM C566	Adjust plant settings accordingly
PLANT - SCALES, WEIGHING ACCURACY		
Initially then	NRMCA CPMB 100	Stop plant operations, repair, recalibrate standard test weights accurate to plus

TABLE X - CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit/Corrective Action
monthly		or minus 0.1% and provide for checking plant scales
PLANT - CALIBRATION OF BATCHING AND RECORDING EQUIPMENT		
Initially then every 10 shifts	Record/Report	Record required/recorded/actual batch mass,. Stop plant operations, repair recalibrate. See paragraph 3.11.1
PLANT - RECORD OF BATCH PLANT CONTROLS		
Every lot	Record/Report	Record type/amt of each material per lot
PLANT - MIXTURE UNIFORMITY - STATIONARY MIXER		
Every 4 months during paving	COE CRD-C 55 as modified	After initial approval, use abbreviated method. Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
NUCLEAR DENSITY GAGE RCC CALIBRATION		
Daily	Test block	Calculate calibration factor for placing period. Report change of more than 5% of previous value to CO and initiate gage evaluation
RCC MOISTURE DENSITY RELATIONSHIP		
Start of each lot	ASTM D1557 Sample taken at plant discharge	See paragraph 3.9.8
FIELD DENSITY AND FIELD MOISTURE		
Per 100 ft of paving lane and 100 of joint	ASTM C1040/C1040M, method A and ASTM D6938 at the placement within 30 minutes of mixing RCC	See paragraph 3.9.8
CONCRETE MIXTURE - TEMPERATURE		
When test specimens prepared	ASTM C1064/C1064M Sample at paving site	See par. 3.4
CONCRETE MIXTURE - STRENGTH		
8 per lot	ASTM C31/C31M Sample at paving site	See par. CONCRETE STRENGTH See par. 3.9.9
SURFACE SMOOTHNESS		
Continuous and within 1 hour of placement		Exceed tolerances: notify CO and modify operation. See paragraph 3.10.4
PAVEMENT TEXTURE		
1 core per sublot	3 point direct measurement	See paragraph 3.10.6
PAVEMENT THICKNESS		
1 core per sublot	3 point direct measurement	See paragraph 3.10.5

TABLE X - CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit/Corrective Action
PAVING - INSPECTION BEFORE PAVING		
Prior to each paving operation	Report	Inspect underlying material, construction joint faces, forms, reinforcing, dowels, and embedded items
PAVING - INSPECTION DURING PAVING		
During each paving operation		Monitor and control paving operation, including placement, consolidation, finishing, texturing, curing, and joint sawing. See paragraph 3.9.13
PAVING - ROLLER VIBRATION		
Weekly, during paving	Vibration meter	Test frequency and amplitude of each roller. Repair or replace defective rollers
MEMBRANE COMPOUND CURING		
Daily	Visual	Compute coverage based on quantity/area. Re-spray areas with defective coverage Re-calibrate equipment
INSPECTION OF HOT WEATHER MEASURES		
Once per	Visual	Repair defects, report conditions to CO
INSPECTION OF COLD WEATHER PROTECTION		
Once per	Visual	Repair defects, report conditions to CO

3.9.7 Calibration of Mixing Plant

The accuracy of proportioning for continuous plants 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.

3.9.8 Field Density Testing

****

NOTE: For record, nuclear density gauge readings of moisture content and density should be taken at 50 mm (2 inch) intervals to the thickness of the pavement minus 50 mm (2 inches), although the deepest reading only will be the basis for acceptance. The deepest readings of the nuclear density gauges of the Contractor and Government should be checked for agreement. The deepest reading should be approximately 50 mm (2 inches) less than the depth of the pavement slab.

****

a. Furnish one operable and properly calibrated single probe nuclear density gauge for each paver. Submit a copy of the State license authorizing the use of a nuclear gage, and manufacturer certification that operators have completed an approved safety and gage operation training session. For each gage to be used on site, provide the date of calibration, the calibrating organization, list of calibration

standards, and the calibration curve. The submittal shall include a description of the nuclear density gauge apparatus proposed for use, the manufacturer's literature and the latest manufacturer's calibration results of the nuclear density gauge.

b. The maximum wet density or "target density" shall be determined by ASTM D1557 using a 150 mm 6-inch mold.

c. The test shall be performed using a single probe nuclear density gauge operating in the direct transmission mode so density of the full depth of the pavement can be measured. Each test shall include readings at depths of [_____], [_____] and [_____] mm 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 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. All holes left in the concrete as a result of nuclear density testing shall be filled with a cement grout.

d. Additional tests shall be made as directed, particularly during start-up and when problems with attaining required density occur. The nuclear density gauge shall be made available for Government use upon request.

e. See Appendix A, at the end of this Section for sample density computations. If any nuclear density gauge reading is below 97.8 percent for interior or fresh joint or below 95.8 percent for a cold joint, another test shall be performed within a 1.5 to 2.4 m 5 to 8 foot 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 paver. 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 the operation of the paver, to rolling procedures, or other operations to assure that the specified density and surface requirements can be achieved.

3.9.9 Concrete Strength

Contractor Quality Control operations for concrete strength shall consist of the following steps: [Note: two methods specified: a) cylinders/beams correlated during mix design and only cylinders cast during production, and b) beams correlated during mix design for ages and beams cast during production.]

a. [Correlation of Beams and Cylinders in Laboratory, Cylinders in Field

1). Take samples for strength tests at the paving site. Fabricate and cure test cylinders in accordance with ASTM C31/C31M; test them in accordance with ASTM C39/C39M.

2). Fabricate and cure 2 test cylinders per sublot from the same batch or truckload and at the same time acceptance cylinders are fabricated and test them for compressive strength at 7-day age.

3). Average all 8 compressive tests per lot. Convert this average 7-day compressive strength per lot to equivalent [28][90]-day flexural strength using the Correlation Ratio determined during mixture proportioning studies. See Appendix B at the end of this Section.

****
NOTE: Adjust ages to match design requirement.
****

4). Compare the equivalent [28][90]-day flexural strength from the conversion to the Average Flexural Strength Required for Mixtures from paragraph of same title.

****
NOTE: Adjust ages to match design requirement.
****

5). If the equivalent average [28][90]-day strength for the lot is below the Average Flexural Strength Required for Mixtures by 138 Pa 20 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

6). Fabricate and cure two beams for every 1528 cubic m 2000 cubic yards of concrete placed. Fabricate and cure in accordance with ASTM C31/C31M; test at 14-days of age in accordance with ASTM C78/C78M.

****
NOTE: Adjust ages to match design requirement.
****

7) The Contractor's CQC testing agency shall maintain up-to-date control charts for strength, showing the 7-day CQC compressive strength, the 14-day compressive strength (from acceptance tests) and the [28][90]-day equivalent flexural strength of each of these for each lot.]

b. [Beams Only in Laboratory, Beams Only in Field

1). Take samples for strength tests at the paving site. Fabricate and cure test beams in accordance with ASTM C31/C31M; test them in accordance with ASTM C78/C78M.

2). Fabricate and cure 2 test beams per sublot from the same batch or truckload and at the same time acceptance beams are fabricated and test them for flexural strength at 7-day age.

3). Average all 8 flexural tests per lot. Convert this average 7-day flexural strength per lot to equivalent [28][90]-day flexural strength using the Correlation Ratio determined during mixture proportioning studies.

4). Compare the equivalent [28][90]-day flexural strength from the conversion to the Average Flexural Strength Required for Mixtures from paragraph of same title.

5). If the equivalent average [28][90]-day strength for the lot is

below the Average Flexural Strength Required for Mixtures by 69 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

6). The Contractor's CQC testing agency shall maintain up-to-date control charts for strength, showing the 7-day CQC flexural strength and the [28][90]-day flexural strength (from acceptance tests) of each of these for each lot.]

3.9.10 Surface-Smoothness Determination (Straightedge Testing)

a. Furnish one 3.7 m 12 ft straightedge for each paving spreader for testing the finished surface. Straightedges shall be made available for Government use upon request. 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 the pavement.

b. Immediately after rolling is complete in each area, but not later than 1 hour after the concrete has been placed, the surface of the pavement shall be tested with an approved straightedge or other approved device that will reveal all surface irregularities varying from the testing edge exceeding tolerances specified in Table V-LIMITS AND ALLOWABLE VARIATIONS. The entire area of the pavement involved shall be tested in both a longitudinal and a transverse direction on parallel lines 3 m 10 feet or less apart. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Straightedge lines shall be carried continuously across joints. Perform the testing in the presence of the Contracting Officer.

3.9.11 Surface Texture

The final surface texture of the pavement, after all rolling and curing, shall be smooth and uniform over the whole area of the pavement and shall be totally free of any surface pitting, voids or indentations, pockmarks, surface tears, check cracking, segregation or rock pockets, pumped areas, aggregate drag marks, areas loosened by construction operations, and areas where fines have been washed away during the curing process.

3.9.12 Determine Pavement Thickness

Cores shall be drilled from points in the pavement within 7 days after placement of the pavement. A minimum of one core per sublot will be taken from locations selected in a random fashion by the Contracting Officer. Cores shall be 150 mm 6 inch diameter. Refilling of core holes shall be performed with portland cement mortar, using materials and procedures directed. Cores will become the property of the Government and may be tested for strength determination or other properties as considered appropriate.

3.9.13 Inspection During Placing

The placing foremen shall supervise all placing operations and shall be responsible for measuring and recording concrete temperatures, 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 concrete 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 30 degrees C 85 degrees F, take and record the temperature of the concrete mixture at 30-minute intervals during hot-weather placement. The surface of the base course shall be inspected to ensure that it is sprinkled with water immediately before the concrete is placed and any deficiencies noted. Regardless of ambient temperature, the finished concrete shall be inspected to ensure 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. Immediate steps shall be taken to correct any deficiencies.

c. Temperature Protection. The Contracting Officer shall be notified whenever the concrete 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 concrete mixture exceeds 32 degrees C 90 degrees F, mixing and placing shall be stopped and the Contracting Officer notified.

d. Curing Operation. The curing operation shall be inspected to assure that the surface of the pavement is kept very moist (or wet) continuously until the end of the curing period. The Contracting Officer shall be notified when any pavement surface is allowed to dry before the end of the curing period, and immediate steps shall be taken to correct the situation.

3.10 APPENDIX A

APPENDIX A
Example of Computations

1.0 Field Density.
The calculation of computed percent payment based on field density is illustrated below for a typical set of field tests on the lane interior and on the fresh and cold joints in a typical lot. Assume the following test results for field density made on the lot:

a. Average lane interior density: 98.0 percent (of target density)

b. Average fresh joint density: 97.7 percent (of target density)

c. Average cold joint density: 95.4 percent (of target density)

d. Total area of lot: 2,790 sq m 30,000 sq ft (3,333 sq yd)

e. Length of completed fresh longitudinal construction joint: 610 m (2000 ft) (Paving lane on each side of joint complete)

f. Length of cold longitudinal construction joint: 228 m (750 ft) (Paving lane on one side of joint constructed with this lot)

Step 1: Determine percent payment based on lane interior density and on fresh joint and on cold joint density, using Table I.

a. Lane interior density of 98.0 percent: 95.0 percent payment

b. Fresh joint density of 97.7 percent: 72.0 percent payment

c. Cold joint density of 95.4 percent: 52.0 percent payment

Step 2: Determine percent payment deduction based on lane interior density and on both fresh and cold joint density by subtracting each percent payment from 100.

a. Lane interior: 100 percent - 95.0 percent = 5.0 percent deduction

b. Fresh joint: 100 percent - 72.0 percent = 28.0 percent deduction

c. Cold joint: 100 percent - 52.0 percent = 48.0 percent deduction

Step 3: Determine ratio of fresh joint strip area to lane interior area (total paved area in the lot).

Multiply the length of completed fresh longitudinal construction joint by the specified 3 m 10 ft width and divide by the lane interior area (total paved area in the lot):

610 m x 3m /2790 sq m 2000 ft. x 10 ft./30000 sq ft = 0.6667 ratio of fresh joint strip area to lane interior area

Step 4: Determine the weighted percent payment deduction for fresh joint density:

Multiply percent payment deduction for fresh joint density by ratio of fresh joint strip area to lane interior area:

APPENDIX A
Example of Computations

28.0 percent x 0.6667 = 18.7 percent weighted percent payment deduction for fresh joint density

Step 5: Determine ratio of cold joint strip area to lane interior area (total paved area in the lot):

Multiply the length of completed cold longitudinal construction joint (one side) by the specified 1.5 m 5 ft width and divide by the lane interior area (total paved area in the lot):

228 m x 1.5 m/2790 sq ft 750 ft x 5 ft/30000 sq ft = 0.125 ratio of cold joint strip area to lane interior area

Step 6: Determine the weighted percent deduction for cold joint density:

Multiply percent payment deduction for cold joint density by ratio of cold joint strip area to lane interior area:

48.0 percent x 0.125 = 6.0 percent payment deduction for cold joint density

Step 7: Compare weighted percent payment deduction for fresh joint area, for cold joint area, and for lane interior density, and select the larger:

a. Percent payment deduction for lane interior density: 5.0 percent

b. Weighted percent payment deduction for fresh joint density: 18.7 percent

c. Weighted percent payment deduction for cold joint density: 6.0 percent

d. Select the larger = 18.7 percent

Step 8: Determine computed percent payment based on field density by subtracting the larger value from Step 7 from 100:

100 - 18.7 percent = 81.3 percent computed percent payment based on field density.

2.0 Thickness
A lot in which 18 percent of the area is deficient in thickness by an average of 10 mm 3/8 inch (Category II) will have a computed percent payment for thickness of:

Category	Proportion of Total Lot Area		Percent Payment From Table II	Weighted Percent Payment
I	(1.0-0.18) = 0.82	x	100	82.0
II	0.18	x	65	11.7
				93.7

Computed Percent Payment for Total Lot = 93.7

3.11 Appendix B

APPENDIX B

Procedure for Molding RCC Test Specimen for Flexural Strength Testing Using a Vibrating Hammer:

A-1 Field of Application

The procedure is for molding RCC test specimens using a vibrating hammer for third-point flexural-strength testing. Maximum aggregate size shall not exceed 25 mm 1 inch.

A-2 Equipment

1. Rectangular steel molds with inside measurements of 100 x 100 x 400 mm 4-inch x 4-inch x 16-inch.

2. Vibrating hammer, conforming to ASTM C1435/C1435M, shall weigh 10 ± 2 kg, have a minimum power input of 900W and be capable of providing 2000 impacts/minute.

3. Removable steel collar to contain the last layer of RCC.
4. Steel compaction plate with a minimum thickness of 15 mm 0.6-inch that can fit into the rectangular mold.
5. Steel finishing plate with a minimum thickness of 15 mm 0.6-inch that can fit into the rectangular mold.

A-3 Molding Specimens for Flexural-Strength Testing

1. The specimens must be produced within 20 min of collecting the sample.
2. Using the wet density of the RCC, weigh a quantity of fresh concrete corresponding to the volume of the test specimen to be produced.
3. Use a flat shovel to fill the mold to the halfway point, moving the shovel along the rim of the mold to distribute the concrete evenly and keeping segregation to a minimum. A tamping rod can be used to spread the concrete evenly within the mold prior to consolidation.
4. Compact the concrete until the mold is half full. Install the collar. Put in the remaining concrete and compact it.
5. Remove the collar, place the steel plate on top of the mold, and complete consolidation by applying the compactor to the steel plate.
6. Spray all concrete surfaces with an evaporation retarder. Immediately cover the specimens with a nonabsorbent, nonreactive plate to retard evaporation.
7. Store the specimens on a rigid, level surface protected from sunlight, vibration, and other disturbances in an environment maintained at a temperature of 15 to 25°C 60 to 77°F. The specimens should be removed from the molds 24 ± 4 h after fabrication and moist-cured at a temperature of 21 to 25°C 70 to 77°F so that they are constantly covered with a thin coating of moisture until time of testing. The specimens shall not be exposed to running water.

A-4 Flexural-Strength Testing

Perform flexural testing in accordance with ASTM C78/C78M.

3.12 APPENDIX C

APPENDIX C
RCC Pavement Mixture Proportioning Method

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NOTE: TO DOWNLOAD UFGS GRAPHICS OF APPENDIX C

Go to http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf**.**

Appendix C exists as a PDF file to be inserted here after the project specification has been printed to pdf.

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-- End of Section --