UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2023
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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 13 13.17

ROLLER COMPACTED CONCRETE PAVING

11/20

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA **UFGS-32 13 13.17 (November 2020)**

Preparing Activity: USACE **Superseding**
UFGS-32 13 16.16 (November 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2023
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SECTION 32 13 13.17

ROLLER COMPACTED CONCRETE PAVING
11/20

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NOTE: This guide specification covers the requirements for roller compacted concrete (RCC) pavements for roads, streets, parking areas, repair yards, open-storage areas, and other utility grade pavements. For DOD projects, RCC cannot be used for airfield pavement unless approved by the USACE Transportation Systems Center or the appropriate DOD service.

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

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

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

PART 1 GENERAL

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NOTE: Use guidance found in Appendix D of UFC 3-250-04FA when preparing contract specifications for RCC pavement construction.

Insert name and location of project. Tailor specifications for the specific site conditions, available materials, design requirements and construction practices.

Attachment:
Appendix A - Example of Computations
Appendix B - Procedures For Molding RCC Test Specimens For Flexural Strength Testing Using a Vibrating Hammer
Appendix C - RCC Pavement Mixture Proportioning Method

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1.1 UNIT PRICES

1.1.1 Measurement Procedures

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NOTE: It is necessary for the Designer to 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.

****

1.1.1.1 Concrete Quantity

1.1.1.1.1 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 one 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.

1.1.1.1.2 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.

1.1.1.2 Cement Quantity

1.1.1.2.1 Measurement of Cement Quantity

The quantity of cement to be paid for will be the number of metric 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 1000 2000 and rounding off to the nearest tenth of a metric ton ton.

1.1.1.2.2 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.

1.1.1.3 Pozzolan Quantity

1.1.1.3.1 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 kilogram per 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.

1.1.1.3.2 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.

1.1.1.4 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.

****

1.1.1.4.1 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.

1.1.1.4.2 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.

1.1.1.5 Portland-Pozzolan Cement

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

1.1.1.5.1 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.

1.1.1.5.2 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.

1.1.1.6 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 includes 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, use a unit price of $200.00 per cubic meter yard for purposes of calculating the payment reduction.

1.1.2 Payment Adjustments

****

NOTE: If payment adjustment are not used, the specification will have to be edited to delete references to payment adjustments. 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.

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

****

1.1.2.1 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 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, comply with testing specified in paragraph: Contractor Quality Control. Complete and report all tests within 24 hours after completion of construction of each lot.

1.1.2.2 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, remove and replace that lot, or accept 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.

1.1.2.3 Density

1.1.2.3.1 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.

1.1.2.3.2 Target Density

Determine, for each lot, the laboratory maximum wet density of an RCC sample tested in accordance with ASTM D1557 based on a one-point wet density test 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, use the "target density" of the previous lot for quality control until the new "target density" is obtained.

1.1.2.3.3 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 1 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 1 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 deduction 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 1
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

1.1.2.4 Surface Smoothness

Use the straightedge method for longitudinal and transverse testing. Where drawings show required deviations from a plane surface (for example crowns, drainage inlets), finish the surface to meet the approval of the Contracting Officer. Record detailed notes of the results of the testing and furnish a copy to the Contracting Officer after each day's testing.

1.1.2.4.1 Smoothness Requirements

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NOTE: Smoothness requirements can be relaxed for RCC applications on roads design for tanks.
****

Straightedge Testing: Provide a finished surface of the pavement that has no abrupt change of 9.5 mm 3/8 inch or more, and a pavement that is within the limits specified hereinafter when checked with an approved 4 m 12 foot straightedge. Provide a pavement surface with variation from the specified straight edge not greater than 9.5 mm 3/8 inch in either the longitudinal or transverse direction.

1.1.2.4.2 Testing Method

After completion of the final rolling of a lot, test the entire surface of the pavement in each lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. If any pavement areas are ground, retest these areas immediately after diamond grinding. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Test the transverse lines 25 feet or less apart, as directed. Test the longitudinal lines at the centerline of each paving lane shown on the drawings, regardless of whether the contractor is allowed to pave two lanes at a time, and test at the 1/8th point in from each side of the lane. Test all other areas having obvious deviations. Test continuously across all joints in the longitudinal direction. For pilot lanes, carry testing in the transverse direction to the construction joint lines and for adjacent lanes carry the straightedge 610 mm24 inches across construction joints, and apply the readings in this area to the adjacent lane. Record the location and deviation from straightedge for all measurements.

1.1.2.4.3 Payment Adjustment for Smoothness

When between 5.0 and 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph "Smoothness Requirements" above, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When more than 10.0 percent and less than 15.0 percent of all measurements exceed the tolerance, the computed percent payment will be 90 percent. When between 15.0 and 20.0 percent of all measurements exceed the tolerance, the computed percent payment will be 75 percent. Remove and replace all pavement within the lot, at no additional cost to the Government, when 20.0 percent or more of the measurements exceed the tolerance.

1.1.2.5 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. Acquire all cores in accordance with ASTM C42/C42M and test in accordance with ASTM C174/C174M.

   (1) When the measurement of any core indicates that the pavement is deficient in thickness by 6 mm 1/4 inch or more, drill and test additional cores 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) Remove and replace any areas 13 mm 1/2 inch or more deficient in thickness, re-core and include 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 2 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. Use the full paving lane width and midway between cores having thicknesses, representing different categories, for calculating area of pavement and the percent payment calculations. Remove and replace any pavement area represented by cores with a deficiency in thickness of 13 mm 1/2 inch or more before any payment calculations are made. The area represented by the core is to 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 can be taken and 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 2
Percent Payment for Thickness

Percent Payment Category	Deficiency in Thickness Determined by Cores	Percent Payment or Action Required
I	0.0 - 6.30.00 to 0.24	100
II	6.4 - 12.00.25 to 0.49	65
III	12.7 or greater0.50 or greater	Remove and Replace

1.1.2.6 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 3.

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

Table 3 Percent Payment for Surface Texture	
Percent of Lot Area with Deficient Surface Texture	Percent Payment or 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

1.2 REFERENCES

****

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

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

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

****

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

AMERICAN CONCRETE INSTITUTE (ACI)

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

ACI 211.3R (2016) Guide for Selecting Proportions for No-Slump Concrete

ACI 327R (2014) Guide to Roller-Compacted Concrete Pavements

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M (2022) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C33/C33M (2018) Standard Specification for Concrete Aggregates

ASTM C39/C39M	(2021) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C42/C42M	(2020) Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C174/C174M	(2017) Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C192/C192M	(2019) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C294	(2012; R 2017) Standard Descriptive Nomenclature for Constituents of Concrete Aggregates
ASTM C295/C295M	(2019) Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	(2019) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494/C494M	(2019; E 2022) 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	(2021) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2022) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1040/C1040M	(2016) Standard Test Methods for In-Place Density of Unhardened and Hardened Concrete, Including Roller Compacted Concrete, by Nuclear Methods
ASTM C1064/C1064M	(2017) Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C1170/C1170M	(2020) Standard Test Method for Determining Consistency and Density of Roller-Compacted Concrete Using a Vibrating Table
ASTM C1260	(2021) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1435/C1435M	(2020) Standard Practice for Molding Roller-Compacted Concrete in Cylinder Molds Using a Vibrating Hammer
ASTM C1567	(2022) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM D1557	(2012; E 2015) 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; R 2017) Standard Practice for Random Sampling of Construction Materials
ASTM D6938	(2017a) 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 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 400	(1963) Requirements for Water for Use in Mixing or Curing Concrete

1.3 EQUIPMENT, TOOLS, AND MACHINES

1.3.1 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, joint sawing, sealing, and curing of roller-compacted concrete (RCC) pavement.

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.

1.4 QUALITY CONTROL

****
NOTE: Where they are available, specify only ACI certified personnel. Check the American Concrete Institute (ACI) website for local availability (www.concrete.org/Certification).
****

1.4.1 Contractor Quality Control Staff

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

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. USACE Laboratory accreditation documents and staff certifications

c. Equipment list and calibration certificates

d. Nuclear gage license and calibration curves

Provide Contractor Quality Control personnel, that are assigned to concrete construction, American Concrete Institute (ACI) certified in the following grade (or 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. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Concrete Flatwork Technician/Finisher.

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

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

1.4.2 Other Staff

Submit for approval, the qualifications and resumes for the following staff:

a. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious materials and tests identified in this specification. Resume with detail of education, training and experience related to the project-specific test methods and deleterious materials. Submit resumes at least 20 days before petrographic and deleterious materials examination is to commence.

b. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager certification at the Plant Manager level.

1.4.3 Laboratory Accreditation

Provide laboratory and testing facilities to support quality control which is accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260 and includes onsite temperature-controlled concrete curing facilities. Submit for approval a current accreditation which includes the required and optional test methods, as specified throughout this Section.

a. Provide aggregate testing and mixture proportioning studies performed by a commercial laboratory. Accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM C1077, including all applicable test procedures.

b. Acceptance Testing: Furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory. Utilize steel molds for molding the beam specimens. Furnish and maintain boxes or other facilities suitable for storing and curing the specimens at the site while in the mold within the temperature range stipulated by ASTM C31/C31M. Provide flexural loading equipment in accordance with ASTM C78/C78M.

c. Contractor Quality Control: Utilize only an approved, independent, commercial laboratory for sampling and testing, except for testing cementitious materials and admixtures, the manufacturer's laboratory

can be use.

d. Laboratory Inspection: The Contracting Officer or his/her representative will inspect the laboratory equipment and test procedures prior to the start of concreting operations for conformance to ASTM C1077. The laboratory certification is required for the duration of the project.

1.4.4 Allowable Tolerances

****
NOTE: Table 5 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 5. The table identifies specified limits and allowable tolerances from these limits.

Table 5
Limits and Allowable Variations

Parameter	Specified Limit	Allowable Variation	Exceeding Action
Grade	as shown on contract drawings	as shown on contract drawings	remove and replace
Alignment	as shown on contract drawings	Up to 13 mm1/2 inch variation	remove and replace (construction and transverse joints only)
Thickness	as shown on contract drawings	Plus or Minus 6 mm 1/4 inch	pay adjustment up to 13 mm1/2 inch otherwise remove and replace
Density	Per ASTM D1557	98.0 percent interior 96.0 percent at joints	remove and replace
Smoothness	checked with 4 m12 ft straightedge	Up to 10 percent of all measurements within specified limit	pay adjustment or remove and replace
Hardstands, parking areas, open store areas	Longitudinal and Transverse	9.5 mm3/8 inch	

Table 5 Limits and Allowable Variations			
Parameter	Specified Limit	Allowable Variation	Exceeding Action
Roads and Streets	Longitudinal Transverse	5 mm3/16 inch 6 mm1/4 inch	
Abrupt Offsets	Any Direction	3 mm1/8 inch	grind specified tolerance or remove and replace
Surface Texture	Conforming to designated test patch on test section	Up to 5 percent of area less than test patch surface textures	Pay adjustment or remove and replace
Strength	Specified Strength	Not more than 10 percent of strength results can be less than f'c	Remove and replace if more than 10 percent of test results is less than specified f'c

1.5 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a “G” to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

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

Choose the first bracketed item for Navy, Air Force

and NASA projects, or choose the second bracketed item for Army projects.
****

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

SD-01 Preconstruction Submittals

Batching and Mixing Plant

Transporting and Placing Methods

Test Section

Placement Schedule

Contractor Quality Control

SD-03 Product Data

Placing and Spreading; G, PO

Joints; G, AO

SD-05 Design Data

Mixture Proportioning Studies; G, DO

SD-06 Test Reports

Sampling and Testing; G, DO

SD-07 Certificates

Contractor Quality Control Staff; G, AO

Laboratory Accreditation; G, AO

Commercial Laboratory; G, DO

1.6 QUALITY ASSURANCE

1.6.1 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 DELIVERY, STORAGE, AND HANDLING

1.7.1 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. Provide Dual silos containing a clear air space between silo sidewalls to prevent cross contamination.
****

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

1.7.1.1 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 in adequately designed weather-tight trucks, conveyors, or other means that will completely protect the cementitious material from exposure to moisture.

1.7.1.2 Storage of Cementitious Materials

Immediately upon receipt at the site of the work, store cementitious materials in a dry and properly ventilated structure. Provide storage facilities to 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.

1.7.2 Aggregate Materials

1.7.2.1 Storage

Store aggregate at the site of the mixing plant, avoiding breakage, segregation, or contamination by foreign materials. Store each size of aggregate from each source separately in free-draining stockpiles. Provide free-draining storage for aggregate at least 24 hours immediately prior to use.

1.7.2.2 Handling

Handle aggregate preventing segregation or degradation. Keep vehicles used for stockpiling or moving aggregate clean of foreign materials.

PART 2 PRODUCTS

2.1 BATCHING AND MIXING PLANT

2.1.1 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.

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 Batching and Mixing Plant a minimum of 30 days in advance of RCC test section construction and prior to plant assembly. Locate the mixing plant onsite as indicated on the drawings. Include as a minimum the following:

a. Detailed layout of aggregate stockpiles and RCC batching equipment.

b. Equipment manufacturer's literature on the Batching and Mixing Plant prior to plan assembly including manufacturer's literature showing that the equipment meets all requirements specified herein and to include but not limited to:

(1) Cementitious material storage, handling, and controls

(2) Aggregate handling controls

(3) Water system controls

(4) Mixers and controls

(5) Re-screening systems

(6) Cooling systems

(7) Plant conveyors, bins, and feeders

(8) If truck mixers are used, a certified copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist and Calibration documentation on all measuring and weighing devices, submitted prior to uniformity testing.

2.1.2 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. Use a stationary-type plant having a twin-shift pug mill mixer and either weigh-batch type or continuous type with a minimum rated capacity of [230][_____] metric tons 250 tons per hour. Use a plant 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.

2.1.3 Cementitious Material Feed Unit

Use suitable equipment, incorporating either weighing or volumetric measurements, to separately batch or feed the required percentage of each cementitious material in the mixture within tolerances specified. Use silos and feeders 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. Provide provisions for readily sampling each cementitious material.

2.1.4 Aggregate Bins

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

2.1.5 Water Control Units

Provide satisfactory means, incorporating either weighing, metering, or volumetric measurements, to batch or feed the required quantity of water in the mixture within tolerances specified. Provide adjusting controls that are convenient to and capable of easy and accurate operation by the mixer operator. When metering controls the quantity of water, provide capability for a fixed quantity of water delivered through the meter to be readily checked by weight or volume. A water storage tank is required to prevent surge drawdown effect.

2.1.6 Batching or Feeding Tolerances

Provide batching or feeding to conform to the mixture proportions directed within the tolerances in Table 4. 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 4 Batching or Feeding Tolerances	
Material	Tolerance, percent
Each Cementitious Material	plus or minus 2.0
Water	plus or minus 3.0
Admixtures	zero to plus 4.0
Each Individual Aggregate Size Group	plus or minus 3.0
Total Aggregate	plus or minus 4.0

2.1.7 Additional Requirements for Batch-Type Mixing Plants

a. Plant Scales: Utilize plant scales conforming to requirements of NRMCA CPMB 100, with modifications as follows: Use plant scales for any weigh box or hopper that are of either beam or springless-dial type and sensitive to 0.5 percent of maximum load required. Beam-type scales having 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: Provide weigh box or hopper for aggregates that conform to requirements of NRMCA CPMB 100, with modifications as follows: 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 gate design on both the bins and the hoppers are required to prevent leakage of aggregate when closed. On manually or semi-automatically operated plants, provide an interlocking device to prevent opening more than one gate at a time. The interlocking device is not 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 are to conform to requirements of NRMCA CPMB 100, with modifications as follows: Provide weigh hoppers with 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. Suspend the hopper on dial or beam scales equipped with a pointer so the tare weight of the hopper is shown for each weighing; net weight of cementitious material is to be measured within 1 percent of the weight required.

d. Mixer Unit: Utilize a stationary mixer of the twin pug mill-type capable of producing a uniform mixture within tolerances specified for batch method mixer. Use a mixer with the following properties:

(1) 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.

(2) Control of mixing time capable of being set at intervals of not more than 5 seconds throughout cycles up to 3 minutes.

(3) A mechanical batch counter installed as part of the timing device and be designed to preclude register of dry batches or of any material run through during operation of pulling bins.

2.1.8 Additional Requirements for Continuous-Mixing Plants

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

a. Provide aggregate feed with the following properties for each bin:

(1) 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.

(2) Feed rate readily adjustable from the control panel to change aggregate proportions or to compensate for changes in moisture content.

(3) Feed rate controls automatically maintain the established proportions of aggregate when the combined aggregate delivery is increased or decreased.

(4) Combined aggregate belt feeding equipped with an approved belt scale that 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.

(5) Capability for storing, metering, and feeding blend material as a separate material when use of blending material is necessary.

b. Provide cementitious material control with the following properties:

(1) Approved system to separately meter the required amount of each cementitious material in the mix within the tolerance specified.

(2) Metering by readily adjustable vane feeders or other approved positive metering devices.

(3) Metering and feed 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.

(4) Control of the quantity of each cementitious material automatically linked to the aggregate belt scales.

(5) A provision so the amount of each cementitious material delivered can be readily sampled and checked by weight.

c. Provide a mixer unit with the following properties:

(1) Blades adjustable for angular position on shafts and reversible to retard flow of the mixture.

(2) 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. Provide a discharge hopper having a capacity of at least one metric ton ton equipped with dump gates to assure rapid and complete discharge without segregation.

2.2 MATERIAL SOURCES

Certified copies of laboratory test reports and sources for cement, supplementary cementitious materials (SCM), aggregates, admixtures, curing compound, epoxy, and proprietary patching materials proposed for use on this project. Perform all aggregate tests no earlier than 9 months prior to contract award.

2.2.1 Aggregate Sources

****

NOTE: The specification provides in Table 6, 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. Provide all aggregate for each nominal size group of aggregates from a single aggregate source and that meet specified quality requirements. Complete aggregate quality testing prior to performing mixture proportion studies.

2.2.2 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. Provide all portland cement for the project 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.

2.2.3 Aggregate Samples

Provide facilities for obtaining 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.

2.2.4 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. Provide all pozzolan for the project from a single source.

2.2.5 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. Provide all GGBFS for the project from a single source.

2.3 CEMENTITIOUS MATERIALS

2.3.1 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.

****

Provide portland cement conforming to ASTM C150/C150M, Type I or II. Use low alkali cement if the proposed aggregates are found to have greater than 0.04 percent expansion when tested in accordance with paragraph: Alkali-Silica Reactivity.

2.3.2 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.

****

Utilize fly ash conforming to the requirements of ASTM C618, Class F with a loss on ignition not exceeding 4 percent, including the optional requirements for drying shrinkage, uniformity, and effectiveness in controlling Alkali-Silica reaction. Use class F fly ash for use in mitigating Alkali-Silica Reactivity with a Calcium Oxide (CaO) content of less than 8 percent.

2.3.3 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.

****

Utilize portland-pozzolan cement conforming to the requirements of ASTM C595/C595M, Type IP.

2.3.4 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.

****

Utilize ground granulated blast furnace slag conforming to the requirements of ASTM C989/C989M, grade 100 or 120.

2.4 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.

2.5 CURING MATERIALS

a. Utilize impervious-Sheet materials conforming to ASTM C171. The type is optional.

b. Utilize membrane-forming curing compound conforming to ASTM C309, Type 2.

2.6 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 if used, provide fine aggregate and blending material having at least 90 percent by weight of aggregate passing the 4.75 mm No. 4 sieve.

2.6.1 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.

****

Provide crushed or uncrushed gravel, crushed stone, or a combination thereoffor coarse aggregate. Provide crushed gravel which contain not less than 60 percent by weight of crushed particles size having at least one freshly fractured face, in each sieve. Provide coarse aggregates that consist of clean, hard, uncoated particles meeting the specified requirements of ASTM C33/C33M and deleterious substances for Class 5S. Provide aggregate particles generally spherical or cubical in shape.

2.6.2 Fine Aggregate

2.6.2.1 General Requirements

Provide natural sand, manufactured sand, or a combination of the two meeting the requirements of TABLE 6 - QUALITY LIMITS FOR AGGREGATE for the fine aggregate. Where necessary to meet grading requirements, a fine blending material may be used. Provide aggregate particles generally spherical or cubical in shape and composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M.

2.6.2.2 Blending Material

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

****

NOTE: Edit Deleterious Table according to use of RCC pavement. Use ASTM C33/C33M limits for roads, streets, and open storage areas. Include test within brackets for airfield paving.

****

2.6.3 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 3.

****

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. Provide test results of each individual group and combination having a measured expansion less than 0.08 percent at 28 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 listed below. If any of the above options does not lower the expansion to less than 0.08 percent at 28 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. Any changes in aggregate sources or mix proportioning will require retesting of the aggregate(s)as stated above.

2.6.3.1 Class F Fly Ash 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 20 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 28 days after casting.

2.6.3.2 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 28 days.

2.6.4 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 mmNo. 4 to 0, 19 to 5 mm3/4-inch to No. 4, and 38 to 19 mm1.5 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.

****

Provide a combined aggregate consisting of a minimum of at least two nominal size groups of coarse and fine aggregate with blending material, if necessary, as previously described. Provide each nominal aggregate size group with a gradation such that the two or more materials can be combined in proportions that will produce a combined gradation within the specified limits. Batch separately each size group of aggregate and blending material and feed separately to the mixer. The specified grading limits are determined in a 2 part process:

a. Determining the initial combined aggregate grading

b. Determining the base grading limit

2.6.4.1 Initial Combined Aggregate Grading Limits

Combine nominal aggregate size groups to produce a uniform distribution of aggregate particles forming a smooth, well-graded curve. Provide a selected aggregate blend that falls within the limits specified in the Table 7 - Initial Combined Aggregate Grading Limits. Utilize sSieve analysis of fine and coarse aggregates in accordance with (ASTM C136/C136M, ASTM C117) to develop the Contractor's selected aggregate blend and initial grading.

Table 7
Initial Combined Aggregate Grading Limits

Sieve Size	Cumulative Percent Passing (by weight)
25 mm1 inch	100
19 mm3/4 inch	85-100
12.5 mm1/2 inch	70-95
9.5 mm3/8 inch	55-85
4.75 mmNo. 4	40-65
2.36 mmNo. 8	30-55
1.18 mmNo. 16	20-45
0.600 mmNo. 30	15-35
0.300 mmNo. 50	10-25
0.150 mmNo. 100	5-15
0.075 mmNo. 200	2-10

2.6.4.2 Base Aggregate Grading Limits

After testing is completed and the aggregate blend meeting the initial combined aggregate grading shown in Table 7 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 is established. Utilize the base grading limit for each

nominal aggregate size group, including any necessary blending material, in the mix proportioning study with tolerances shown in Table 8 applied to each individual sieve size. The base grading limit for each aggregate size group is used for acceptance of aggregates entering the mixer.

Table 8
Grading Limits for Each Aggregate Sieve Size

Sieves	Tolerance, plus or minus Percentage Points
12.5 mm, 9.5 mm1/2 inch, 3/8 inch	5
2.36 mm, 1.18 mm, 0.600 mmNo. 8, No. 16, No. 30	4
25 mm, 19 mm, 4.75 mm, 0.300 mm1 inch, 3/4 inch, No. 50, No. 4	3
0.150 mm, 0.075 mmNo. 100, No. 200	2

2.7 ADMIXTURES

If used, provide water-reducing and retarding admixtures in accordance with ASTM C494/C494M, Type B or D.

2.8 EQUIPMENT

2.8.1 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.
****

Provide heavy-duty, track-equipped paver machines of the self-propelled type, similar to laydown machines (pavers) used for asphalt concrete or soil-cement construction. Provide pavers that are:

a. Equipped with hoppers, distributing screws, vibrating screed and have 2 tamping bars, adjustable screeds capable of being operated both manually and automatically, and equalizing devices.

b. Equipped with dual tamping bars and high density vibrating screeds capable of placing the RCC mix to at least 90 percent of the required density and 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 place the concrete to the required thickness, free from segregation.

d. Equipped with interchangeable side forms (shoes) which form the edge

of the pavement lane from vertically to 15 degrees from vertical.

e. Designed to operate forward at variable speeds and in reverse.

2.8.2 Paver Control

Provide a paver with automatic control of 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 by Contracting Officer. Electronic radar sensing devices may be used as screed control provided the base layer immediately below the RCC layer has been mechanically trimmed using stringlines or laser control devices. Upon final compaction and approval of the base layer, no vehicles or construction equipment are to be placed upon the area to receive RCC.

2.8.3 Compaction Equipment

2.8.3.1 Vibratory Rollers

Provide vibratory rollers that are self-propelled, double-drum, steel-wheeled. Light, walk behind, plate type or similar sized vibratory rollers will be allowed to compact the RCC. 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. Use at least one self-propelled vibratory roller, in good operating condition and meeting these requirements, full time for each paver used full time. Adjust, modify, or replace any rollers that pick up material from the surface of the pavement. Provide vibratory roller having 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.

2.8.3.2 Rubber-Tired Roller

Provide rubber-tired roller having 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.

2.8.3.3 Finish Roller

Utilize a smooth-wheeled tandem roller with a weight of 5 to 9 metric tons tons. The vibratory roller may be used without vibration as a finish roller to remove surface blemishes. Utilize a finish roller with the steel wheel coated with neoprene rubber.

2.8.4 Straightedge

Provide one 3.6 meter 12 foot straightedge for each paving spreader for testing the finished surface. Make straightedges available for Government use upon request. Utilize straightedges constructed of aluminum or other lightweight metal and having blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy; and handles to facilitate movement on the pavement.

2.8.5 Nuclear Density Gauge

Furnish one operable and properly calibrated nuclear density gauge for each paver conforming to ASTM C1040/C1040M, Method A, and be of a single-probe type. Make the nuclear density gauge available for Government use upon request.

2.8.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound with the following features and configuration:

a. Be mobile, self-propelled, and pneumatically wheeled.

b. The curing compound reservoir equipped with constantly mechanically (not air) agitation during operation and a 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 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.

2.9 SAWING EQUIPMENT

****

NOTE: Retain bracketed sentence as necessary to correlate with paragraph Removal of Existing Pavement Slab. Otherwise delete. Also delete wheel

saw option on Navy projects.
****

Provide equipment for sawing joints and for other similar sawing with the following features and configuration:

a. Standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment.

b. Diamond tipped blades. If demonstrated to operate properly, abrasive blades may be used.

c. Provide spares as required to maintain the required sawing rate.

d. Wheel saws with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which produce a saw kerf at least 38 mm 1-1/2 inch wide to be used in the removal of concrete.

e. Saws capable of sawing to the full depth required.

f. Early-entry saws may be used, subject to demonstration and approval of the Contracting Officer. The initial sawcut depth can not be changed.

2.10 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

****
NOTE: Designer to fill in blanks as appropriate. Specified strength is based on flexural strength used in the structural design of the pavement or a correlation of cylinders to beams should be used. The flexural strength range for RCC is typically in the range of 450 psi to 600 psi2.7 to 4.2 MPa at 90 days of age. Designer to ensure that this strength is attainable with the available aggregates. Specify strength at 90 days. Alternate strength ages may be modified to 28 or 56 days. Consult the Transportation Systems Center for more guidance. Edit this and succeeding paragraphs to ensure the strength age is the same.
****

2.10.1 Specified Flexural Strength

****
NOTE: Use the Tailoring Option "Beams", or "Cylinders/Beams", to specify flexural strength for concrete. Use "Splitting Tensile" if specifying strength by cylinders only. 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.

****

Specified flexural strength, R, for RCC is 3.8 MPa 550 psi at 28 days as determined by equivalent flexural strength, as specified in paragraph: Mixture Proportioning for Flexural Strength. Maximum allowable water-binder(cementitious material) ratio is 0.45. The water-binder (cementitious material) ratio will be the equivalent water-cement ratio as determined by conversion from the volume ratio of water to cement plus SCM by the absolute volume equivalency method described in ACI 211.1. ACI 211.1can be supplemented with ACI 211.3R or ACI 327R.

2.10.2 Concrete Strength for Final Acceptance

****

NOTE: Use the Tailoring Option "Beams", or "Cylinders/Beams", to specify flexural strength for concrete. Use "Splitting Tensile" if specifying strength by cylinders only.

****

The strength of the concrete will be considered acceptable when the equivalent 28 day flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day flexural strength tests specified in paragraph: Mixture Proportioning for Flexural Strength, The strength of the concrete will be considered acceptable when the average equivalent 28-day flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day compressive strength tests specified in paragraph: Mixture Proportioning for Flexural Strength and no individual set (2 specimens per sublot) in the lot are 170 kPa 25 psi or more below the equivalent 'Specified Flexural Strength'. Remove and replace any lot or sublot, respectively, that fails to meet the above criteria at no additional cost to the Government.

2.11 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.

****

At least 45 days in advance of RCC test section construction and prior to plant assembly. Include:

a. Laboratory report on mixture design studies following proportioning method as outlined in Appendix C.

b. Source information on all proposed RCC mix materials.

c. Laboratory report of coarse and fine aggregate quality tests including individual and combined gradations and ASR testing.

d. Certified test results for chemical admixtures.

e. Mill certificates for portland cement and supplemental cementitious materials.

f. Individual beam and cylinder strength data results.

g. Compressive strength summaries and plots

h. Correlation ratios for acceptance testing and CQC testing,28 day strength test results.

The Contractor is responsible for all activities leading to development of the 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.

2.12 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.

****

Provide RCC composed of portland cement, water, and fine and coarse aggregates, including any necessary fine blending material. Pozzolans may be used in the RCC composition. The cementitious materials used may be portland cement in combination with a pozzolan or, at the Contractor's option, cementitious material may be portland-pozzolan cement or 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. Government approval in writing is required to use any othere admixtures demonstrated to be beneficialand used in the mixture proportioning studies. All materials used in the mixture proportioning studies are to be representative of those proposed for use on the project.

2.13 Criteria for Mixture Proportions

Proportion the RCC mixture based on the following criteria:

a. Provide a RCC mixture with workability appropriate for the paving machine to achieve the required density, thickness, smoothness, grade, and finish texture.

b. The strength of the concrete will be considered acceptable when the equivalent 28 day flexural strengths for each lot are above the 'Specified Flexural Strength' as determined by correlation with 14-day flexural strength tests specified in paragraph: Mixture Proportioning for Flexural Strength,

c. Minimize the volume of Portland cement.

d. The mixture may contain pozzolan at a minimum replacement of 20 percentof the volume of cementitious materials.

e. The mixture may contain granulated ground blast furnace slag.

2.14 Mixture Proportioning for Flexural Strength

****

NOTE: The first Tailoring Option, "Beams", includes items a through j; the second option "Cylinders/Beams" includes the second listing of items 1 through 10.

****

Select the total mixture proportions using the procedure detailed in Appendix C at the end of this Section. Determine Compressive and flexural strength performance for each trial mixture by testing 3 nominal 150 by 300 mm 6 by 12-inch cylinders and 3 nominal 150 by 500 mm 6 by 6 by 20-inch beams each at 7, 14, 28, days.

a. Strength: Proportion a minimum of three trial mixes at approximately 2 percent above and below the cementitious material content initially selected to meet the target project design flexural strength.

b. Workability: Adjust the paste volume for each of the trial mixes to produce workability approximately 10 seconds higher and 10 seconds lower than the target workability level. Base the subsequent moisture variations on observed performance during compaction of specimens.

c. Pozzolan: If pozzolan is used, proportion two additional 2 trial mixes during the trial mix design study to establish the effects of the pozzolan addition. Using the cementitious material content selected to meet the target project flexural design, proportion two additional mixes varying the percentage of pozzolan by plus 5 percent and minus 5 percent from the selected proportioning. Replacement is calculated 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.

2.14.1 Concrete Strength

a. Fabricate all beams and cylinders for each mixture from the same batch or blend of batches. Fabricate beams in accordance to Appendix B and cure all beams and cylinders in accordance with ASTM C192/C192M, using 152 x 152 mm 6 x 6 inch steel beam forms and 152 x 305 mm 6 x 12 inch single-use cylinder forms.

b. Cure test beams from each mixture for 7, 14, and 28 day flexural tests; 3 beams to be tested per age.

c. Cure test cylinders from each mixture for 7, 14, and 28 day compressive strength tests; 3 cylinders to be tested per age.

d. Test beams in accordance with ASTM C78/C78M, cylinders in accordance with ASTM C39/C39M.

e. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

(1) 7-day flexural strength
(2) 14-day flexural strength
(3) 28-day flexural strength

(4) 7-day compressive strength
(5) 14-day compressive strength
(6) 28-day compressive strength

f. From these graphs select a w/c that will produce a mixture giving a 28 day flexural strength equal to the required strength determined in accordance with paragraph "Average CQC Flexural Strength Required for Mixtures".

g. Using the above selected w/c, select from the graphs the expected 7, 14, and 28 day flexural strengths and the expected 7, 14, and 28 day compressive strengths for the mixture.

h. From the above expected strengths for the selected mixture determine the following Correlation Ratios:

(1) Ratio of the 14-day compressive strength of the selected mixture to the 28 day flexural strength of the mixture (for acceptance).

(2) Ratio of the 7-day compressive strength of the selected mixture to the 28 day flexural strength of the mixture (for CQC control).

i. If there is a change in materials, make additional mixture design studies using the new materials and determine a new correlation ratios.

j. Obtain Contracting Officer approval of the mixture proportions prior to placement of any concrete pavement. Provide a water-binder (cementitious materials) ratio for approval that does not exceed the maximum value specified in paragraph: "Specified Flexural Strength" and do not increase ratio without the Contracting Officer's written approval.

a. Fabricate all beams for each mixture from the same batch or blend of batches. Fabricate and cure all beams in accordance with

ASTM C192/C192M, using 152 x 152 mm 6 x 6 inch steel beam forms.

b. Cure test beams from each mixture for 7, 14, and 28 day flexural tests; 4 beams to be tested per age.

c. Test beams in accordance with ASTM C78/C78M.

d. Using the average strength for each w/c at each age, plot all results from each of the three mixtures on separate graphs for w/c versus:

(1) 7-day flexural strength
(2) 14-day flexural strength
(3) 28-day flexural strength

e. From these graphs select a w/c that will produce a mixture giving a 28 day flexural strength equal to the required strength determined in accordance with paragraph "Average CQC Flexural Strength Required for Mixtures".

f. Using the above selected w/c, select from the graphs the expected 7, 14, and 28 day flexural strengths.

g. From the above expected strengths for the selected mixture, determine the Ratio of the 7-day flexural strength of the selected mixture to the 28 day flexural strength of the mixture (for CQC control).

h. From the above expected strengths for the selected mixture, determine the Ratio of the 14-day flexural strength of the selected mixture to the 28 day flexural strength of the mixture (for acceptance).

i. If there is a change in materials, provide additional mixture design studies made using the new materials and determine a new Correlation Ratios.

j. Obtain Contracting Officer approval of the Contractor's mixture proportions prior to placement of any concrete pavement. Provide an approved water-cementitious materials ratio that does not exceed the maximum value specified in paragraph: "Specified Flexural Strength" and do not increase ratio without the Contracting Officer's written approval.

PART 3 EXECUTION

3.1 PRE-PLACEMENT ACTIONS

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

3.1.1 Test Strips

Place as many test strips as necessary to adjust contractor's RCC mixture to allow evaluation of the placing characteristics and texture of the mixture and to make necessary adjustments prior to placing the test section. The test strips may be in the vicinity of the onsite plant or off site. The Contracting Officer or his Representative is to be notified 7 days in advance of the start of the test strip placement and is required be present to observe equipment and the placement process. Construct the strips one paver width wide and 9-12 m a minimum of 60 feet in length. Perform Removal of the onsite strips in coordination with the Contracting

Officer or his representative at no additional cost to the Government.

3.1.2 Test Section

****

NOTE: For non-critical 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 test section should demonstrate ALL the required elements specified and should be done after calibration of the mixing plant.

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.

****

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 a minimum include:

a. Cold and hot weather protection methods

b. Paving sequence

c. Joint pattern

d. Curing equipment

e. Smoothness testing methods

f. Density measurement equipment and procedures

g. Diamond grinding equipment and procedures

At least 10 days but not more than 30 days prior to construction of the pavement, construct a test section near the job site at the location designated on the contract plans. Notify the Contracting Officer at least 5 days in advance of the date of test section construction. Place the test section in portions as directed by the Government. Remove all test sections unacceptable to the Contracting Officer at the Contractor's expense.

a. Timing: Two separate days are to 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. Prior to placing the test section, complete the uniformity testing and calibrate the mixing plant.

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

(1) Be no less than two adjacent paving lanes each 30 m 100 feet long

(2) Be the designated thickness and number of lifts

(3) Use the same lane width proposed for use in the project

(4) Include at least one cold transverse joint.

(5) 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

(6) Initial saw cutting and saw cutting for joint reservoir widening and joint sealant installation

(7) 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 six 150 mm6-inch diameter coresfull depth, from points selected in the test section by the Contracting Officer 5 days after completion of the test section. Obtain cores in accordance with

ASTM C42/C42M. Perform a visual examination of the cores for consolidation. Use the RCC cores to define the effected pavement limits for cores showing signs of large air voids other then normal entrapped air voids, a layer of paste greater then 6 mm1/4 inch at the top of the core, rock pockets or aggregate segregation. Remove and replace pavements within these defined limits as stated above at no additional cost to the Government. Test compressive strength of the cores in accordance to ASTM C39/C39M at 7, 14, and 28 days of age.

f. Acceptance: The acceptability of the test section is determined by 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 if outside the paving limits after completion of the test section evaluations and with the approval of the Contracting Officer. Submit all test results in report form and obtain the Contracting Officer approval, prior to starting full production.

3.1.3 Subgrade Preparation

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

Condition all previously constructed material underlying the RCC pavement as specified in Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASE] [SELECT-MATERIAL] [FOR FLEXIBLE PAVING]. Correct all deficiencies in the underlying material prior to placing RCC concrete on a cleaned and moistened surface, as directed. The Contracting Officer will inspect and approve the surface of the underlying material prior to placing RCC pavement.

3.1.4 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. Establish and control the finished pavement gradelines and elevations shown at the site of work in accordance with bench mark elevations shown on the contract drawings. Finish the surface of the underlying material to the necessary grade such that when the required thickness of RCC is placed, the pavement surface will meet the indicated grade. Construct the finished and completed RCC pavement 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.
****

Provide initial submittal 30 days in advance of the test section construction. A resubmittal is to be done after completion of a successful test section at least 10 days in advance to the RCC Pavement full production placement.

a. Provide 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

b. Instructions on adjustment 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.

Haul concrete from the mixer to the placing site in dump trucks. Dump the trucks directly into the hopper of the paver or into an approved secondary material distribution system which deposits material into the paver hopper. Do not dump RCC directly onto the prepared subgrade or adjacent areas. 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. Hauling over freshly placed concrete will not be permitted. Remove RCC not meeting these specifications from the placement area and disposed of at a location designated by the Contracting Officer.

3.3 BATCHING AND MIXING

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

3.3.1 Mixing

Convey the aggregates, cementitious materials, water, and admixtures to the mixer in proportions, as required. In batch mixing,dry-mixed at least 15 seconds the aggregates and cementitious materials charged into the mixer.
Add water and continue mixing as required to obtain a homogeneous mixture. Adjust the paddles of the pug mill, as necessary, to provide the required mixing time and to provide a thorough mixing. Maintain the shaft speed of the pug mill at the speed recommended by the manufacturer. Maintain the RCC mixture below the tips of the paddles of the pug mill mixer when paddles are in vertical position. Maintain the mixer and mixer paddle surfaces free of hardened concrete and other contamination.

Replace mixer paddles when the dimensions are worn down more than 10 percent from new paddles of the same type and manufacture. Keep new paddles 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, control the total water content of the mix as necessary to meet all requirements stated herein. Vary the water content at frequent intervals, as necessary and as considered appropriate, because of placing and compacting operations. In general, base water content on:

a. The action of the vibratory roller on the freshly placed concrete

b. The field density test results attained in the pavement

c. The texture of the RCC surface being produced

3.3.3 Mixture Uniformity Testing

Perform mixture uniformity testing, prior to the production and placement of any RCC, to evaluate the batching and mixing process. Use the same RCC mix proportions, materials,and mixing equipment for testing as proposed for use on the project. Perform all mixture uniformity testing in accordance with COE CRD-C 55 as modified herein and paragraph CONTRACTOR QUALITY CONTROL.

3.3.3.1 Mixer Regular Uniformity Testing

a. Perform regular uniformity testing on three separate samples or batches representing 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, use at least 75 seconds for 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.

c. Batch RCC that meets the limits of the five uniformity requirements listed in Table 9 below. For regular testing, perform all five tests on each of three batches of concrete. The range for determining acceptability is the range of test results for each of the three samples representing the single batch. The range for regular testing is the average of the ranges of the three batches. If more than one

mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers may apply to the others, subject to the approval of the Contracting Officer.

3.3.3.2 Abbreviated Uniformity Testing

When abbreviated testing is performed, batch the concrete to meet only those requirements in Table 9 listed for abbreviated testing. Use the same concrete proportions for uniformity tests that are to be used on the project. Perform five required tests on a single batch of concrete for abbreviated testing. The range for abbreviated testing is equal to the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers can apply to the others, subject to the approval of the Contracting Officer. Perform all mixer performance (uniformity) testing in accordance with COE CRD-C 55 and with paragraph titled TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL.

Table 9
Uniformity Requirements - Stationary Mixers

Parameter	Regular Test - Allowable Maximum Range for Average of 3 Batches	Abbreviated Test - Allowable Maximum Range for 1 Batch
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 m1.5 lbs/ft	16 kg/cubic m1.0 lbs/ft
Consistency (Test - ASTM C1170/C1170M	3.0 sec	3.0 sec

3.4 PLACING AND SPREADING

3.4.1 Placing

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

a. Placement Schedule: Schedule of paving operations, at least 15 days prior to start of paving unless otherwise specified.

b. Timing: Place mixture as nearly continuous as possible, with an absolute minimum of stops and starts; control speed of placing to permit proper rolling. Control the timing of placement so that all RCC mixture isplaced and rolled within the time limit specified in paragraph COMPACTION. Except as specified below, for certain extremely small odd-shaped isolated areas, place and spread all concrete with the paver.

c. Charging: Do not allow the level of concrete in the paver hopper to

approach empty between loads. Maintain concrete mix above the auger shaft during paving.

****

NOTE: If the total pavement thickness is greater than 250 mm10 inches, use the first statement in brackets regarding lift thickness; otherwise, the second statement should be used.

****

d. Setup: Adjust the paver and the speed to prevent segregation, to meet the surface requirements, and to produce a depth that, when compacted, the surface will conform to cross section, grade, and contour indicated. Do not place a layer of RCC in excess of 250 mm 10 inches or less than 100 mm 4 inches in compacted thickness.

e. Edges: Construct each edge of each lane with a sloped face of 15 degrees from vertical configuration, as directed. Utilize an edge shoe constructed so that it is within 19 mm 3/4 inch of the compacted base surface.

f. Lanes: Place mixture 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 by COR 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 is considered a "cold joint" and treatment as specified herein for cold joints isto be provided. Limit the time elapse between placement of lifts to 60 minutes on multi-lift 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. Where practical, place each lane of such length that the succeeding lane can be placed without the use of a cold joint.

g. Joints: Utilize pavers 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 is to be constructed as a cold joint. Utilize a separate paver for placement of each lift of pavement in multi-lift construction. Obtain COR approval for the length of a lane that is to be followed by another lane.Decrease or increase this length of lane as required by air temperatures, wind, and other climatic conditions existing at the time of placement. Construct longitudinal joints and edges to true line markings. Establish lines parallel to the centerline of an area to be paved.

h. Control of Water: Discontinue placing concreteduring rain except for light mists that do not cause intermixing of cement and water slurry on the surface.Place concrete 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

Complete fresh longitudinal construction joints between separate lanes of concrete pavement within the time limitations in the paragraph PLACING AND SPREADING. Treat other longitudinal joints as "cold joints." Construct joints to assure continuous bond between old and new sections of pavement. Utilize extra passes of the vibratory roller and other

compaction and hand finishing 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, locate the screed of the paver to overlap the previously placed lane 25 to 50 mm 1 to 2 inches and tobe sufficiently high so that compaction will produce a smooth, dense joint, without offset. Remove any excess concrete, placed on the edge of the previously placed lane by the paver, by carefully using a lute by hand to push back concrete 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, remove and waste the excess concrete by approved methods.

3.4.4 Handwork

Correct any paving operations that require significant handwork, other than as specified above, before restarting. Broadcasting or fanning of concrete mixture over areas being compacted will not be permitted. Suspend spreading operation, when segregation occurs in the concrete during placement, until the cause is determined and corrected. Remove segregated coarse aggregate from the surface prior to compaction. Correct irregularities in alignment of the pavement left by the mechanical spreader by hand trimming directly behind the spreader before rolling. Distortion of pavement during edge trimming arenot permitted.

3.4.5 Placing Odd-Shaped Areas

In isolated instances involving very small, odd-shaped areas where use of machine spreading is impractical, spread concrete by hand. Spread concrete in a manner to prevent segregation. Spread mixture 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

Discontinue placement when the air temperature reaches 5 degrees C 40 degrees F and is falling and do not resume until the air temperature reaches 2 degrees C 35 degrees F and is rising. Do not place RCC on any surface containing frost or frozen material. Make provisions to protect the concrete from freezing during the specified curing period. Heat mixing water and/or aggregates , 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 are to be as approved by COR. Utilize aggregates free of ice, snow, and frozen lumps before entering the mixer. Provide coverings and other means 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. Remove and replace concrete damaged by freezing as directed.

3.4.7 Placing During Hot Weather

Take the following precautions, during periods of hot weather when the maximum daily air temperature is likely to exceed 30 degrees C 85 degrees F:

a. Utilize a 45 minute maximum period between placing succeeding lifts or lanes.

b. Sprinkle the underlying material 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, to ensure the concrete when placed is less than degrees 32C 90 F.

d. Apply a waterfog or mist, not streams of water to the finished surfaces of the newly laid pavement to keep damp, with approved spraying equipment until the pavement is covered by the curing medium.

When the Contracting Officer determines heat or wind to be excessive, immediately take additional measures, as necessary, to protect the concrete surface. Construct wind screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective, immediately stop paving operations 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. Do not operate rollers in the vibratory mode when not moving. Vary the frequency and amplitude of vibration, as needed or directed, within the range specified. Keep the surfaces of roller drums and wheels clean at all times.

3.5.1 Timing

Begin rolling within 10 minutes of spreading and, except for fresh joints, complete rolling within 45 minutes of start of mixing, except during hot or dry weather conditions. In hot or dry weather, begin rolling within 5 minutes of spreading and, except for joints, complete rolling within 30 minutes of start of mixing. Delays in rolling freshly laid mixture will not be permitted.

3.5.2 Initial Rolling

Initial rolling consist of vibratory passes of the vibratory roller. This requirement for vibratory rolling is not to be relaxed. Initial static passes may be necessary before the vibratory rolling to "set" the pavement surface before vibratory compaction is started. Count a round trip over the same material 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, conduct preliminary tests and examination of density, crown, grade, smoothness, and surface texture under the supervision of the Contracting Officer. Correct deficiencies before rolling is continued, so that the finished surface will conform to requirements for grade, surface texture, and smoothness specified herein. Make further smoothness checks as directed by the Contracting Officer.

3.5.4 Vibratory Rolling and Testing

Continue rolling 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. Perform nuclear density testing in accordance with paragraph CONTRACTOR QUALITY CONTROL.

3.5.5 Final Rolling

Stop rolling with a steel wheeled vibratory roller whenthe specified density is attained . All additional rolling beyond the vibratory passes required to produce the specified field density are at the Contractor's expense. As soon as rolling with the vibratory roller is complete, provide at least two additional passes of a rubber-tired roller with tire pressure and loading per wheel at the midpoint of the range previously specified, unless otherwise directed. Follow these passes by 2 complete passes of the finish roller with a neoprene coated steel wheel.

3.5.6 Operation of Rollers and Tampers

Adjust the speed of rollers to be slow enough to avoid displacement of the concrete but not more than 2.5 km/hr 1.5 mph. Immediately correct any displacement of concrete resulting from reversing direction of roller or from any other cause. Vary slightly in length alternate passes of roller and overlap sufficiently to provide full coverage over the surface. Utilize additional rollers if pavement density specified is not attained and/or if paving operations are getting ahead of rolling. Do not alter paving operations to accommodate a lack of rollers. Thoroughly compacted places inaccessible to large vibratory rollers with walk-behind rollers and hand-tampers to the required density, using multiple thin lifts, as necessary. Take additional field density tests for hand-tampered areas to check for required density.

3.5.7 Rolling Pattern

a. Commence rolling at the outer edge of the lane, followed by the other edge, and then the center. On subsequent adjacent lanes, begin rolling at the outer edge. Extend rolling of the first pass along each edge 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 is to go no closer than the 450 mm 18 inches 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, roll the outer 450 mm 18 inches 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, roll the uncompacted joint area after the center of the lane. Provide additional passes of the vibratory roller and rubber-tired roller to this joint area, as necessary, to produce the specified compaction in the joint area.

e. Utilize approved hand-finishing operations, as necessary to produce a tight surface at the joint, meeting the specified surface tolerances in Table 3. Utilize a consistent rolling pattern throughout production.

3.6 JOINTS

Provide a detailed plan of the proposed paving pattern showing all planned construction, contraction and expansion joints. Place all longitudinal and transverse construction joints on a 30 foot grid that are perpendicular to the finished layout of the pavement. The joint area is considered the RCC material within 305 mm12 inches of the joint. Construct joints to:

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 is to be trimmed by sawing the edge of the hardened concrete with a power concrete saw, not earlier than 24 hours age.

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

b. Make the sawcut the full depth of the pavement to produce a face within 15 degrees of vertical, free of all loose or uncompacted material.

c. Carefully remove the outer portion to prevent any damage to the sawed face. Resaw edge if damage occurs.

d. If necessary, utilize additional rolling 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, operate the roller to pass over the end of the freshly placed concrete.

b. Cut the tapered end of the strip, with a power concrete saw to full depth of the lift and the excess material removed.

c. In continuing placement of the strip, position the paver on the transverse joint so that sufficient fresh concrete will be spread to obtain a joint which will conform to required full-depth density and smoothness specified, after rolling. When necessary, hand finish the fresh mixture at the joints and provide additional rolling to assure that specified full-depth density and surface finish is attained.

3.6.3 Joints in Multi-lift 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. Place the top layer so that longitudinal joints in that layer will coincide with joints in the lower layers of the pavement.

b. Place the transverse joints in the top layer to coincide with transverse joints in the lower layers of the pavement.

3.6.4 Slip Joints

Construct slip joints between roller-compacted and conventional concrete where no expansion joint is required and as shown on the contract drawings. For either RCC or PCC, coat the edge of the initial placement 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, sawcut the RCC full depth at the joint line and remove excess RCC material. Prepare the joint for sealing as described below. Provide a full depth expansion joint, in lieu of a slip joint, for any mismatched joints or three sided joint. Utilize a thickened edge type joint for the pcc side.

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 (30 to 70 ft) spacing. Saw joints for hardstands, streets, and roads. Sawing of transverse joints on tank trails may be deleted. Delete this paragraph if all 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.

****

a. Saw transverse contraction joints at 12 m 30 foot spacing or as otherwise indicated. Saw longitudinal construction joints between lanes to form a reservoir for joint sealant in the same manner as specified below.

****

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. Accomplish initial joint sawing where indicated by using a 3 mm 1/8 inch blade to the depth indicated. Vary the time of sawing depending on existing and anticipated weather conditions and to prevent uncontrolled cracking of the pavement. Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit sawing the concrete without chipping, spalling, or tearing. Conduct sawing operations as requiredduring both day and night regardless of weather conditions. If water-curing is required, discontinue only in small areas to facilitate sawing.

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

d. Spacing and Alignment. Saw all joints at the required spacing consecutively in the sequence of the concrete placement. Use a chalk-line or other suitable guide to mark the alignment of the joint. Do not vary the saw cut more than 13 mm 1 inch from the true joint alignment from edge to edge of the pavement area, and do not have abrupt offsets.

e. Undercutting. Inspect the sawed faces of joints for undercutting or washing of the concrete due to the early sawing, and delay sawing 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 21 days, widen the joint by sawing the upper portion of the groove 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, thoroughly flushed the saw cut and adjacent concrete surface with water until all waste from sawing is removed from the joint. Upon sawing the initial sawcut, install a temporary seal in the joint until the end of the curing period.

h. Equipment. Provide sawing equipment that is adequate in the number of units and the power to complete the sawing at the required rate. Provide, at the job site, an ample supply of saw blades before concrete placement is started, and at least one standby sawing unit in good working order during the sawing operation.

3.6.6 Routing Cracks

Thirty to 45 days after placement of concrete, route all random cracks which have been opened to 3 mm 1/8 inch or more and seal as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT. Immediately after routing, clean and seal all random cracks. Accomplish routing with a vertical spindle type rotary router mounted on a rigid chassis so that the spindle will caster to minimizing spalling.

3.6.7 Sealing Joints

Seal construction and contraction joints as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT.

3.7 CURING AND PROTECTION

****

NOTE: 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.

****

3.7.1 General

a. Continuously protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Have all equipment needed for adequate curing and protection of the concrete 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, remove and replace the damaged pavement , and implement another method of curing as directed.

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

3.7.2 Membrane Curing

a. Timing. Apply a uniform coating of white-pigmented, membrane-forming, curing compound to the entire exposed surface of the concrete and the edge surfaces as soon as the free water has disappeared from the surface. Do not allow the concrete to dry before the application of the membrane. If any drying has occurred, moisten the surface of the concrete with a fine spray of water, and apply the curing compound as soon as the free water disappears.

b. Coverage. Apply the curing compound to the finished surfaces by means of an approved automatic self-propelled spraying machine. Apply the curing compound 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 squarem/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, apply a second coat in a direction approximately at right angles to the direction of the first coat. If pinholes, abrasions, or other discontinuities exist, apply an additional coat to the affected areas within 30 minutes.

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

e. Membrane Damage. Resprayed by the method and at the coverage specified above, any concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied or any areas where the curing compound is damaged by subsequent construction operations within the curing period.

3.7.3 Burlap

Utilize burlap covers 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. Utilize burlapthat is either new or used exclusively for curing concrete. Apply burlap strips having a length after shrinkage of at least 305 mm 1 foot greater than necessary to cover the entire width and edges of the pavement. Overlay mats at least 150 mm 6 inches. Before placing mats thoroughly wet and keep mats 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 or equipment is permitted until the end of the curing period, except for approved curing equipment having wheel loads not exceeding 2000 kg 4,500 pounds Maintain a supply of plastic sheeting meeting the requirements of ASTM C171 and keep readily available to cover pavement less than 12 hours old if rainfall

occurs.

3.8 TREATMENT OF DEFECTIVE PAVEMENT

Remove and replace defective pavements unless the deficiency is subject to payment adjustments. RCC mixtures that are improperly proportioned or become contaminated are considered defective pavements. Skin patching of an area that has been rolled are not 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. Remove and replace any defects greater than allowed for pay adjustment.

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

3.8.1 Pavement Removal and Replacement

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

3.8.2 Mix Proportion Variations

Variation in aggregate grading of of mix proportioning are subject to pay adjustment. Remove and replace pavement sections where grading variations are greater than allowed for pay adjustment orvariations in other mixture constituents beyond the specified tolerances.

3.8.3 Grade Variations

Mark and remove high spots indicated by the testing straight edge in excess of applicable tolerance or reduced by rubbing with a carborundum brick and water. Discontinue rubbing 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, corrected by an approved surface-grinding machine after the RCC is 14 days old or remove and replace the defective pavement. When grinding of 13 mm 1/2 inch or more would be required, remove and replace the pavement.

3.9 CONTRACTOR QUALITY CONTROL

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.

3.9.1 Laboratory Accreditation

Provide laboratory and testing facilities at the expense of the Contractor. Utilize laboratories that are accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. The accreditation are to be current and include the required and optional test methods, as specified throughout this Section.

a. Aggregate Testing and Mix Proportioning: Utilize a commercial laboratory for aggregate testing and mixture proportioning studies

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

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. Maintain any certifications at the laboratory for the duration of the project.

3.9.2 Reports

Report all results of tests conducted at the project site on the same day tested and deliver to the Contracting Officer. These requirements do not relieve the Contractor of the obligation to report certain failures immediately as required in preceding paragraphs. Confirmed in writing in the routine reports, such reports of failure and the action taken. The Contracting Officer has the right to examine all Contractor quality control records at any time.

3.9.3 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 m10hours 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.

3.9.4 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.

3.9.5 Testing and Evaluation

****
NOTE: In Table 10 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 10, and any additional tests to ensure that the requirements of these specifications are met.

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Cementitious Materials Sampling			
1 Sample per 500 metric tons tons	None	none	2.2 kg5 lbs samples to be collected labeled, stored and delivered to the Contracting Officer after completion of the project
Fine Aggregate Gradation and Fineness Modulus			

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
1 sample every 500 metric tons tons of aggregate during production	ASTM C136/C136M sample stockpile	Outside limits on any sieve	Retest
		2nd failure	report to COR, stop, repair, retest
1 per sublot during RCC placement	ASTM C136/C136M sample discharge belt from plant	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, stop, repair, retest
Coarse Aggregate Gradation			
1 sample every 500 metric tons tons of aggregate during production	ASTM C136/C136M sample stockpile	Outside limits on any sieve	Retest
		2nd failure	report to COR, stop, repair, retest
1 per sublot during RCC placement	ASTM C136/C136M sample discharge belt from plant	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, stop, repair, retest
Aggregate Deleterious and Quality			
First test no later than time of uniformity testing and then every [30][60] days of RCC production	see paragraph AGGREGATES		Stop production, retest, replace aggregate. Increase testing interval to 90 days if previous 2 tests pass
Aggregate Moisture			
Daily	ASTM C566		Stop, adjust plant settings accordingly
Plant - Scales, Weighing Accuracy			
Monthly	NRMCA CPMB 100		Stop plant ops, repair, recalibrate standard test weights accurate to plus or minus 0.1 percent and provide for checking plant scales
Plant - Calibration of Batching and Recording Equipment			

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
Weekly	Record/Report	Record required/recorded/actual batch mass	Stop plant ops, repair, recalibrate. See paragraph 3.11.1
Plant - Record of Batch Plant Controls			
Every lot	Record/Report		Record type and amount of each material per lot
Plant - Mixer Uniformity - Stationary Mixers			
Every 4 months during paving	COE CRD-C 55	After initial approval, use abbreviated method	Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
RCC Moisture Density Relationship			
Start of each lot	ASTM D1557	Sample taken at plant discharge	See paragraph 3.9.8
Nuclear Density Gage RCC Calibration			
Daily	Test Block	Calculate calibration factor for placing period	Report change of more than 4 percent of previous value to Contracting Officer and initiate gage evaluation
Field Density and Field Moisture			
Per 100ft of paving lane and 100ft 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 point of discharge within the paving lane	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			

TABLE 10
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

Frequency	Test Method	Control Limit	Corrective Action
8 per lot	ASTM C39/C39M sample at point of discharge within the paving lane	See paragraph CONCRETE STRENGTH TESTING for CQC Perform fabrication of strength specimens and initial cure outside the paving lane and within 300 m 1,000 feet of the sampling point.	
Surface Smoothness			
Continuous and within 1 hour of placement		Exceed tolerances	Notify Contracting Officer and modify operation. See paragraph 3.10.4
Pavement Texture			
Each lot			See paragraph 3.10.6
Pavement Thickness			
1 core per sublot	ASTM C174/C174M		See paragraph 3.10.5
Paving - Inspection Before Paving			
Prior to each paving operation	Report	Inspect underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items	
Paving - Inspection During Paving			
During paving operation	Report	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	Calculate coverage based on quantity/area	Respray areas where coverage defective. Recalibrate equipment
Inspection of Hot Weather Measures			

TABLE 10 CONTRACTOR TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Once per day	Visual		Repair defects, report conditions to Contracting Officer
Inspection of Cold Weather Protection			
Once per day	Visual		Repair defects, report conditions to Contracting Officer

3.9.6 Calibration of Mixing Plant

Check the accuracy of proportioning for continuous plants 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.

3.9.7 Field Density Testing

****

NOTE: For record, nuclear density gauge readings of moisture content and density should be taken at 50 mm 2 inchintervals to the thickness of the pavement minus 50 mm2 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 mm2 inches less than the depth of the pavement slab.

****

a. Furnish one operable and properly calibrated single probe nuclear density gauge meeting the requirements of ASTM C1040/C1040M 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. 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 in the submittal.

b. Determined the maximum wet density or "target density" by ASTM D1557 using a 150 mm 6-inch mold.

c. Perform the density test 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. Include test readings at a depth of 2" above the bottom of the lift being placed mm Report both wet and dry densities, and all individual readings. Determined moisture content at the same depths. Report wet field density as a percentage of the "Target Density" maximum laboratory wet density as determined for that lot. Fill all holes left in the concrete as a result of nuclear density testing with a commercially available pre-packaged nonshrink grout that meets the requirements of ASTM C1107/C1107M.

d. Take additional tests as directed, particularly during start-up and when problems with attaining required density occur. Upon request, provide a nuclear density gauge for Government use.

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, perform another test 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, immediately notified the Contracting Officer, and apply additional vibratory roller passes 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, discontinue the paving operation 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.

3.9.8 Concrete Strength

Contractor Quality Control is responsible for the following steps for concrete strength determination:

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

(1) Take samples for strength tests at the paving site. Fabricate test cylinders in accordance to ASTM C1435/C1435M 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 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 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 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.

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

(6) The Contractor's CQC testing agency is responsible for maintaining 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 day equivalent flexural strength of each of these for each lot.

3.9.9 Surface-Smoothness Determination (Straightedge Testing)

a. Furnish one 3.7 m 12 ft straightedge for each paving spreader for testing the finished surface. Provide straightedges for Government's representative use upon request. Provide straightedges constructed of aluminum or other lightweight metal and blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Provide straightedges with handles to facilitate movement on the pavement.

b. Test the surface of the pavement with an approved straightedge immediately after rolling is complete in each area, but not later than 1 hour after the concrete has been placed or test with other approved device that will reveal all surface irregularities varying from the testing edge exceeding tolerances specified in Table 5-LIMITS AND ALLOWABLE VARIATIONS. Test the entire area of the pavement involved in both a longitudinal and a transverse direction on parallel lines 3 m 10 feet or less apart. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Carry straightedge testing continuously across joints. Perform the testing in the presence of the Contracting Officer.

3.9.10 Surface Texture

After all rolling and curing is complete, provide a smooth and uniform final surface texture over the whole area of the pavement. Provide a final surface that is 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.

3.9.11 Determine Pavement Thickness

Drill 150 mm 6 inch diameter cores 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. After the first 2 lots and the thickness of all cores meet the required specified thickness and examination of the cores show good consolidation with appropriate orientation of aggregates and there are no excessive voids 102 mm4 inch diameter cores may be used. Refill core holes with a commercially available pre-packaged nonshrink grout meeting the requirements of ASTM C1107/C1107M. Cores will become the property of the Government and may be tested for strength determination or other properties as considered appropriate.

3.9.12 Inspection During Placing

The placing foremen is responsible for supervising all placing operations and 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, inspect all areas subject to cold-weather protection. Record all deficiencies. During removal of protection, measure the concrete and ambient temperatures 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. Inspect the surface of the base course to ensure that it is sprinkled with water immediately before the concrete is placed and any deficiencies noted. Regardless of ambient temperature, inspect the finished concrete 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. Correct any deficiencies immediately.

c. Temperature Protection. Notify the Contracting Officer whenever the concrete temperature is not within specifications limits during the period of protection or protection removal fails to comply with the specifications requirements, and take immediate steps to correct the situation. Regardless of the ambient temperature, stop mixing and placing operations, and notify the Contracting Officer when the temperature of the concrete mixture exceeds 32 degrees C 90 degrees F.

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

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 1.

a. Lane interior density of 98.0 percent: 100.0 percent payment

b. Fresh joint density of 97.7 percent: 98.2 percent payment

c. Cold joint density of 95.4 percent: 86.5 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 - 100.0 percent = 0.0 percent deduction

b. Fresh joint: 100 percent - 98.2 percent = 1.8 percent deduction

c. Cold joint: 100 percent - 86.5 percent = 13.5 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:

1.8 percent x 0.6667 = 1.2 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:

13.5 percent x 0.125 = 1.7 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: 0.0 percent

b. Weighted percent payment deduction for fresh joint density: 1.2 percent

c. Weighted percent payment deduction for cold joint density: 1.7 percent

d. Select the larger = 1.7 percent

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

100 - 1.7 percent = 98.3 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 2	Weighted Percent Payment
I	(1.0-0.18) = 0.82	x	100	82.0
II	0.18	x	65	11.7
			Computed Percent Payment for Total Lot =	93.7

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. Utilize a maximum aggregate size of not to exceed 25 mm 1 inch.

A-2 Equipment

1. Rectangular steel molds with inside measurements of 100 x 100 x 400 mm 6-inch x 6-inch x 16-inch.

2. Utilize a vibrating hammer, conforming to ASTM C1435/C1435M, having a 10 ± 2 kg weight, having a minimum power input of 900W and being 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. Produce specimens 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. Do not expose specimens to running water.

A-4 Flexural-Strength Testing

Perform flexural testing in accordance with ASTM C78/C78M.

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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