Preparing Activity: USACE New

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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CONCRETE PAVING FOR SMALL AIRFIELD PROJECTS
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NOTE: This guide specification covers the requirements for construction of exterior concrete pavement for airfield projects with less than 750 cubic meters 1,000 cubic yards. Do not divide projects into small construction phases so this spec can be used. This specification is not permitted for high risk areas such as aircraft arresting systems, compass calibration pads, and fixed-wing short takeoff and vertical landing (STOVL) facilities.

For all situations where this specification will be used consult with the using agency's subject matter experts regarding its applicability. Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC) for approval.

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 must be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

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NOTE: In preparing contract specifications for concrete pavement, the designer will use UFC 3-250-04 STANDARD PRACTICE FOR CONCRETE PAVEMENTS for guidance. State highway specifications are not permitted. All airfield concrete pavements will use the UFGS without exception.

Specifications developed for Corps of Engineers managed projects must be edited in accordance with ER 1110-34-1 Engineering and Design Transportation Systems Mandatory Center of Expertise (Section 11, 12, App A, B, C).

Contact the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC) for guidance on interpreting and editing this specification section.

This specification section is structured for Contractor sampling and testing of materials and mixture proportioning. If Government sampling, testing and mixture proportioning is required, contact the TSMCX, AFCEC pavement SME, or NAVFAC for specification language.

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[1.1 UNIT PRICES

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NOTE: Delete unit price paragraphs when the work is covered by a lump-sum contract price.

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1.1.1 Measurements

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including thickened edges [monolithic curb], where required, placed in the completed and accepted pavement. Concrete will be measured in place in the completed and accepted pavement only within the neat line 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, or electrical conduits, nor for any void, or other structure extending into or through the pavement slab, measuring 0.1 cubic meter 3 cubic feet or less in volume. No other allowance for concrete will be made unless placed in specified locations in accordance with the approved contract modification. The quantity of other materials specified herein, and used in the construction of the work covered by this section, will not be measured for payment, but will be considered a subsidiary obligation, covered under the price per cubic meter yard for concrete. Joint sealing materials are covered in [Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT] [Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].

1.1.2 Payments

1.1.2.1 Unit Price

The quantity of concrete measured as specified above will be paid for at the contract unit price when placed in completed and accepted pavements. Payment will be made at the contract price for cubic meter yard for the scheduled item, with necessary adjustments as specified below. Payment will constitute full compensation for providing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement, except for other items specified herein for separate payment.

]1.2 REFERENCES

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

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

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

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

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

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 201.1R	(2008) Guide for Conducting a Visual Inspection of Concrete in Service
ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 214R	(2011) Evaluation of Strength Test Results of Concrete

ACI 305R	(2020) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
ACI 309R	(2005) Guide for Consolidation of Concrete
ACI 325.14R	(2017) Guide for Design and Proportioning of Concrete Mixtures for Pavements

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2019) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A185/A185M	(2007) Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
ASTM A615/A615M	(2022) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2022) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078/A1078M	(2019) Standard Specification for Epoxy-Coated Steel Dowels in Concrete Pavement
ASTM C29/C29M	(2017a) Standard Test Method for Bulk Density ("Unit Weight") and Voids in Aggregate
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 C78/C78M	(2022) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	(2018) Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94/C94M	(2022a) Standard Specification for

	Ready-Mixed Concrete
ASTM C114	(2022) Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123/C123M	(2014) Standard Test Method for Lightweight Particles in Aggregate
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C138/C138M	(2017a) Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142/C142M	(2017) Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed 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 C231/C231M	(2022) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM 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 C494/C494M	(2019; E 2022) Standard Specification for

	Chemical Admixtures for Concrete
ASTM C595/C595M	(2021) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2023; E 2023) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685/C685M	(2017) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989/C989M	(2022) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017/C1017M	(2013; E 2015) Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064/C1064M	(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 C1240	(2020) Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	(2021) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2022) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2022) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1646/C1646M	(2016) Making and Curing Test Specimens for Evaluating Frost Resistance of Coarse Aggregate in Air-Entrained Concrete by Rapid Freezing and Thawing
ASTM C1895	(2020) Standard Test Method for Determination of Mohs Scratch Hardness

ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1751	(2018) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
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 D4791	(2019) Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA QC 3	(2015) Quality Control Manual: Section 3, Plant Certifications Checklist: Certification of Ready Mixed Concrete Production Facilities

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 521	(1981) Standard Test Method for Frequency and Amplitude of Vibrators for Concrete

U.S. DEPARTMENT OF DEFENSE (DOD)

TSPWG M 3-250-04.97-05	(2019) Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

1.3 SUBMITTALS

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

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, 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.
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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][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

Proposed Techniques; G[, [_____]]

SD-03 Product Data

Diamond Grinding Plan; G[, [_____]]

Dowels; G[, [_____]]

Dowel Bar Assemblies; G[, [_____]]

Equipment

SD-05 Design Data

Preliminary Proposed Proportioning; G, DOProportioning Studies; G, DO

SD-06 Test Reports

Mixer Performance (Uniformity) Testing; G[, [_____]]

Batch Tickets

Contractor Quality Control Reports

Sampling and Testing; G[, [_____]]

Diamond Grinding of PCC Surfaces; G[, [_____]]

Repair Recommendations Plan; G[, [_____]]

SD-07 Certificates

Contractor Quality Control Staff; G[, [_____]]

Laboratory Accreditation[and Validation]

NRMCA Certificate of Conformance

Petrographer Resume; G[, [_____]]

Licensed Surveyor

Concrete Batch Plant Operator

1.4 QUALITY CONTROL

1.4.1 Contractor Quality Control (CQC) Staff

Reference Section 01 45 00 QUALITY CONTROL for general CQC personnel qualification requirements. Submit the Contractor Quality Control Staff for approval. Provide American Concrete Institute certificates of CQC staff in addition to the qualifications and resumes of the petrographer, surveyor, concrete batch plant operator, and CQC System Manager. All Contractor Quality Control personnel assigned to concrete construction are required to be American Concrete Institute (ACI) certified in the following grade:

a. Identify an individual within the onsite work organization as the Concrete Paving CQC Manager, who is responsible for overall management of concrete paving CQC and has the authority to act in all concrete paving CQC matters including authority to stop concrete paving work which is out of compliance.

   The minimum requirements for the Concrete Paving CQC Manager consist of 8 years airfield concrete paving experience similar to work required under this contract with a minimum of 3 years in a concrete paving CQC role. The Concrete Paving CQC Manager is a separate person, and is in addition to the CQC System Manager identified in Section 01 45 00 QUALITY CONTROL.

b. CQC staff is required to oversee all aspects of sawing operations (sawing, flushing, vacuuming, checking for random cracking, lighting).

c. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Advanced Concrete Flatwork Finisher.

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

e. Laboratory Testing Technicians: ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician, Level 1 or 2.

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. Detail the education, training and experience related to the project-specific test methods and deleterious materials in the Petrographer Resume and submit at least 20 days before petrographic and deleterious materials examination is to commence.

b. Licensed Surveyor: Perform all survey work under the supervision of a Licensed Surveyor.

c. Concrete Batch Plant Operator: National Ready Mix Concrete Association (NRMCA) Plant Manager certification.

1.4.3 Preconstruction Testing of Materials

All sampling and testing is required to be performed by an approved commercial laboratory. For cementitious materials and chemical admixtures use a laboratory maintained by the manufacturer of the material. Materials are not allowed to be used until notice of acceptance has been given. Additional payment or extension of time is not allowed due to failure of any material to meet project requirements.

1.4.3.1 Aggregates

Sample aggregates in the presence of a Government Representative. Obtain samples in accordance with ASTM D75/D75M that are representative of the materials to be used for the project. Perform all aggregate tests no earlier than one year prior to initial submission of the proportioning studies submittal.

1.4.3.2 Chemical Admixtures, Curing Compounds, and Epoxies

Submit certified copies of test results of admixtures, curing compounds, and epoxies that are going to be used on the project at least 30 days before the material is used. Provide test results less than 5 years old prior to use in the work. Reject if the test results do not meet the Level 2 proof of compliance requirements of ASTM C494/C494M.

1.4.3.3 Cementitious Materials

Cement, slag cement, and pozzolan will be accepted on the basis of manufacturer's certification of compliance, accompanied by mill test reports showing that the material in each shipment meets the requirements of the referenced test standard under which it is provided. Provide mill test reports no more than 6 months old prior to use in the work. Do not use cementitious materials until notice of acceptance has been given. Cementitious materials may be subjected to testing by the Government from samples obtained at the mill, at transfer points, or at the project site. If tests prove that a cementitious material that has been delivered is unsatisfactory, promptly remove it from the project site.

1.4.4 Acceptability of Work

The materials and the pavement itself will be accepted on the basis of production testing. The Government may make check tests to validate the results of the production testing. If the results of the production testing vary by less than 2.0 percent of the Government's test results, the results of the production testing will be used. If the results of the Government and production tests vary by 2.0 percent, but less than 4.0 percent, the average of the two will be considered the value to be used. If these vary by 4.0 percent or more, carefully evaluate each sampling and testing procedure and obtain another series of Government and production tests on duplicate samples of material. If these vary by 4.0 percent or more, use the results of the tests made by the Government and the Government will continue check testing of this item on a continuous basis until the two sets of tests agree within less than 4.0 percent on a regular basis. Testing performed by the Government does not relieve the specified testing requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Bulk Cementitious Materials

Provide all cementitious materials in bulk at a temperature, as delivered to storage at the site, not exceeding 65 degrees C 150 degrees F. Provide sufficient cementitious materials in storage to sustain continuous operation of the concrete mixing plant while the pavement is being placed. Provide separate facilities to prevent any intermixing during unloading, transporting, storing, and handling of each type of cementitious material.

1.5.2 Aggregate Materials

Store aggregate at the site of the batching and mixing plant avoiding breakage, segregation, intermixing or contamination by foreign materials. Store each size of aggregate from each source separately and allow the fine aggregate and the smallest size coarse aggregate to drain. Provide a minimum 0.6 m 24 inch thick sacrificial layer left undisturbed for each aggregate stored on ground or provide a hard surface course beneath the stockpiles. Maintain sufficient aggregate at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed. Do not allow tracked equipment on coarse aggregate stockpiles.

1.5.3 Other Materials

Store reinforcing bars and accessories above the ground on supports. Store all materials to avoid contamination and deterioration.

1.6 ACCEPTANCE

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NOTE: Provide accredited and validated laboratories on USACE managed projects. Utilization of the USACE Materials Testing Center (MTC) for laboratory validation is optional for Air Force and Navy managed projects.

****

1.6.1 Acceptance Requirements

Provide all sampling and testing required for acceptance including batch tickets. Select sample locations on a random basis in accordance with ASTM D3665. Individuals performing sampling, testing and inspection duties are required to meet the qualifications of the accredited [and validated]laboratory. The Government reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas are additional and must meet the same requirements as random tests. Provide facilities and personnel where directed to assist in obtaining samples for any Government testing. Acceptance of work is based on compliance with the pavement characteristics discussed below.

1.6.2 Concrete Strength

Acceptance test results are the average strengths of two specimens tested at 28 days. The strength of the concrete is considered satisfactory so long as every average of three consecutive acceptance test results equal or exceeds the specified compressive strength (f'c) and no individual test result falls below f'c by more than 3.4 MPa 500 psi. Remove and replace the deficient area where any portion of the work fails to meet the acceptance criteria for concrete strength, at no additional cost to the Government.

1.6.3 Thickness

Provide the pavement design thickness required. Measure pavement thickness in accordance with ASTM C174/C174M using cores taken from the completed pavement section. Record and report all pavement thicknesses. If any thicknesses deviate from the design thickness by more than the values listed in Table 1 Maximum Job Thickness Deviations, remove and replace full panels as necessary to bring the pavement within tolerance.

Table 1
Maximum Job Thickness Deviations

Job Design Thickness	Individual Thickness Deficiency Greater than or Equal to	Average Job Thickness Deficiency Greater than or Equal to
Greater than or equal to 200 mm 8 inches	19 mm 0.75 inch	13 mm 0.50 inch
Less than 200 mm 8 inches	13 mm 0.50 inch	6 mm 0.25 inch

1.6.4 Surface Smoothness

****
NOTE: Retain first bracketed item if any runway or taxiway pavement is included in the design. Retain second bracketed item for all designs including any other airfield pavement.
****

[Provide runways and taxiways with a variation from the specified straight

edge not greater than 3 mm 1/8 inch in the longitudinal direction and not greater than 6 mm 1/4 inch in the transverse direction.][Provide all other airfield areas with a variation from a straight edge not greater than 6 mm 1/4 inch in either the longitudinal or transverse direction.] Perform all smoothness testing on each design lane and report all measurements to the nearest 2 mm1/16 in. Perform the testing at 5 foot intervals. Smoothness requirements do not apply over crowns, drainage structures, or similar penetrations. Where more than 20.0 percent of the measurements exceed the tolerance, remove and replace full panels at no additional cost to the Government to bring the full design lane within tolerance.

1.6.5 Grade

Provide finished surfaces of all airfield pavements that vary less than 13 mm 1/2 inch above or below the plan grade line or elevation indicated. The above deviations from the approved grade line and elevation are not permitted in areas where closer conformance with the planned grade and elevation is required for the proper functioning of appurtenance structures. Provide finished surfaces of new abutting pavements that coincide at their juncture. Provide horizontal control of the finished surfaces of all airfield pavements that vary not more than 13 mm 1/2 inch from the design joint alignment indicated. Remove and replace full panels where the deviation from grade exceeds the specified tolerances by 50 percent or more, at no additional cost to the Government.

1.6.6 Diamond Grinding

****

NOTE: For some projects the designer may need to consider reducing the amount of diamond grinding below a maximum of 20 percent.

****

The maximum depth of diamond grinding is 6 mm 1/4 inch. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the maximum diamond grinding depth permitted, at no additional cost to the Government. The maximum area corrected by diamond grinding the surface of the hardened concrete is [20][_____] percent of the total area of the project.

Submit a Diamond Grinding Plan for review and approval prior to diamond grinding. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth and area are limited above. Reduce high areas by diamond grinding the hardened concrete with an approved equipment after the concrete is at a minimum age of 14 days. Remove and replace all pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. All areas in which diamond grinding has been performed are subject to the thickness tolerances specified in paragraph THICKNESS, above.

Prior to production diamond grinding operations, perform a test section at the approved location. Perform a test section that consists of a minimum

of two adjacent passes with a minimum length of 12 m 40 feet to allow evaluation of the finish, transition between adjacent passes, and the results of crossing a transverse joint. Production diamond grinding operations are not to be performed prior to approval.

1.6.6.1 Bumps

Reduce any bumps by diamond grinding areas exceeding the tolerances shown by the smoothness measurements. Continue diamond grinding until the tolerances for surface smoothness are met. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding. Perform additional smoothness measurements in all areas corrected by diamond grinding and report results to the nearest 2 mm1/16 in.

1.6.7 Deficient Areas

The size of a deficient area is measured as one or more failing tests or measurements that are in between two passing tests. Deficient areas may be reduced in size by performing additional tests or measurements to show areas that meet the requirements for acceptance.

1.6.8 Laboratory Accreditation[and Validation]

****

NOTE: At the discretion of the Air Force or Navy project engineer, the requirements for the USACE MTC validation of construction testing laboratories may be deleted. Validation of the project laboratories will provide an additional level of quality control for the project, and is strongly recommended by NAVFAC and USACE based on past experience.
For all Air Force and Army projects, retain the bracketed statement requiring USACE MTC validation of laboratories.

For all Army managed projects, retain the bracketed statement requiring USACE MTC validation of laboratories.

****

Provide laboratory and testing facilities. Submit accreditation of the commercial laboratory by an independent evaluation authority, indicating conformance to ASTM C1077, including all applicable test procedures identified in this specification. If multiple laboratories are proposed, identify which tests will be conducted by each. Submit accreditation documentation a minimum of 30 days before any specified testing is performed. The laboratories performing the tests are required to be accredited in accordance with ASTM C1077, including ASTM C78/C78M and ASTM C1260. Provide current accreditation and include the required and optional test methods, as specified.[In addition, all contractor quality control testing laboratories performing testing require USACE validation by the Material Testing Center (MTC) for both parent laboratory and on-site laboratory. Validation on all laboratories is required to remain current throughout the duration of the paving project. Request MTC laboratory validation at https://mtc.erdc.dren.mil/requestvalidation.aspx for costs and scheduling. Contact the MTC Director at https//mtc.erdc.dren.mil/contact2.aspx with questions or additional information.]

PART 2 PRODUCTS

****

NOTE: Coordinate all product requirements with the appropriate agency's Pavements or Materials Engineer.

****

2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of concrete airfield pavement. However, where the construction covered herein interfaces with other sections, construct each interface to conform to the requirements of both this section and the other section including tolerances for both.

2.2 CEMENTITIOUS MATERIALS

****

NOTE: Edit these paragraphs as appropriate for the particular project. Obtain guidance for use of cementitious materials from the Pavement Materials engineer or from the TSMCX, AFCEC pavement SME, or NAVFAC, especially for areas subject to alkali-aggregate reactivity, or sulfate attack.

When sulfate bearing soil or water is encountered, specify Type II cement for moderate sulfate concentration and Type V cement for high concentration and consider requiring use of fly ash or slag cement for partial replacement. Do not specify Type I or III cement. See UFC 3-250-04 for guidance.

Do not specify Type III cement unless accelerated paving is involved and then only after laboratory mixture proportioning studies and tests during the design stage of the project.

****

Provide cementitious materials consisting of blended cement or portland cement in combination with supplementary cementitious materials (SCM), that conform to appropriate specifications listed below. New submittals are required when the cementitious materials sources or types change.

2.2.1 Portland Cement

****

NOTE: ASTM C 150 has deleted the option to specify low alkali cement. To mitigate ASR, current practice (ASTM C 1778) is to limit the total alkalis in the concrete mixture as addressed in paragraph Composition.

****

Provide portland cement conforming to ASTM C150/C150M, Type [I] [II] [V], [including the Optional Physical Requirements for early stiffening]. [Provide Type III cement only in the following locations [_____].]

2.2.2 Blended Cements

****

NOTE: Portland cement blended with limestone up to 15 percent by mass of the blended cement is acceptable.

****

Provide blended cement conforming to ASTM C595/C595M, Type IP, IS, or IL[including the optional requirement for sulfate resistance]. Provide pozzolan added to the Type IP blend consisting of ASTM C618 Class F or Class N and that is interground with the cement clinker. Include a written statement from the manufacturer that the amount of pozzolan in the finished cement does not vary more than plus or minus 5 mass percent of the finished cement from lot to lot or within a lot. Provide limestone added to the Type IL blend that is interground with the cement clinker. Include a written statement from the manufacturer that the amount of limestone in the finished cement does not vary more than plus or minus 2.5 mass percent of the finished cement from lot to lot or within a lot. Limit the percent of slag, pozzolan, or limestone to a maximum of IS(50), IP(35) or IL(15). The percentage and type of mineral admixture used in the blend is not allowed to change from that submitted for the aggregate evaluation and mixture proportioning.

2.2.3 Pozzolan

2.2.3.1 Fly Ash

****

NOTE: Class C fly ash is not permitted for paving concrete.

Use loss on ignition not exceeding 3 percent for frost areas to reduce carbon interference with air entraining admixture.

****

Provide fly ash conforming to ASTM C618, Class F including the optional requirement for uniformity and a loss on ignition not exceeding [3] [6] percent. Provide Class F fly ash for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 4 percent.

2.2.3.2 Raw or Calcined Natural Pozzolan

Provide natural pozzolan that is raw or calcined and conforms to ASTM C618, Class N, including the optional requirements for uniformity and a loss on ignition not exceeding [3] [6] percent. Provide Class N pozzolan for use in mitigating Alkali-Silica Reactivity with a total equivalent alkali content less than 4 percent.

2.2.3.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

Provide Ultra Fine Fly Ash (UFFA) and Ultra Fine Pozzolan (UFP) conforming to ASTM C618, Class F or N, and the following additional requirements:

a. The strength activity index at 28 days of age of at least 95 percent of the control specimens.

b. The average particle size is a maximum of 6 microns.

[2.2.3.4 Silica Fume

****
NOTE: Use Silica Fume only for OCONUS projects where Class F fly ash and slag cement are not available, and with written approval from the TSMCX, AFCEC pavement SME, or NAVFAC. If not applicable, delete this paragraph here and throughout all other locations in this specification..
****

Provide silica fume conforming to ASTM C1240 including the optional limits on reactivity with cement alkalis. Provide silica fume as a dry, densified material or as a slurry. Provide the services of a manufacturer's technical representative that is experienced in mixing, proportioning, placement procedures, and curing of concrete containing silica fume at no expense to the Government. This representative is required to be present on the project prior to and during at least the first 4 days of concrete production and placement using silica fume.

]2.2.4 Slag Cement

Provide slag cement (ground-granulated blast-furnace slag) that conforms to ASTM C989/C989M, Grade 100 or Grade 120.

2.2.5 Supplementary Cementitious Materials (SCM) Content

Provide a concrete mix that contains one of the SCMs in Table 2 within the ranges specified therein.

TABLE 2

SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class F Fly Ash and Class N Pozzolan	25	35
Slag Cement	40	50
[Silica Fume]	[7]	[7]

2.3 AGGREGATES

****
NOTE: During the design stage, the designer must research the availability of local aggregate materials near the project area to determine if they conform with this specification. If local materials do not meet the requirements of this specification material needs to be imported that meets the specification. Aggregate quality requirements are not allowed to be reduced or eliminated for airfield projects.

****

2.3.1 Aggregate Sources

2.3.1.1 Durability of Coarse Aggregate

****

NOTE: Subject to written approval by the Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Systems Command (NAVFAC), the third paragraph can be specified for projects in negligible weathering areas, as defined by ASTM C 33, Figure 1.

****

Provide durable aggregate that meets one of the following requirements:

a. Provide aggregate with a satisfactory service record in freezing and thawing of at least 5 years successful service in three concrete paving projects. Include a condition survey of the existing concrete and a review of the concrete-making materials, including coarse aggregates, cement, and mineral admixtures in the service record. Consider the previous aggregate source and test results, cement mill certificate data, mineral admixture chemical and physical composition, and the mix design (cement factor and water-cementitious material ratio) in the review. Provide service record performed by an independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Include photographs and a written report addressing D-cracks and popouts in accordance with ACI 201.1R in the service record.

b. Provide coarse aggregate with a durability factor of 80 or more when subjected to freezing and thawing of specimens prepared in accordance with ASTM C1646/C1646M and tested in accordance with ASTM C666/C666M, Procedure A. Test all coarse aggregate size groups and sources proposed for use individually. Historical data, within 2 years of proportioning studies submission, that is representative of material on the project may be provided.

[c. Provide coarse aggregate with a maximum sodium sulfate soundness loss of 12 percent, or with a magnesium sulfate soundness loss of 18 percent after five cycles when tested in accordance with ASTM C88.]

2.3.1.2 Alkali-Silica Reactivity

Evaluate and test fine and coarse aggregates to be used in all concrete for alkali-aggregate reactivity. Test all aggregate fractions, size groups, and sources proposed for use individually.

a. Evaluate the fine and coarse aggregates separately using ASTM C1260. If the expansion is less than 0.30 percent after 14 days of immersion in a 1N NaOH solution, provide a SCM within the limits of Table 2.

b. If any individual aggregate has an expansion greater than 0.30 percent after 14 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. As an alternative provide low alkali portland cement or blended cement and

SCM within the limits of Table 2 that has a measured expansion less than 0.08 percent after 28 days of immersion in 1N NaOH solution in accordance with ASTM C1567.

2.3.1.3 Combined Aggregate Gradation

In addition to the grading requirements specified for coarse aggregate and for fine aggregate, provide the combined aggregate grading meeting the following requirements:

a. Provide materials selected and the proportions used such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point and its associated production tolerance thus determined falls within the parallelogram described therein. Refer to TSPWG M 3-250-04.97-05 for combined aggregate plot area recommendations for the intended placement technique(s).

b. Determine the Coarseness Factor (CF) from the following equation:

$$CF = \frac{\text{(cumulative percent retained on the 9.5 mm sieve)(100)}}{\text{(cumulative percent retained on the 2.36 mm sieve)}}$$

$$CF = \frac{\text{(cumulative percent retained on the 3/8 inch sieve)(100)}}{\text{(cumulative percent retained on the No. 8 sieve)}}$$

c. The Workability Factor (WF) is defined as the percent passing the 2.36 mm No. 8 sieve based on the combined aggregate gradation. Adjust the WF, prorated upwards only, by 2.5 percentage points for each 56 kg per cubic meter 94 pounds per cubic yard of cementitious material greater than 335 kg per cubic meter 564 pounds per cubic yard.

d. Plot a diagram using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram, plot a parallelogram with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, revise the grading of each size of aggregate used and the proportions selected as necessary.

e. Plot the associated production tolerance limits, identified in Table 8, around the CF and adjusted WF point.

2.3.2 Coarse Aggregate

2.3.2.1 Material Composition

****

NOTE: Modify this paragraph appropriately when it is desirable to limit coarse aggregate to crushed materials. Crushing gravel tends to improve quality, bond characteristics, and generally results in higher compressive strength. Investigate using crushed gravel when mixture proportioning studies or local experience indicates that low compressive strength concrete will be produced with an uncrushed gravel.

Do not under any conditions permit use of steel

furnace slag for any aggregate. It is markedly different from iron blast furnace slag.

In power check pads, the high temperatures from jet blast can cause distress in aggregates in the concrete. Include bracketed item if power check pads are to be constructed. A lab study of available aggregates must be made if no service record is available. Only basalt is permitted on Navy projects.

Retain the bracketed requirement for washing coarse aggregate if aggregates in the area require it to meet the limits of Table 3. Add the requirement to use a log washer or other specific equipment if experience in the area shows the need. Delete if not needed. It is permissible to list certain aggregate sources that do not require washing if that is appropriate. Make this decision during preparation of specifications; do not make the Resident Engineer decide after award if aggregates need to be washed.

****

Provide coarse aggregate consisting of crushed or uncrushed gravel, crushed stone, [crushed adequately seasoned air-cooled iron blast-furnace slag; steel furnace slag is not permitted], or a combination thereof. [Provide coarse aggregate for paving power check pads consisting of limestone, dolomite, basalt or other approved low-silica content aggregate which do not cause thermal distress from jet blast.] Provide aggregates, as delivered to the mixers, consisting of clean, hard, uncoated particles meeting the requirements of ASTM C33/C33M except as specified herein. [Provide coarse aggregate that has been washed sufficient to remove dust and other coatings.] [Provide coarse aggregate that has been cleaned by processing with an approved log washer.] [Provide iron blast-furnace slag conforming to the grading to be used in the concrete with a compact density of not less than 1125 kg per cubic meter 70 lb per cubic foot determined in accordance with ASTM C29/C29M]. Provide coarse aggregate with no more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. Provide coarse aggregates with a maximum sodium sulfate soundness loss of 12 percent, or with a magnesium sulfate soundness loss of 18 percent after five cycles when tested in accordance with ASTM C88.

2.3.2.2 Particle Shape Characteristics

Provide particles of the coarse aggregate that are generally spherical or cubical in shape. The quantity of flat particles and elongated particles in any size group coarser than the 9.5 mm 3/8 inch sieve are not allowed to exceed 20 percent by weight as determined by the Flat Particle Test and the Elongated Particle Test of ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 3; an elongated particle is one having a ratio of length to width greater than 3.

2.3.2.3 Size and Grading

****

NOTE: Use nominal maximum aggregate size of 37.5 mm 1-1/2 inch for airfield pavements. Subject to

approval of the TSMCX, AFCEC pavement SME, or NAVFAC, a 25 mm 1-inch nominal maximum aggregate size may be used with two size groups. If utilizing a nominal maximum aggregate size of 37.5 mm 1-1/2 inch retain the third bracketed item. If approval has been given to use 25 mm 1-inch nominal maximum aggregate size, retain the fourth bracketed item. Utilizing a 25 mm 1-inch nominal maximum aggregate size requires the use of dowels in all joints.

****

Provide coarse aggregate with a nominal maximum size of [37.5 mm 1.5 inches with a minimum of 10 percent retained on the 25 mm 1.0 inch][25 mm 1.0 inches with a minimum of 5 percent retained on the 19 mm 0.75 inch] sieve of the proposed combined aggregate gradation that meets the criteria of paragraph COMBINED AGGREGATE GRADATION.[Grade and provide the coarse aggregates in a minimum of two size groups meeting the individual grading requirements of ASTM C33/C33M, [Size No. 4 (37.5 mm to 19 mm 1.5 ins. to 0.75 in.) and Size No. 67 (19 mm to 4.75 mm 0.75 in. to No. 4)][Size No. 57 (25 mm to 4.75 mm 1.0 ins. to No. 4) and Size No. 8 (9.5 mm to 2.36 mm 3/8 in. to No. 8)]. A third coarse aggregate size group may be required to meet the criteria of paragraph COMBINED AGGREGATE GRADATION.] Mix designs that include a minimum of three coarse aggregate size groups can use grading limits not defined by ASTM C33/C33M provided all other requirements are met. Provide upper and lower grading limits of historic gradations for all proposed coarse aggregates not defined by ASTM C33/C33M.

2.3.2.4 Deleterious Materials - Airfield Pavements

****

NOTE: Select the first bracketed option for chert in areas subjected to severe freezing and thawing. Select the second bracketed option for chert in areas subjected to negligible to moderate freezing and thawing. The first bracketed option may also be selected in negligible and moderate weather areas where airfield pavements have had historical problems with popouts. It is very rare for sedimentary deposits to meet deleterious limits that are less than 1 percent. Selecting the first tailoring option may require using non-sedimentary aggregates. Verify the availability and location of non-sedimentary aggregates for the project.

Weather Severity	Air Freezing Index Coldest Year in 30 (a)	Average Precipitation for any Single Month During the Freezing Period
Moderate	500 or less	Any Amount
Moderate (b)	501 or more	Less than 25 mm 1 inch
Severe	501 or more	25 mm 1 inch or more

Weather Severity	**Air Freezing Index Coldest Year in 30 (a)**	**Average Precipitation for any Single Month During the Freezing Period**
(a) Calculated as described in UFC 3-130-01. See ASTM C33/C33M for simplified map of CONUS weather severity.		
(b) In poorly drained areas, the weather must be considered severe even though the other criteria indicate a rating of moderate.		

****

The amount of deleterious material in each size group of coarse aggregate is not allowed to exceed the limits shown in Table 3 below, determined in accordance with the test methods shown.

TABLE 3	
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD PAVEMENTS	
Materials (d)	Percentage by Mass
Clay lumps and friable particles (ASTM C142/C142M)	1.0
Material finer than 0.075 mm No. 200 sieve (a) (ASTM C117)	1.0
Lightweight particles (b) (ASTM C123/C123M)	0.5
Chert, cherty stone, and other aggregates (less than 2.40 Sp. Gr.) (c) (ASTM C123/C123M and ASTM C295/C295M)	[0.1][1.0]
(a) Limit for material finer than 0.075 mm No. 200 sieve is allowed to be increased to 1.5 percent for crushed aggregates if the fine material consists of crusher dust that is essentially free from clay or shale. Use X-Ray Diffraction or other appropriate techniques as determined by petrographer to quantify amount and justify increase.	
(b) Test with a separation medium with a density of Sp. Gr. of 2.0. This limit does not apply to coarse aggregate manufactured from blast-furnace slag unless contamination is evident.	

TABLE 3	
LIMITS OF DELETERIOUS MATERIALS IN COARSE AGGREGATE FOR AIRFIELD PAVEMENTS	
Materials (d)	Percentage by Mass
(c) Chert is defined as a rock composed of quartz, chalcedony or opal, or any mixture of these forms of silica. It is variable in color. The texture is so fine that the individual mineral grains are too small to be distinguished by the unaided eye. Its hardness is such that it scratches glass but is not scratched by a knife blade. It may contain impurities such as clay, carbonates, iron oxides, and other minerals. Cherty stone is defined as any type of rock (generally limestone) that contains chert as lenses and nodules, or irregular masses partially or completely replacing the original stone. Other aggregates consist of obsidian, ash tuff, and palygorskite.	
(d) Perform testing in accordance with the referenced test methods, except use the minimum sample size specified below.	

2.3.2.5 Testing for Deleterious Materials in Coarse Aggregate

No extension of time or additional payment due to any delays caused by the testing, evaluation, or personnel requirements is allowed. The minimum test sample size of the coarse aggregate is 15 kg 33 pounds for the 19 mm 3/4 inch and larger maximum size and 8.5 kg 19 pounds for the 4.75 to 19 mm No. 4 to 3/4 inch coarse aggregate. Provide facilities for the ready procurement of representative test samples.

2.3.3 Fine Aggregate

2.3.3.1 Composition

Provide fine aggregate consisting of natural sand, manufactured sand, or a combination of the two, each composed of clean, hard, durable particles meeting the requirements of ASTM C33/C33M. Stockpile and batch each type of fine aggregate separately. Provide fine aggregate with particles that are generally spherical or cubical in shape. For fine aggregate provided as a combination of sources, test each source individually.

2.3.3.2 Grading

Provide fine aggregate, as delivered to the mixer, with a grading that conforms to the requirements of ASTM C33/C33M and having a fineness modulus of not less than 2.50 nor more than 3.40. For fine aggregate supplied as a combination of sources, determine the fineness modulus on a composite sample.

2.3.3.3 Deleterious Material

The minimum test sample size for fine aggregate proposed for use in airfield paving is 5 kg 10 pounds. The amount of deleterious material in the fine aggregate is not to exceed the limits listed in table 4 when performed on the full sample:

TABLE 4	
LIMITS OF DELETERIOUS MATERIALS IN FINE AGGREGATE	
Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123/C123M using a medium with a density of Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.4 CHEMICAL ADMIXTURES

2.4.1 General Requirements

Only use chemical admixtures when the specific admixture type and manufacturer is the same material used in the mixture proportioning studies. Provide air-entraining admixture conforming to ASTM C260/C260M. Use an accelerating admixture conforming to ASTM C494/C494M, Type C or Type E, when specified in paragraph MIXTURE PROPORTIONS below provided it is not used to reduce the amount of cementitious material. Calcium chloride and admixtures containing calcium chloride are not allowed. Provide retarding or water-reducing admixture that meet the requirements of ASTM C494/C494M, Type A, B, or D, except that the 6-month and 1-year compressive strength tests are waived. Type S specific performance admixtures are not allowed. ASTM C1017/C1017M flowable admixtures are not allowed.

2.4.2 High Range Water Reducing Admixture (HRWRA)

****

NOTE: Select the first bracketed option for projects not using Silica Fume. Select the second bracketed option for OCONUS projects that require the use of Silica Fume.

****

[ASTM C494/C494M, Type F and G high range water reducing admixtures are not allowed.][Provide a high-range water-reducing admixture that meets the requirements of ASTM C494/C494M, Type F or G, that is free from chlorides, alkalis, and is of the synthesized, sulfonated complex polymer type. Add the HRWRA to the concrete as a single component at the batch plant. Add the admixture to the concrete mixture only when its use is approved or directed, and only when it has been used in mixture proportioning studies to arrive at approved mixture proportions. Submit certified copies of the independent laboratory test results required for compliance with ASTM C494/C494M.]

2.5 MEMBRANE FORMING CURING COMPOUND

Provide membrane forming curing compound that conforms to COE CRD-C 300 and is white pigmented.

2.6 WATER

Provide water for mixing and curing that is fresh, clean, potable, and

free of injurious amounts of oil, acid, salt, or alkali, except that non-potable water, or water from concrete production operations, can be used if it meets the requirements of ASTM C1602/C1602M.

2.7 JOINT MATERIALS

****
NOTE: Coordinate with Section 32 01 19.61 for Army projects and 32 13 73.19 for all other projects.
****

2.7.1 Expansion Joint Material

Provide preformed expansion joint filler material conforming to ASTM D1751 or ASTM D1752 Type II or III. Provide expansion joint filler that is 19 mm 3/4 inch thick, unless otherwise indicated, and provided in a single full depth piece.

2.7.2 Slip Joint Material

Provide slip joint material that is 6 mm 1/4 inch thick expansion joint filler, unless otherwise indicated, conforming to paragraph EXPANSION JOINT MATERIAL.

2.8 REINFORCING

****
NOTE: Edit these paragraphs to conform to project requirements. Delete those not needed. Add epoxy-coated bars (ASTM A775/A775M) or low-alloy bars (ASTM A706/A706M) when required by design. Low-alloy steel bars are intended for welding.
****

Provide reinforcement that is free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that might reduce the bond with concrete. Removal of thin powdery rust and tight rust is not required. However, reinforcing steel which is rusted to the extent that it does not conform to the required dimensions or mechanical properties is not allowed to be used.

2.8.1 Reinforcing Bars and Bar Mats

Provide deformed reinforcing bars conforming to ASTM A615/A615M, Grade 420 Grade 60 or ASTM A996/A996M, Grade 420 Grade 60. Provide bar mats conforming to ASTM A184/A184M.

2.8.2 Welded Wire Reinforcement

Provide welded wire reinforcement that is deformed or smooth, conforming to ASTM A1064/A1064M or ASTM A185/A185M, and provided in flat sheets.

2.9 DOWELS

****
NOTE: Retain paragraph on dowels. Even if not required, allow dowels as an option. .
****

2.9.1 Dowels

Provide dowels in single piece bars fabricated or cut to length at the shop or mill before delivery to the site. Dowels are to be free of loose, flaky rust and loose scale and be clean and straight. Dowels may be sheared to length provided that the deformation from true shape caused by shearing does not exceed 1 mm 0.04 inch on the diameter of the dowel and does not extend more than 1 mm 0.04 inch from the end of the dowel. Dowels are required to be smooth steel bars conforming to ASTM A615/A615M, Grade 280 or 420 Grade 40 or 60; ASTM A996/A996M, Grade 350 or 420 Grade 50 or 60. Epoxy coat dowels in conformance with Type 1 coating requirements of ASTM A1078/A1078M, to include the ends. Provide grout retention rings that are fully circular metal or plastic devices capable of supporting the dowel until the epoxy hardens. Dowel sleeves or inserts are not permitted.

2.9.2 Dowel Bar Assemblies

Provide dowel bar assemblies that consist of a framework of metal bars or wires arranged to provide rigid support for the dowels throughout the paving operation, with a minimum of four continuous bars or wires extending along the joint line. Provide dowels that are welded to the assembly or held firmly by mechanical locking arrangements that prevent them from rising, sliding out, or becoming distorted during paving operations.

2.10 EPOXY RESIN

Provide epoxy-resin materials that consist of two-component materials conforming to the requirements of ASTM C881/C881M, Class as appropriate for each application temperature to be encountered, except that in addition, the materials meet the following requirements:

a. Type IV, Grade 3 for use for embedding dowels and anchor bolts.

b. Type III, Grade as required for use as patching materials for complete filling of spalls, saw-cut runouts, and other voids and for use in preparing epoxy resin mortar.

c. Type IV, Grade 1 for use for injecting cracks.

d. Type V, Grade as required for bonding freshly mixed portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete.

2.11 EQUIPMENT

Maintain all plant, equipment, tools, and machines used in the work in satisfactory working conditions at all times. Submit the following:

a. Details and data on the batching and mixing plant prior to plant assembly including manufacturer's literature showing that the equipment meets all requirements specified herein.

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NOTE:For OCONUS projects, contact NRMCA (http://www.nrmca.org) concerning approved engineers available in the geographic area.

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b. Obtain National Ready Mixed Concrete Association (NRMCA) certification of the concrete plant, at no expense to the Government. Provide inspection report of the concrete plant by an engineer approved by the NRMCA. A list of NRMCA approved engineers is available on the NRMCA website at http://www.nrmca.org. Submit a copy of the NRMCA QC Manual Section 3 Concrete Plant Certification Checklist, NRMCA Certificate of Conformance, and Calibration documentation on all measuring and weighing devices prior to uniformity testing.

c. A description of the equipment proposed for transporting concrete mixture from the central mixing plant to the paving equipment.

d. A description of the equipment proposed for the machine and hand placing, consolidating and curing of the concrete mixture. Manufacturer's literature on the paver and finisher, together with the manufacturer's written instructions on adjustments and operating procedures necessary to assure a tight, smooth surface on the concrete pavement. The literature is required to show that the equipment meets all details of these specifications.

2.11.1 Batching and Mixing Plant

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NOTE: The batching and mixing plant must be no further than 45 minutes haul time from the placing site during all periods of the work day.

****

2.11.1.1 Location

Utilize a batching and mixing plant off Government premises no more than 45 minutes haul and gate security check time from the placing site. Provide communications between the plant and the active work site at all times during concrete placement.

2.11.1.2 Type and Capacity

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NOTE: Adjust the production rate using the typical paving lane width, thickness, and anticipated placement rate for the project.

The paving sequence plan and proposed paving pattern and size of the job dictate the necessary plant capacity requirements to avoid any delay in paving operations.

****

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of [75][_____] cubic meters [100][_____] cubic yards per hour, that conforms to the requirements of NRMCA QC 3 including provisions addressing:

1. Material Storage and Handling
2. Batching Equipment
3. Central Mixer

4. Ticketing System
5. Delivery System

2.11.1.3 Ready-Mixed Concrete

Provide ready-mixed concrete in accordance with ASTM C94/C94M.

2.11.1.4 Concrete Made by Volumetric Batching and Continuous Mixing

Provide concrete made by volumetric batching and continuous mixing in accordance with ASTM C685/C685M.

2.11.1.5 Concrete Uniformity Requirements

Provide concrete meeting the uniformity requirements of ASTM C94/C94M. Perform uniformity testing no earlier than 6 months before placement using the approved mixture proportions for the project. Submit mixer performance (uniformity) testing showing concrete is within the limits of ASTM C94/C94M.

2.11.2 Truck

Truck mixers are not allowed for mixing or transporting slipformed paving concrete. Provide only truck mixers designed for mixing or transporting paving concrete with extra large blading and rear opening specifically for low-slump paving concrete. Provide truck mixers, the mixing of concrete therein, and concrete uniformity and testing thereof that conform to the requirements of ASTM C94/C94M. Determine the number of revolutions between 70 to 100 for truck-mixed concrete and the number of revolutions for shrink-mixed concrete by uniformity tests as specified in ASTM C94/C94M and in requirements for mixer performance stated in paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION in PART 3. If requirements for the uniformity of concrete are not met with 100 revolutions of mixing after all ingredients including water are in the truck mixer drum, discontinue use of the mixer until the condition is corrected. Water is not allowed to be added after the initial introduction of mixing water except, when on arrival at the job site, the slump is less than specified and the water-cement ratio is less than that given as a maximum in the approved mixture. Additional water may be added to bring the slump within the specified range provided the approved water-cement ratio is not exceeded. Inject water into the head of the mixer (end opposite the discharge opening) drum under pressure, and turn the drum or blades a minimum of 30 additional revolutions at mixing speed. The addition of water to the batch at any later time is not allowed.[Perform mixer performance (uniformity) tests for truck mixers in accordance with ASTM C94/C94M.]

2.11.3 Transporting Equipment

Deliver concrete to the paving site in accordance with ASTM C94/C94M. Do not use non-agitating equipment unless total haul time is less than 15 minutes.Provide transporting equipment designed and operated to deliver and discharge the required concrete mixture completely without segregation.

[2.11.4 Transfer and Spreading Equipment

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NOTE: Delete this requirement when transporting equipment will be trafficking on existing airfield

pavement placed prior to the start of work for the current project. Select a transfer spreader when transporting equipment will be trafficking on either subgrade, base course, or drainage layers. When either conveyance system below is appropriate select both options to allow the contractor the option for either (i.e. an MTV or a placer-spreader).
****

[Provide a Material Transfer Vehicle (MTV) capable of moving between the hauling equipment and the paver and equipped with a swing conveyor that delivers material to the paver from outside the paving lane without making contact with the paver while allowing the paver to operate at a constant speed.] [Alternatively,] [Provide placer-spreader equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver that is specially manufactured, self-propelled transfer equipment which accepts the concrete outside the paving lane, transfers, and spreads it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.]

]2.11.5 Paver-Finisher

2.11.5.1 General

Use a heavy duty vibratory truss screed or triple roller tube paver for concrete placement.

2.11.5.2 Heavy Duty Vibratory Truss Screed

Provide a heavy duty vibratory truss screed designed specifically for paving and finishing low slump concrete with an engine having a minimum of 6.7 kW 9 horsepower. The truss screed is required to be easily adjustable and capable of spanning the lane being paved with a minimum weight of 27 kg per m 18 pounds per foot of lane width. Operate the screed to shape, compact, and smooth the surface and finish the surface so that no significant amount of hand finishing except use of cutting straightedges is required. Provide adjustment for variation in lane width or thickness and to prevent more than 200 mm 8 inches of the screed extending over previously placed or existing concrete.

2.11.5.3 Triple Roller Tube Paver

Provide a triple roller tube paver with an engine having a minimum of 55.2 kW 74 horsepower. The paver is required to be easily adjustable and capable of spanning the lane being paved with a minimum weight of 720 kg per m 480 pounds per foot of lane width. Operate the paver to shape, compact, and smooth the surface and finish the surface so that no significant amount of hand finishing except use of cutting straightedges is required.

2.11.5.4 Vibrators

Provide full-depth consolidation using immersion vibrators from a work bridge. Provide vibrators that can be operated at any desired depth within the slab and can be completely withdrawn from the concrete as required. Equip vibrators with controls to immediately stop vibration as forward motion of the work ceases. Space immersion vibrators across the paving lane as necessary to properly consolidate the concrete with a

maximum clear distance between vibrators of 750 mm 30 inches. Place outside vibrators within 300 mm 12 inches from the lane edge. Measure the vibrator frequency and amplitude in accordance with COE CRD-C 521.

2.11.5.5 Other Types of Finishing Equipment

Grate tampers (jitterbugs), laser screeds, single or double rotating tube floats, or bridge deck finishers are not allowed.

2.11.6 Curing Equipment

Provide equipment for applying membrane-forming curing compound mounted on a self-propelled frame that spans the paving lane. Constantly agitate the curing compound reservoir mechanically (not air) during operation and provide a means for completely draining the reservoir. Provide a spraying system that consists of a mechanically powered pump which maintains constant pressure during operation, an operable pressure gauge, and either a series of spray nozzles evenly spaced across the lane to provide 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. Protect all spray nozzles with wind screens. Calibrate the spraying system in accordance with ASTM D2995, Method A, for the rate of application required in paragraph MEMBRANE CURING. Provide hand-operated sprayers allowed by that paragraph with compressed air supplied by a mechanical air compressor. Immediately replace curing equipment if it fails to apply an even coating of compound at the specified rate.

2.11.7 Texturing Equipment

Provide texturing equipment as specified below. Before use, demonstrate the texturing equipment on a test section, and modify the equipment as necessary to produce the texture directed.

2.11.7.1 Burlap Drag

Securely attach a burlap drag to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. Provide length of the material between 600 to 900 mm 24 to 36 inches dragging flat on the pavement surface. Provide burlap drag with a width at least equal to the width of the slab. Provide clean, reasonably new burlap material, completely moistened before start of use, and keep clean and maintained moist during use. Provide burlap conforming to AASHTO M 182, Class 3 or 4.

2.11.7.2 Broom

Apply surface texture using an approved stiff bristle broom drag of a type that provides a uniformly scored surface transverse to the pavement center line. Provide broom with handles longer than the width of slab to be finished capable of traversing the full width of the pavement at a uniform speed and with a uniform pressure that results in scores uniform in appearance and approximately 2 mm 1/16 inch in depth but not more than 3 mm 1/8 inch in depth.

2.11.8 Sawing Equipment

Provide saws capable of sawing to the full depth required.

2.11.8.1 Diamond Saw

Provide equipment for sawing joints and for other similar sawing of concrete consisting of standard diamond-type concrete saws mounted on a wheeled chassis which can be easily guided to follow the required alignment. Provide diamond tipped blades. Provide spares as required to maintain the required sawing rate. Early-entry saws may be used subject to demonstration and approval. No change to the initial sawcut depth is permitted.

2.11.8.2 Wheel Saw

Provide wheel saws used in the removal of concrete with large diameter tungsten carbide tipped blades mounted on a heavy-duty chassis which produce a saw kerf at least 40 mm 1-1/2 inches wide.

2.11.9 Straightedge

Provide and maintain at the job site, in good condition, a minimum 4 m 12 foot straightedge for each paving train for testing the hardened portland cement concrete surfaces. Provide straightedges constructed of aluminum or magnesium alloy and blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Provide straightedges with handles for operation on the pavement.

2.11.10 Work Bridge

Provide a self-propelled working bridge capable of spanning the required paving lane width where workmen can efficiently and adequately reach the pavement surface.

2.11.11 Diamond Grinding of PCC Surfaces

Perform diamond grinding by sawing with an industrial diamond abrasive which is impregnated in the saw blades. Assemble the saw blades in a cutting head mounted on a machine designed specifically for diamond grinding that produces the required texture and smoothness level without damage to the concrete pavement or joint faces. Provide diamond grinding equipment with saw blades that are 3 mm 1/8-inch wide, a minimum of 55 to 60 blades per 300 mm 12 inches of cutting head width, and capable of cutting a path a minimum of 0.9 m 3 ft wide. Diamond grinding equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints is not permitted. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property.

2.12 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

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NOTE: Concrete for airfield pavement is typically proportioned and accepted on the basis of 90-day flexural strength. However, use 28-day compressive strength for small projects. Specified compressive strength must be equivalent to the flexural strength used in the design of the pavement. Do not specify a compressive strength that exceeds an equivalent flexural strength of 4.5 MPa 650 psi at 28 days of age. Designer must also ensure that the specified strength is attainable with the available aggregates.

****

2.12.1 Specified Compressive Strength

Specified compressive strength, f'c, for concrete is 35 MPa 5,000 psi at 28 days of age as determined by test specimens fabricated in accordance with ASTM C192/C192M and tested in accordance with ASTM C39/C39M.

2.12.2 Water-Cementitious Materials Ratio

The allowable water-cementitious material ratio is 0.38 0.45. The water-cementitious material ratio is the equivalent water-cement ratio as determined by conversion from the weight ratio of water to cement plus SCM by the mass equivalency method described in ACI 211.1.

2.12.3 Air Content

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NOTE: For the standard coarse aggregate with the nominal maximum size of 37 mm 1.5 inches, the total air content must be specified as 6.0 percent where freezing and thawing is a concern. For a coarse aggregate with the nominal maximum size of 25 mm 1.0 inch, the total air content must be specified as 6.5 percent where freezing and thawing is a concern. Specify 4.0 percent where freezing and thawing is not a concern.

****

Provide concrete that is air-entrained with a total air content of [4.0] [6.0] [6.5] plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C231/C231M.

2.12.4 Slump

The maximum allowable slump of the concrete at the point of placement is 75 mm 3 inches for pavement constructed with fixed forms.

2.12.5 Concrete Temperature

The temperature of the concrete as delivered is required to conform to the requirements of paragraphs PAVING IN HOT WEATHER and PAVING IN COLD WEATHER, in PART 3. Determine the temperature of concrete in accordance with ASTM C1064/C1064M.

2.13 MIXTURE PROPORTIONS

2.13.1 Composition

Provide concrete composed of cementitious material, water, fine and coarse aggregates, and admixtures. Include supplementary Cementitious Materials (SCM) choice and usage in accordance with paragraph SUPPLEMENTARY CEMENTITIOUS MATERIALS (SCM) CONTENT. Provide a minimum total cementitious materials content of 310 kg per cubic meter 517 pounds per cubic yard. Limit the total alkali loading contributed by the portland cement or the portland cement portion of a blended cement to a maximum of 1.8 kg per cubic meter 3.0 lb per cubic yard. Calculate the alkali loading as the product of the portland cement content of the concrete multiplied by the alkali content of the portland cement or the portland

cement portion of the blended cement, divided by 100. Determine the alkali content in accordance with ASTM C114.

2.13.2 Proportioning Studies

Perform trial design batches, mixture proportioning studies, and testing, at no expense to the Government. Submit for approval the Preliminary Proposed Proportioning to include items a., b., and i. below a minimum of 7 days prior to beginning the mixture proportioning study. Submit the results of the mixture proportioning studies signed and stamped by the registered professional engineer having technical responsibility for the mix design study, and submitted at least 30 days prior to commencing concrete placing operations. Include a statement summarizing the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic meter yard basis. Base aggregate quantities on the mass in a saturated surface dry condition. Provide test results demonstrating that the proposed mixture proportions produce concrete of the qualities indicated. Base methodology for trial mixtures having proportions, slumps, and air content suitable for the work as described in ACI 211.1 and ACI 325.14R. Submit test results including:

a. Coarse and fine aggregate gradations and plots. Include historic gradation averages and standard deviations on individual sieves for each aggregate size group if available.
b. Combined aggregate gradation and coarseness vs. workability plots.
c. Coarse aggregate quality test results including deleterious materials.
d. Fine aggregate quality test results including deleterious materials.
e. Mill certificates for cement and supplementary cementitious materials.
f. Certified test results for air entraining, water-reducing, retarding, and non-chloride accelerating admixtures.
g. Specified compressive strength, slump, and air content.
h. Documentation of required average compressive strength, f'cr.
i. Recommended proportions and volumes for proposed mixture and each of three trial water-cementitious materials ratios.
j. Individual cylinder breaks.
k. Compressive strength summaries and plots.
l. Historical record of ACI 214R strength test results, documenting production standard deviation (if available).
m. Narrative discussing methodology on how the mix design was developed in accordance with ACI 211.1 and ACI 325.14R.
n. Alternative aggregate blending to be used during the test section if necessary to meet the required surface and consolidation requirements.

2.13.2.1 Water-Cementitious Materials Ratio

Perform at least three different water-cementitious materials ratios, which produce a range of strength encompassing that required on the project. The maximum water-cementitious materials ratio of the approved mix design becomes the maximum water-cementitious materials ratio for the project, and in no case exceeds 0.45.

2.13.2.2 Trial Mixture Studies

Perform separate sets of trial mixture studies made for each combination of cementitious materials and each combination of admixtures proposed for use. No combinations are to be used until proven by such studies, except that, if approved in writing and otherwise permitted by these specifications, an accelerating or retarding admixture can be used without separate trial mixture study. Perform separate trial mixture studies for

each placing method (fixed form or hand placement) proposed. Report the temperature of concrete in each trial batch. Design each mixture to promote easy and suitable concrete placement, consolidation and finishing, and to prevent segregation and excessive bleeding. Proportion laboratory trial mixtures for maximum permitted slump and air content.

2.13.2.3 Mixture Proportioning for Compressive Strength

Follow the step by step procedure below:

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

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

c. Test cylinders in accordance with ASTM C39/C39M.

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:
    3-day compressive strength
    7-day compressive strength
    28-day compressive strength

e. From these graphs select a w/c that produces a mixture giving a 28-day compressive strength equal to the required average compressive strength (f'cr) determined in accordance with the next paragraph.

f. If there is a change in materials, perform additional mixture design studies using the new materials.

g. No concrete pavement placement is allowed until the mixture proportions are approved. The approved water-cementitious materials ratio is restricted to the maximum w/c ratio and is not be increased without written approval.

h. If previous trial mixture studies have been completed and approved using the same materials within one year only one w/c ratio is required for verification purposes. Select a w/c ratio within the range of the previous trial mixture studies.

2.13.3 Required Average Compressive Strength

Establish mixture proportions during trial mixture studies that produce a required average compressive strength (f'cr) exceeding the specified compressive strength (f'c) by the amount indicated below.

2.13.3.1 From Previous Test Records

Where a concrete production facility has previous test records current to within 24 months, establish a standard deviation in accordance with the applicable provisions of ACI 214R. Test records used to calculate the standard deviation are to be representative of materials, quality control procedures, and expected conditions. Test records are to be within 7 MPa 1000 psi of the strength specified for the proposed work and consist of at least 30 consecutive tests. A strength test is the average of the strengths of two specimens made from the same sample of concrete and

tested at 28-days. Use the equations below to compute the required average compressive strength (f'cr):

$$f'_{cr,1} = f'_c + 1.34KS$$

$$f'_{cr,2} = f'_c + 2.33KS - 3.5 \text{ MPa} \quad f'_{cr,2} = f'_c + 2.33KS - 500 \text{ psi}$$

$$f'_{cr,final} = \text{larger of } f'_{cr,1} \text{ and } f'_{cr,2}$$

Where:
f'c = specified compressive strength
K = Modification factor
S = Standard Deviation

Where a concrete production facility does not have test records meeting the requirements above but does have a record based on 15 to 29 consecutive tests, establish a standard deviation as the product of the calculated standard deviation and a modification factor from Table 5

TABLE 5	
MODIFICATION FACTOR FOR STANDARD DEVIATION	
NUMBER OF TESTS	MODIFICATION FACTOR (K)
20	1.08
25	1.03
30 or more	1.00

2.13.3.2 Without Previous Test Records

When a concrete production facility does not have sufficient field strength test records for calculation of the standard deviation, determine the required average compressive strength (f'cr) by the following equation:

$$f'_{cr} = f'_c + 8.3 \text{ MPa} \quad f'_{cr} = f'_c + 1{,}200 \text{ psi}$$

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Perform the following actions to prepare for paving operations:

a. Concrete plant has been inspected and approved. Mixer uniformity testing for optimum mixing time has been determined.

b. All equipment in the paving train is in operational condition, ready for use, clean, and free of hardened concrete and foreign material.

c. An acceptable length of grade for concrete paving is available. All base materials are verified to conform to project plans and

specification requirements.

d. Test reports for all materials in the concrete mixture are on file at the job site and at the plant site.

e. Backup testing equipment and a test equipment backup plan is available.

f. All necessary concrete placement tools such as hand tools, straight edges, hand floats, edgers, and hand vibrators are available.

g. The needed number of haul trucks are available.

h. Vibrators have been checked for frequency and amplitude. Vibrator spacing has been checked and conforms to the vibrator manufacturer recommendations.

i. Measures have been developed and taken to mitigate extreme weather conditions during paving.

j. Weather forecast for each day of paving is available and checked daily.

k. Fixed-forms and reinforcing steel is placed, clean, and adequately supported.

3.1.1 Weather Precaution

When windy conditions during paving appear probable, have equipment and material at the paving site to provide windbreaks, shading, fogging, or other action to prevent plastic shrinkage cracking or other damaging drying of the concrete. During these conditions, monitor and report the evaporation rate hourly.

3.1.2 Proposed Techniques

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NOTE: Include joint layout and typical detail of joint/dowel bar spacing in drawings and coordinate with paragraph PLACING DOWELS. Insert office title for approval of joint plan changes.

****

Submit placing and protection methods; paving sequence; jointing pattern; data on curing equipment; demolition of existing pavements; pavement diamond grinding equipment and procedures. Submit for approval the following items:

a. A description of the placing and protection methods proposed when concrete is to be placed in or exposed to hot, cold, or rainy weather conditions.

b. A detailed paving sequence plan and proposed paving pattern showing all planned construction joints; transverse and longitudinal dowel bar spacing; and identifying paving lanes and hand placement areas. Deviations from the jointing pattern shown on the drawings are not allowed without written approval of the [design engineer] [_____].

c. Plan and equipment proposed to control alignment of sawn joints within

the specified tolerances.

d. Data on the curing equipment, media and methods to be used.

e. Method used to measure pavement smoothness.

f. Pavement demolition work plan, presenting the proposed methods and equipment to remove existing pavement and protect pavement to remain in place.

g. Submit a Diamond Grinding Plan for review and approval prior to diamond grinding. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. Those performing diamond grinding are required to have a minimum of three years experience in diamond grinding of airfield pavements. In areas not meeting the specified limits for surface smoothness and plan grade, reduce high areas to attain the required smoothness and grade, except as depth is limited below. Reduce high areas by diamond grinding the hardened concrete with an approved equipment after the concrete is at a minimum age of 14 days.

3.2 CONDITIONING OF UNDERLYING MATERIAL

3.2.1 General Procedures

Confirm the underlying material upon which concrete is to be placed is clean, damp, and free of debris, waste concrete, waste cement, frost, ice, standing water, and running water. Confirm the underlying material is well drained and has been satisfactorily graded and uniformly compacted in accordance with [Section 32 11 20 [BASE COURSE FOR RIGID][AND][SUBBASES FOR FLEXIBLE] PAVING] [Section 32 11 23.23 BASE COURSE DRAINAGE LAYERS] prior to setting forms or placement of concrete. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver.

3.2.2 Traffic on Underlying Material

****

NOTE: Do not allow transporting equipment to operate on the prepared underlying material in front of the paver. Operating hauling equipment in the paving lane will cause the paver to stop frequently producing a discontinuity in the pavement surface. Coordinate with Part 2, subparagraph TRANSFER AND SPREADING EQUIPMENT.

****

Transporting equipment is not to be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher. Subject to specific approval, crossing of the prepared underlying material at specified intervals for construction purposes may be permitted, provided rutting or indentations do not occur. Rework and repair the surface before concrete is placed.

3.3 WEATHER LIMITATIONS

3.3.1 Placement and Protection During Inclement Weather

Do not commence placing operations when heavy rain or other damaging weather conditions appear imminent. At all times when placing concrete, maintain on-site sufficient waterproof cover and means to rapidly place it over all unhardened concrete or concrete that might be damaged by rain. Immediately cover and protect all unhardened concrete from rain or other damaging weather. Suspend placement of concrete whenever rain, high winds, or other weather commences to damage the surface or texture of the placed unhardened concrete, washes cement out of the concrete, or changes the water content of the surface concrete.

Remove and replace any slab damaged by rain or other weather full depth by full slab width to the nearest original joint as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.3.2 Paving in Hot Weather

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NOTE: See ACI 305R for additional information concerning hot weather concreting. Do not delete this paragraph or the next paragraphs addressing weather.

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Prepare for hot weather paving in accordance with ACI 305R. When the ambient temperature during paving is expected to exceed 32 degrees C 90 degrees F, properly place and finish the concrete in accordance with procedures previously submitted, approved, and as specified herein. Provide concrete that does not exceed 35 deg C95 deg F when measured in accordance with ASTM C1064/C1064M at the time of delivery. Cool the mixing water or aggregates or place in the cooler part of the day to obtain an adequate placing temperature. Cool steel forms and reinforcing as needed to maintain steel temperatures below 49 degrees C 120 degrees F. Cool or protect transporting and placing equipment if necessary to maintain proper concrete placing temperature. Keep the finished surfaces of the newly laid pavement damp by applying a fog spray (mist) with approved spraying equipment until the pavement is covered by the curing medium.

3.3.3 Prevention of Plastic Shrinkage Cracking

Develop and institute measures to prevent plastic shrinkage cracks during weather with low humidity, high temperature, or appreciable winds. Halt further placement of concrete if plastic shrinkage cracking occurs until protective measures are in place to prevent further cracking. Periods of high potential for plastic shrinkage cracking can be anticipated by use of ACI 305R. In addition to the protective measures specified in the previous paragraph, further protect the concrete placement by erecting shades and windbreaks and by applying fog sprays of water, the addition of monomolecular films, or wet covering. Apply monomolecular films after finishing is complete. Do not use monomolecular films in the finishing process. Immediately commence curing procedures when such water treatment is stopped. Repair plastic shrinkage cracks in accordance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Never trowel over or fill plastic shrinkage cracks with slurry.

3.3.4 Paving in Cold Weather

Cold weather paving is required to conform to ACI 306R. During periods of cold-weather protection make daily reports of pertinent temperatures. Use special protection measures, as specified herein, if freezing temperatures are anticipated or occur before the expiration of the specified curing period. Do not begin placement of concrete unless the ambient temperature is at least 2 degrees C 35 degrees F and rising. Thereafter, halt placement of concrete whenever the ambient temperature drops below 5 degrees C 40 degrees F. When the ambient temperature is less than 10 degrees C 50 degrees F, the temperature of the concrete when placed is required to be not less than 10 degrees C 50 degrees F nor more than 25 degrees C 75 degrees F. Provide heating of the mixing water or aggregates as required to regulate the concrete placing temperature. Provide materials entering the mixer that are free from ice, snow, or frozen lumps. Do not incorporate salt, chemicals, or other materials in the concrete to prevent freezing.[If allowed under paragraph MIXTURE PROPORTIONS in PART 2, use an accelerating admixture when the ambient temperature is below 10 degrees C 50 degrees F.] Provide covering and other means for maintaining the concrete 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 pavement slabs, full depth by full width, damaged by freezing or falling below freezing temperature to the nearest planned joint, and replace as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS, at no expense to the Government.

3.4 CONCRETE PRODUCTION

Provide batching, mixing, and transporting equipment with a capacity sufficient to maintain a continuous, uniform forward movement of the paving operation. Deposit concrete transported in truck mixers in front of the paver within 90 minutes from the time cement has been charged into the mixer drum of the plant or truck mixer. If the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 60 minutes. Accompany every load of concrete delivered to the paving site with a batch ticket from the operator of the batching plant. Provide batch ticket information required by ASTM C94/C94M on approved forms. In addition provide design quantities in mass or volume for all materials, batching tolerances of all materials, and design and actual water cementitious materials ratio on each batch delivered, the water meter and revolution meter reading on truck mixers and the time of day. Provide batch tickets for each truck delivered to the placing foreman to maintain on file. Submit batch tickets to the Government weekly.

3.4.1 Batching and Mixing Concrete

Maintain scale pivots and bearings clean and free of rust. Remove any equipment which fails to perform as specified immediately from use until properly repaired and adjusted, or replaced.

3.4.2 Transporting and Transfer - Spreading Operations

Deposit concrete as close as possible to its final position in the paving lane. Operate all equipment to discharge and transfer concrete without segregation. Dumping of concrete in discrete piles is not permitted. Operate non-agitating equipment only on smooth roads and for haul time less than 15 minutes. No transfer or spreading operation which

requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete is permitted. Do not exceed a free vertical drop of 1 m 3 feet at any point in concrete conveyance. No equipment is permitted to operate on the grade in front of the paver.

3.5 PAVING

****
NOTE: Correlate these paragraphs with paragraph EQUIPMENT.
****

3.5.1 General Requirements

Construct pavement with paving and finishing equipment utilizing rigid fixed forms. Control paving equipment and its operation with all other operations such that the paver-finisher has a continuous forward movement at a reasonably uniform speed from beginning to end of each paving lane. Failure to achieve a continuous forward motion requires halting operations, regrouping, and modifying procedures, equipment, or mix proportions to achieve this requirement. Personnel are not permitted to walk or operate in the plastic concrete at any time. Select paving equipment and procedures which can properly operate on open-graded drainage layers without causing displacement or other damage.

3.5.2 Consolidation

Consolidate the concrete full-depth by use of immersion vibrators operated from a work bridge spanning the lane of placement. Do not use vibrators to transport or spread the concrete. Insert vibrators into the concrete to a depth that provides the best full-depth consolidation but not closer to the underlying material than 50 mm 2 inches. Insert hand-operated vibrators between 150 to 400 mm 6 to 15 inches on centers. Do not use hand-operated vibrators in the concrete in one location for more than 20 seconds. If vibrators cause visible tracking in the paving lane, or there are any other indications of inadequate consolidation (honeycomb along the edges, large air pockets or other voids, or any other evidence), discontinue paving operations until equipment and procedures have been modified to prevent it. Excessive vibration is not permitted. See ACI 309R for additional guidance on internal consolidation. Provide at least one additional vibrator spud or sufficient parts for rapid replacement and repair of vibrators at the paving site at all times.

3.5.3 Operation

3.5.3.1 Headers

Maintain a sufficient amount of concrete ahead of the paver to provide a roll of concrete which spills over the header. Provide a sufficient amount of extra concrete to prevent any slurry that is formed and carried along ahead of the paver from being deposited adjacent to the header. Maintain the spud vibrators in front of the paver-finisher operation at the desired depth as close to the header as possible before they are lifted. Provide additional consolidation adjacent to the headers by hand-manipulated vibrators.

3.5.3.2 Fill-In Lanes

Provide provisions to prevent damage to the previously constructed or

existing pavement when placing fill-in lanes. Control heavy duty vibratory truss screeds and triple roller tubes from applying excess pressure to the existing pavement and to prevent abrasion of the pavement surface. Maintain the overlapping area of existing pavement surface completely free of any loose or bonded foreign material as the paver-finisher operates across it.

3.5.4 Required Results

Adjust and operate the paver-finisher to produce a well consolidated slab throughout that is true to line and grade within specified tolerances. Provide a paver-finishing operation that produces a surface finish with a minimum, isolated amount of irregularities, tears, voids of any kind, and any other discontinuitiesacross the pavement. Provide equipment and paving operations that produce a finished surface requiring only the use of cutting straightedges. Keep hand finishing behind the paving equipment to a minimum.

3.5.5 Fixed Form Paving

Provide paving equipment for fixed-form paving and the operation that conforms to the requirements of paragraph EQUIPMENT, and all requirements specified herein.

3.5.5.1 Forms for Fixed-Form Paving

****
NOTE: Delete subparagraph e. when overlay pavements are not required.
****

a. Provide straight forms made of steel and in sections not less than 3 m 10 feet in length that are clean and free of rust or other contaminants. Seal any holes or perforations in forms prior to paving unless otherwise permitted. Maintain forms in place and passable by all equipment necessary to complete the entire paving operation without need to remove horizontal form supports. Provide flexible or curved forms of proper radius for curves of 31 m 100-foot radius or less. Provide wood forms for curves and fillets made of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend that have adequate strength and are rigidly braced. Provide forms with a depth equal to the pavement thickness at the edge. Where the project requires several different slab thicknesses, forms may be built up to provide an increase in depth of not more than 25 percent by bolting or welding a tubular metal section or by bolting wood planks to the bottom of the form to completely cover the underside of the base of the form. Provide forms with the base width of the one-piece or built-up form not less than eight-tenths of the vertical height of the form, except provide forms 200 mm 8 inches or less in vertical height with a base width not less than the vertical height of the form. Provide forms with maximum vertical deviation of top of any side form, including joints, not varying from a true plane more than 3 mm 1/8 inch in 3 m 10 feet, and the upstanding leg not varying more than 6 mm 1/4 inch.

b. Provide form sections that are tightly locked and free from play or movement in any direction. Provide forms with adequate devices for secure settings so that when in place they withstand, without visible spring or settlement, the impact and vibration of the consolidating

and finishing equipment.

c. Set forms for full bearing on foundation for entire length and width and in alignment with edge of finished pavement. Support forms during entire operation of placing, compaction, and finishing so that forms do not deviate vertically more than 3 mm 0.01 foot from required grade and elevations indicated. Check conformity to the alignment and grade elevations shown on the drawings and make necessary corrections immediately prior to placing the concrete. Clean and oil the forms each time before concrete is placed. Concrete placement is not allowed until setting of forms has been checked and approved by the CQC team.

d. Do not anchor guide rails for fixed form pavers into new concrete or existing concrete to remain.

[e. Use stakes or other approved methods to securely hold forms for overlay pavements and for other locations where forms are set on existing pavements. Carefully drill holes in existing pavements for form stakes by methods which do not crack or spall the existing pavement. After use, fill the holes flush with the surrounding surface using approved material, prior to overlying materials being placed. Immediately discontinue any method which does not hold the form securely or which damages the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location without proceeding further until the proposed method is approved.]

3.5.5.2 Form Removal

Keep forms in place at least 12 hours after the concrete has been placed. When conditions are such that the early strength gain of the concrete is delayed, leave the forms in place for a longer time. Remove forms by procedures that do not damage the concrete. Do not use bars or heavy metal tools directly against the concrete in removing the forms. Promptly repair any concrete found to be defective after form removal, using procedures specified or as directed.

3.5.6 Placing Reinforcing Steel

****
NOTE: Delete bracketed item if CRCP is not being constructed.
****

Provide the type and amount of steel reinforcement indicated. Regardless of placement procedure, provide reinforcing steel free from coatings which could impair bond between the steel and concrete, with reinforcement laps as indicated. Regardless of the equipment or procedures used for installing reinforcement, adequately consolidate the entire depth of concrete.[If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, submit the entire operating procedure and equipment proposed for approval at least 30 days prior to proposed start of paving.]

3.5.6.1 Pavement Thickness Greater Than 300 mm 12 inches

For pavement thickness of 300 mm 12 inches or more, place an initial lift of concrete on the underlying material to the required elevation of the steel reinforcement, consolidate the initial lift of concrete, place the

steel reinforcement upon the surface of the initial lift, place a second lift of concrete to final grade, consolidate, and finish in the required manner. When placement of the second lift causes the steel reinforcement to be displaced horizontally from its original position, provide provisions for increasing the thickness of the initial lift and depressing the steel reinforcement into the unhardened concrete to the required elevation. Limit the increase in thickness only as necessary to permit correct horizontal alignment to be maintained. Remove and replace any portions of the initial lift of concrete that have been placed more than 30 minutes without being covered with the second lift with newly mixed concrete without additional cost to the Government.

3.5.6.2 Pavement Thickness Less Than 300 mm 12 Inches

For pavements less than 300 mm 12 inches thick, position the reinforcement on suitable chairs or continuous mesh support devices securely fastened to the subgrade prior to concrete placement. Consolidate concrete after the steel has been placed.

3.5.7 Placing Dowels

Provide a method to install and hold dowels in position that meets the tolerances for location, alignment, and spacing of Table 6 after the pavement has been completed. Do not place longitudinal dowels closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced longitudinal dowel is closer than that dimension, move it away from the joint to a location 0.6 times the dowel bar length, but not closer than 150 mm 6 inches to its nearest neighbor. Resolve dowel interference at a transverse joint-longitudinal joint intersection by removing the closest transverse dowel. Do not position the end of a transverse dowel closer than 300 mm 12 inches from the end of the nearest longitudinal dowel. Install dowels as specified in the following subparagraphs.

TABLE 6 DOWEL ALIGNMENT TOLERANCES	
Dowel Measurement	Tolerance
Horizontal alignment (a)	Maximum of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed
Vertical alignment (b)	Maximum of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed
Horizontal spacing	plus or minus 15 mm 5/8 inch, except as otherwise specified above
Vertical location on the face of the slab	plus or minus 13 mm 1/2 inch
(a) Check horizontal alignment perpendicular to the joint edge with a framing square.	

TABLE 6	
DOWEL ALIGNMENT TOLERANCES	
Dowel Measurement	Tolerance
(b) Measure the vertical alignment of the dowels parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Measure dowels across crowns and other joints at grade changes to a level surface.	

[3.5.7.1 Contraction Joints

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NOTE: Delete references to installation of dowels in contraction joints if not required.
****

Securely hold dowels in longitudinal and transverse contraction joints within the paving lane in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. Securely hold the basket assemblies in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

]3.5.7.2 Construction Joints-Fixed Form Paving

Install dowels by the bonded-in-place method or the drill-and-dowel method. Installation by removing and replacing in preformed holes is not permitted. Prepare and place dowels across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. Provide the spacing of dowels in construction joints as indicated, except that, where the planned spacing cannot be maintained because of form length or interference with form braces, provide closer spacing with additional dowels.

3.5.7.3 Dowels Installed in Hardened Concrete

Install dowels in hardened concrete by bonding the dowels into holes drilled into the hardened concrete. Before drilling commences, cure the concrete for 7 days or until it has reached a minimum field cured compressive strength of 17 MPa 2500 psi. Drill holes 3 mm 1/8 inch greater in diameter than the dowels into the hardened concrete using rotary-core drills. Rotary-percussion drills are permitted provided that excessive spalling does not occurat the concrete joint face. Excessive spalling is defined as spalling deeper than 6 mm 1/4 inch from the joint face or 12 mm 1/2 inch radially from the outside of the drilled hole. Modify the equipment and operation if excess spalling occurs. Drill depth of dowel hole within a tolerance of plus or minus 13 mm 1/2 inch of the half length of the embedded dowel. Blow out the dowel hole with oil-free, compressed air upon completion of the drilling operation. Bond dowels in the drilled holes using epoxy resin. Inject epoxy resin at the back of the hole before installing the dowel and extrude to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel is not permitted. Hold the

dowels in alignment at the collar of the hole after insertion and before the grout hardens by means of a suitable metal or plastic grout retention ring fitted around the dowel. Provide dowels required between new and existing concrete in holes drilled in the existing concrete, all as specified above.

3.5.7.4 Lubricating Dowel Bars

Immediately prior to placement, wipe clean the portion of each dowel intended to move within the concrete and coat with a thin, even film of lubricating oil or light grease. Form oil is not acceptable for dowel lubrication. Do not place caps on the dowel ends.

3.6 FINISHING

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NOTE: Hand finishing is to be allowed only for isolated, small, odd-shaped slabs or places inaccessible to the paver.

****

Provide finishing operations as a continuing part of placing operations starting immediately behind the strike-off of the paver. Provide finishing by the vibratory truss screed or triple roller tube paver. Provide the sequence of operations consisting of transverse finishing, cutting straightedge finishing, edging of joints, and texturing . Provide a work bridge for consolidation and hand finishing operations. Use hand finishing only in isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Keep supplemental hand finishing for machine finished pavement to an absolute minimum. Immediately stop any machine finishing operation which requires appreciable hand finishing other than a moderate amount of straightedge finishing. Make proper adjustments or replace the equipment before recommencing paving. Immediately halt any operations which produce more than 3 mm 1/8 inch of mortar-rich surface (defined as deficient in plus 4.75 mm U.S. No. 4 sieve size aggregate) and modify the equipment, mixture, or procedures as necessary before recommencing paving. Compensate for surging behind the screeds and settlement during hardening and adjust the paving and finishing machines so that the finished surface of the concrete (not just the cutting edges of the screeds) is at the required line and grade. Maintain finishing equipment and tools in a clean and an approved working condition. Water is not allowed to be added to the surface of slabs using finishing equipment, tools, or any other method except fog (mist) sprays may be applied to slab surfaces to prevent plastic shrinkage cracking.

3.6.1 Machine Finishing With Fixed Forms

Provide a machine that is designed to ride the forms and can be operated to screed and consolidate the concrete. Replace paving equipment that causes displacement of the forms. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in minimal passes, immediately stop the operation and adjust the equipment, mixture, and procedures as necessary before recommencing paving.

3.6.2 Surface Correction and Testing

Evaluate the surface for trueness with a 4 m 12 feet straightedge after all other finishing is completed but while the concrete is still plastic.

Equip the straightedge with a handle 1 m 3 feet longer than the width of the placement and operate the straightedge from the sides of the pavement or from bridges. Evaluate the surface trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement to detect variations. Advance the straightedge along the pavement in successive stages of one-half the length of the straightedge. Eliminate minor irregularities and score marks in the pavement surface by means of cutting straightedges. Immediately fill depressions with freshly mixed concrete then strike off, consolidate with an internal vibrator, and refinish. Strike off projections above the required elevation and refinish. Continue the straightedge testing and finishing until the entire surface of the concrete is free from observable departure from the straightedge and conforms to the surface requirements specified in paragraph SURFACE SMOOTHNESS. This straightedging is not allowed to be used as a replacement for the straightedge testing of hardened concrete for acceptance. Use long-handled flat bull floats very sparingly and only as necessary to correct minor, scattered surface defects. Stop the paving operation if frequent use of bull floats is necessary. Adjust the equipment, mixture, or procedures to eliminate surface defects and frequent use of bull floats before recommencing paving. Keep finishing with hand floats and trowels to the absolute minimum necessary. Take extreme care to prevent over finishing joints and edges. Produce the surface finish of the pavement essentially by the finishing machine and not by subsequent hand finishing operations. All hand finishing operations are subject to approval.

3.6.3 Hand Finishing

Use hand finishing operations only as specified below. Provide a work bridge for full-depth consolidation operations. Walking or operating in plastic concrete is not allowed.

3.6.3.1 Finishing and Floating

Strike off and screed the concrete to the required cross section and elevation immediately after placement and full-depth consolidation. Do not overlap the floating operation more than half the length of the float between new and previously floated surfaces. If necessary, place additional concrete then consolidate, screed, and float until the specified surface, cross section, and elevation has been produced.

3.6.4 Texturing

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NOTE:Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING to specify saw-cut grooves. Delete pararaph Surface Grooving if grooving is not used.

For Navy airfield paving projects, do not specify surface grooving textures.

****

Texture the surface of the pavement as described herein when the concrete is still plastic, before the surface sheen has disappeared, and before the curing compound is applied. Apply the texture in a single continuous drag. Multiple passes are not allowed. The corrugations produced by the drag need to be uniform in appearance and approximately 1 mm 1/16 inch in depth. Thoroughly power broom all textured surfaces to remove all debris

after curing is complete.

3.6.4.1 Burlap Drag Surface

Apply surface texture by dragging the surface of the pavement with an approved burlap drag in the direction of the concrete placement. Operate the drag with the fabric moist, and maintain the fabric in a clean condition. Perform the dragging so as to produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.6.4.2 Broom Texturing for Hand Finishing

Hand brooming is permitted only where hand finishing is allowed. Complete brooming before the concrete has hardened to the point where the surface is unduly torn or roughened, but after hardening has progressed enough so that the mortar does not flow and reduce the sharpness of the scores. Overlap successive passes of the broom the minimum necessary to obtain a uniformly textured surface. Wash brooms thoroughly at frequent intervals during use. Remove worn or damaged brooms from the job site. Transversely draw the hand brooms across the surface from the center line to each edge with slight overlapping strokes.

[3.6.4.3 Surface Grooving

Groove the areas indicated on the drawings as required in Section 32 01 18.71 GROOVING FOR AIRFIELD PAVEMENTS.

]3.6.5 Edging

Before texturing has been completed, carefully finish the edge of the slabs along the forms and at the joints with an edging tool to form a smooth rounded surface of 3 mm 1/8 inch radius. Eliminate tool marks and provide edges that are smooth and true to line. Water is not allowed to be added to the surface during edging. Take extreme care to prevent overworking the concrete.

3.6.6 Pavement Penetrations

Construct recesses for the tie-down anchors, lighting fixtures, and other outlets in the pavement to conform to the details and dimensions shown. Carefully finish the concrete in these areas to provide a surface of the same texture as the surrounding area that is within the requirements for plan grade and surface smoothness.

3.7 CURING

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NOTE: Membrane curing should be the first choice for curing methods. For most projects delete the first bracketed item. Retain the first bracketed item requiring moist curing for OCONUS projects using Silica Fume.

****

3.7.1 Protection of Concrete

Continuously protect concrete against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations as required below. 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 or replace the damaged pavement, and provide another method of curing as directed. [Accomplish curing by application of moist curing for the first 72 hours, followed by curing operations as required below for the remainder of the curing period].

3.7.2 Membrane Curing

Apply a uniform coating of white-pigmented, membrane-forming, curing compound to the entire exposed surface of the concrete as soon as the free water has disappeared from the surface after [finishing] [moist curing ceases]. Apply immediately along the formed edge faces after the forms are removed. Do not allow the concrete to dry before the application of the membrane. Moisten the surface of the concrete with a fine spray of water if any drying has occurred and apply the curing compound as soon as the free water disappears. Apply the curing compound to the finished surfaces by means of an approved automatic spraying machine. Apply the curing compound with an overlapping coverage that provides a two-coat application at a coverage of 10 square meters per L 400 square feet per gallon, plus or minus 5.0 percent for each coat. A one-coat application is allowed provided it is applied in a uniform application and coverage of 5 square meters per L 200 square feet per gallon, plus or minus 5.0 percent is obtained. The application of curing compound by hand-operated, mechanical powered pressure sprayers is permitted but application rate must meet the above requirements. 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. Respray curing compound to concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied by the method and at the coverage specified above. Respray curing compound to areas where the curing compound is damaged by subsequent construction operations within the curing period immediately. Adequately protect concrete surfaces to which membrane-curing compounds have been applied during the entire curing period from pedestrian and vehicular traffic, except as required for joint-sawing operations and surface tests, and from any other possible damage to the continuity of the membrane.

[3.7.3 Moist Curing

Maintain concrete to be moist-cured continuously wet for the entire curing period, or until curing compound is applied, commencing immediately after finishing. If forms are removed before the end of the curing period, provide curing on unformed surfaces, using suitable materials. Cure surfaces by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Provide burlap and mats that are clean and free from any contamination and completely saturated before being placed on the concrete. Lap sheets to provide full coverage. Provide an approved system to provide continuous moist curing 24 hours per day and such that the entire surface is wet.

]3.8 JOINTS

3.8.1 General Requirements for Joints

Construct joints that conform to the locations and details indicated and are perpendicular to the finished grade of the pavement. Provide joints that are straight and continuous from edge to edge or end to end of the pavement with no abrupt offset and no gradual deviation greater than 13 mm 1/2 inch. Where any joint fails to meet these tolerances, remove and replace the slabs adjacent to the joint at no additional cost to the Government. Change from the jointing pattern shown on the drawings is not allowed without written approval. Seal joints immediately following curing of the concrete or as soon thereafter as weather conditions permit as specified in Section [32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT][or][32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].

3.8.2 Longitudinal Construction Joints

Install dowels in the longitudinal construction joints or thickened edges as indicated.

3.8.3 Transverse Construction Joints

Install transverse construction joints at the end of each day's placing operations at a planned transverse joint. Match transverse joint locations with adjacent lanes where indicated. If concrete placement is interrupted for 30 minutes or longer, stop work and remove concrete to the nearest completed joint to form a construction joint. Provide transverse construction joints by utilizing headers or by paving through the joint then full-depth sawcutting the excess concrete. Construct pavement with the paver as close to the header as possible with the paver run out completely past the header.

3.8.4 Expansion Joints

Provide expansion joints where indicated and at all intersections of airfield pavement with structures and features that project through or into the pavement. Use joint filler of the type, thickness, and width indicated, and install to form a complete, uniform separation between the structure and the pavement or between two pavements. Attach the filler to the original concrete placement with adhesive and mechanical fasteners extending to the full slab depth. Sawcut the sealant reservoir depth from the filler after placement and curing of the adjacent slab. Tightly fit adjacent sections of filler together, with the filler extending across the full width of the paving lane or other complete distance in order to prevent entrance of concrete into the expansion space. Finish edges of the concrete at the joint face with an edger with a radius of 3 mm 1/8 inch.

[3.8.5 Slip Joints

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NOTE: Slip joints should only be designed if conventional expansion joints or thickened edge joints are not expected to work well. Delete slip joints if not used on project.

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Install slip joints where indicated using the specified materials. Attach preformed joint filler material to the face of the original concrete

placement with adhesive and mechanical fasteners. Sawcut a 19 mm 3/4 inch deep reservoir for joint sealant at the top of the joint. Finish edges of the joint face with an edger with a radius of 3 mm 1/8 inch.

]3.8.6 Contraction Joints

Construct transverse and longitudinal contraction joints by an initial sawcut in the concrete with a 3 mm 1/8 inch blade to the indicated depth. The CQC team is required to inspect and immediately report results of all exposed lane edges for development of cracks below the saw cut during sawing of joints and again 24 hours later. If there are more than six consecutive uncracked joints after 48 hours, saw succeeding joints 25 percent deeper than originally indicated at no additional cost to the Government. Vary the time of initial sawing depending on existing and anticipated weather conditions to prevent uncontrolled cracking of the pavement. Commence sawing of the joints as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. Inspect the sawed faces of joints for undercutting or washing of the concrete due to the early sawing. Delay sawing if undercutting is sufficiently deep to cause structural weakness or excessive roughness in the joint. Continue the sawing operation as required during both day and night regardless of weather conditions. Saw the joints in the sequence of the concrete placement. Provide adequate lighting for night work. Illumination using vehicle headlights is not permitted. Provide a chalk line or other suitable guide to mark the alignment of the joint. Examine the concrete closely for cracks before sawing a joint and do not saw the joint if a crack has occurred near the planned joint location. Discontinue sawing if a crack develops ahead of the saw cut. Immediately after the joint is sawed thoroughly flush the saw cut and adjacent concrete surface with water and vacuum until all waste from sawing is removed from the joint and adjacent concrete surface. Properly protect the concrete from damage and cure at sawed joints. Tightly seal the top of the joint opening and the joint groove at exposed edges with cord backer rod before the concrete in the region of the joint is resprayed with curing compound. Maintain the backer rod until removal is required immediately before sawing the joint sealant reservoir. Respray the surface with curing compound as soon as residual water disappears. Seal the exposed saw cuts on the vertical faces of pilot lanes with bituminous mastic or masking tape. After expiration of the curing period, widen the upper portion of the groove by sawing with ganged diamond saw blades to the width and depth indicated for the joint sealer. Center the reservoir over the initial sawcut.

3.8.7 Thickened Edge Joints

Construct thickened edge joints as indicated on the drawings. Grade the underlying material in the transition area as shown and meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

3.9 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS

3.9.1 General Criteria

Repair or provide complete removal and replacement of new pavement slabs as specified at no cost to the Government. Removal of partial slabs is not permitted. Prior to any repairs, submit a Repair Recommendations Plan detailing areas exceeding the specified limits as well as repair recommendations required to bring these areas within specified tolerances.

3.9.2 Slabs with Cracks

The Government may require cores to be taken over cracks to determine depth of cracking. Drill cores with a minimum diameter of 150 mm 6 inches and backfill with an approved concrete mixture. Perform drilling of cores and filling of holes at no expense to the Government. Clean cracks that do not exceed 50 mm 2 inches in depth; then pressure inject full depth with epoxy resin, Type IV, Grade 1. Remove and replace slabs containing cracks deeper than 50 mm 2 inches.

3.9.3 Removal and Replacement of Full Slabs

Remove new or existing slabs damaged during construction that contain more than 15.0 percent of any longitudinal or transverse joint edge spalled. Remove full slabs in accordance with paragraph REMOVAL OF EXISTING PAVEMENT SLAB below. Remove and replace full depth by full width of the slab. Limit the removal of slabs to the paving lane and nearest joints. Compact and shape the underlying material as specified in the appropriate section of these specifications. Cut off original damaged dowels flush with the joint face. Clean the existing concrete surfaces of all loose material and contaminants, then coat with a double application of membrane forming curing compound as a bond breaker. Install dowels of the size and spacing as specified for other joints in similar pavement by epoxy grouting them into holes drilled into the existing concrete using procedures as specified in paragraph PLACING DOWELS, above. Provide dowels for all edges of the new slab. Lightly oil or grease protruding portions of new dowels in accordance with pargraph LUBRICATING DOWEL BARS. Place concrete as specified for original construction. Take care to prevent any curing compound from contacting dowels. Prepare and seal the resulting joints around the new slab as specified for original construction.

3.9.4 Repairing Spalls Along Joints

Repair spalls along joints to a depth to restore the full joint-face support prior to placing adjacent pavement. Where directed, repair spalls along joints of new slabs, along edges of adjacent existing concrete, and along parallel cracks by first making a vertical saw cut at least 75 mm 3 inches outside the spalled area and to a depth of at least 50 mm 2 inches. Provide saw cuts consisting of straight lines forming rectangular areas without sawing beyond the intersecting saw cut. Chip out the concrete between the saw cut and the joint, or crack, to remove all unsound concrete and into at least 13 mm 1/2 inch of visually sound concrete. Thoroughly clean the cavity thus formed with high pressure water jets supplemented with oil-free compressed air to remove all loose material. Immediately before filling the cavity, apply a prime coat to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. Apply the prime coat in a thin coating and scrub into the surface with a stiff-bristle brush. Provide prime coat for portland cement repairs consisting of a neat cement grout and for epoxy resin repairs consisting of epoxy resin, Type III, Grade 1. Fill the prepared cavity with material identified in Table 7 based on the cavity volume.

TABLE 7	
Spall Repairs	
Volume of Prepared Cavity After Removal Operations	Material
less than 0.00085 cubic meter 0.03 cubic foot	epoxy resin mortar or epoxy resin or latex modified mortar
0.00085 cubic meter 0.03 cubic foot and 0.009 cubic meter 1/3 cubic foot	Portland cement mortar
more than 0.009 cubic meter 1/3 cubic foot	Portland cement concrete or latex modified mortar

Provide portland cement concretes and mortars that consist of very low slump mixtures, 13 mm 1/2 inch slump or less, proportioned, mixed, placed, consolidated by tamping, and cured, all as directed. Provide epoxy resin mortars made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved. Proprietary patching materials may be used, subject to Government approval. Place the epoxy resin materials in the cavity in layers with a maximum thickness of 50 mm 2 inches. Provide adequate time between placement of additional layers such that the temperature of the epoxy resin material does not exceed 60 degrees C 140 degrees F at any time during hardening. Provide mechanical vibrators and hand tampers to consolidate the concrete or mortar. Remove any repair material on the surrounding surfaces of the existing concrete before it hardens. Where the spalled area abuts a joint, provide an insert or other bond-breaking medium to prevent bond at the joint face. For existing joints, seal the bottom contraction crack with backer rod to prevent instrusion of primer or mortar. Saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean the reservoir and then provide the sealer specified for the joints. In lieu of sawing, spalls and popouts not adjacent to joints, both less than 150 mm 6 inches in maximum dimension, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.

3.9.5 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed aggregates, voids, or deleterious materials. Cores evaluated by a qualified petrographer to contain carbonation to a depth greater than 3 mm 1/8 inch or Mohs hardness of less than 2, when tested in accordance with ASTM C1895, are also considered rain damaged. Diamond grind slabs containing weak surfaces less than 6 mm 1/4 inch thick to remove the weak surface. Diamond grind in accordance with paragraph DIAMOND GRINDING OF PCC SURFACES. All diamond ground areas are required to meet the thickness, smoothness, and grade criteria specified in paragraph ACCEPTANCE. Remove and replace slabs containing weak surfaces greater than 6 mm 1/4 inch thick.

3.10 EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR

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NOTE: It is imperative that sufficient exploration

be made (not just reference to as-built drawings) for the designer to know exactly what the in-place existing pavement thickness and load-transfer are at the jointing area--such as dowels, keys, tie bars--and its condition. Normally, the joint between the new pavement and existing pavement is made at an existing joint in the old pavement. Coordinate with Section 02 41 00 DEMOLITION.
****

Demolition of existing operational pavement is not allowed prior to approval of the Proportioning Studies. Remove existing concrete pavement at locations indicated on the drawings. Inventory the pavement distresses (cracks, spalls, and corner breaks) along the pavement edge to remain prior to commencing pavement removal operations. Survey the remaining edge again after pavement removal to quantify any damage caused by removal operations. Perform both surveys in the presence of the Government. Perform repairs as indicated and as specified herein. Carefully control all operations to prevent damage to the concrete pavement and to the underlying material to remain in place. Perform all saw cuts perpendicular to the slab surface forming rectangular areas. Perform all existing concrete pavement repairs prior to paving adjacent lanes.

3.10.1 Removal of Existing Pavement Slab

****
NOTE: Use a wheel saw to produce a saw kerf at least 40 mm 1-1/2 inches wide to prevent stress from propagating across the saw cut into existing pavement to be left in place.
****

Use one of the following methods when existing concrete pavement is to be removed and adjacent concrete is to be left in place:

Method 1

a. Perform the first full depth saw cut on the joint between the removal area and adjoining pavement to stay in place with a standard diamond-type concrete saw.

b. Next, perform a full depth saw cut parallel to the joint that is at least 600 mm 24 inches from the joint and at least 150 mm 6 inches from the end of any dowels with a wheel saw as specified in paragraph SAWING EQUIPMENT.

c. Remove all pavement beyond this last saw cut in accordance with the approved demolition work plan.

d. Remove all pavement between this last saw cut and the joint line by carefully pulling pieces and blocks away from the joint face with suitable equipment and then picking them up for removal. As an alternative, this strip of concrete may be carefully broken up and removed using hand-held jackhammers, 14 kg 30 lb or less, or other approved light-duty equipment which does not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place.

Method 2

a. Sawcut the slab full depth to divide it into several pieces and lift each piece out. Use suitable equipment to provide a truly vertical lift with safe lifting devices used for attachment to the slab.

3.10.2 Edge Repair

Protect the edge of existing concrete pavement against which new pavement abuts from damage at all times. Remove and replace slabs which are damaged during construction as directed at no cost to the Government. Repair of previously existing damaged areas is considered a subsidiary part of concrete pavement construction. Saw off all exposed keys and keyways full depth.

3.10.2.1 Spall Repair

Repair spalls caused by construction activities for slabs that have less than 15.0 percent spalling along any edge. Provide repair materials and procedures as previously specified in paragraph REPAIRING SPALLS ALONG JOINTS. Remove and replace full slabs containing more than 15.0 percent spalling along any edge in accordance with paragraph REMOVAL AND REPLACEMENT OF FULL SLABS.

3.10.2.2 Underbreak and Underlying Material

Repair all underbreak by removal and replacement of the damaged slabs in accordance with paragraph REMOVAL AND REPLACEMENT OF FULL SLABS above. Protect the underlying material adjacent to the edge of and under the existing pavement to remain from damage or disturbance during removal operations and until placement of new concrete. Replace the concrete panels with the dimensions shown on the drawings or as directed. Maintain sufficient underlying material in place outside the joint line to completely prevent disturbance of material under the pavement which is to remain in place. Remove and replace any slab with underlying material that is disturbed or loses its compaction.

3.11 PAVEMENT PROTECTION

3.11.1 Existing Pavement Protection

Protect existing pavement from all damage. Placement of aggregates, rubble, or other similar construction materials is not allowed on existing pavement. Take special care in areas where traffic uses or crosses active airfield pavement. Power broom existing pavements at least daily when traffic operates. Immediately clean up spillage of concrete or other materials upon occurrence. Provide equipment that does not damage or spall existing concrete when trafficking and provide means to protect joints and edges as necessary to prevent damage

3.11.2 New Pavement Protection

Protect new pavement against all damage prior to final acceptance of the work by the Government. Placement of aggregates, rubble, or other similar construction materials on airfield pavements is not allowed. Exclude traffic from the new pavement by erecting and maintaining barricades and signs until the concrete is at least 14 days old or for a longer period if so directed. Operation of the hauling and paving equipment is permitted

on the new pavement as a construction expedient after the pavement has been cured for 7 days, the joints have been sealed or otherwise protected, the concrete has attained a minimum field cured compressive strength of 24.1 MPa 3,500 psi, and approved means are provided to prevent damage to the slab edges. Fabricate and field cure specimens in accordance with ASTM C31/C31M. Continuously maintain and completely clean all new pavement carrying construction traffic or equipment. Immediately clean up spillage of concrete or other materials upon occurrence. For fill-in lanes, provide equipment that does not damage or spall the edges or joints of the previously constructed pavement.

3.12 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL DURING CONSTRUCTION

3.12.1 Testing and Inspection by Contractor

Perform sampling and testing of aggregates, cementitious materials (cement, slag cement, and pozzolan), and concrete during construction to determine compliance with the specifications. Select sample locations on a random basis in accordance with ASTM D3665. 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 concrete at the point of delivery to the paver. Testing by the Government in no way relieves the specified testing requirements. 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.

3.12.2 Sampling and Testing Concrete

Obtain one random composite sample of concrete in accordance with ASTM C172/C172M from one batch or truckload at the frequency shown in Table 7. Fabricate and cure six test cylinders 152 x 305 mm 6 x 12 inches in accordance with ASTM C31/C31M and test them in accordance with ASTM C39/C39M. Test two test cylinders at 7 days, two cylinders at 28 days, and hold two cylinders in reserve for each collected sample.

3.12.3 Thickness and Consolidation Testing

Drill two random cores between 100 and 150 mm 4 and 6 inches in diameter from the pavement at the frequency shown in Table 7. Drill the cores within 3 days after placement. Fill each core hole with an approved concrete mixture and respray cored areas with curing compound. Record eight measurements of thickness around the circumference of each core and one in the center in accordance with ASTM C174/C174M. Record and submit testing, inspection, and evaluation of each core for mortar-rich surface, uniformity of aggregate distribution, segregation, voids, cracks, and depth of reinforcement or dowel (if present). Moisten the core with water to visibly expose the aggregate and take a minimum of three photographs of the sides showing the core's entire length, rotating the core approximately 120 degrees between photographs. Include a ruler for scale in the photographs that does not obscure the core. Provide plan view of location for each core.

3.12.4 Surface Smoothness Testing

Test the entire surface of the pavement in such a manner as to reveal all surface irregularities exceeding the tolerances specified in paragraph ACCEPTANCE. Begin smoothness testing after the concrete has hardened sufficiently to permit walking thereon, but not later than 48 hours after placement. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 1.5 m 5 feet or less apart, as directed. Perform the longitudinal lines at the centerline of each paving lane shown on the drawings, regardless of whether multiple lanes are allowed to be paved at the same time and at the 1/8th point in from each side of the lane. Also perform testing lines across all joints and at other areas having obvious deviations. Retest areas if they are diamond ground. Maintain detailed notes of the testing results and provide a copy to the Government after each day's testing.

3.12.4.1 Straightedge Testing

Use the straightedge method for transverse testing, longitudinal testing, joints, and at the ends of the paving limits for the project. Hold the straightedge in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. Determine the amount of surface irregularity by placing the freestanding (unleveled) straightedge on the pavement surface and measuring the maximum gap between the straightedge and the pavement surface. Determine measurements along the entire length of the straight edge and submit all test results to the government prior to placement of adjacent concrete.

3.12.5 Plan Grade Testing

Within 5 days after paving, test the finished surface of the pavement area to reveal all elevations exceeding the tolerances specified in paragraph ACCEPTANCE. Run lines of levels at intervals corresponding with every longitudinal and transverse joint to determine the elevation at each joint intersection. Record the results of this survey and provide a copy to the Government at the completion of the survey prior to placement of adjacent concrete.

3.12.6 Cementitious Materials Testing

Retest cementitious material that has not been used within 6 months after testing and reject if test results do not meet manufacturer requirements.

3.12.7 Chemical Admixture Testing

Retest chemical admixtures that have been in storage at the project site for longer than 6 months or that have been subjected to freezing and reject if test results do not meet manufacturer requirements.

3.12.8 Testing and Inspection Requirements

Perform CQC sampling, testing, inspection and reporting in accordance with Table 8.

TABLE 8 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Fine Aggregate Gradation and Fineness Modulus			
Once per day	ASTM C136/C136M and ASTM C117 sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Coarse Aggregate Gradation (each aggregate size)			
Once per day	ASTM C136/C136M and ASTM C117 sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Workability Factor and Coarseness Factor Computation			

TABLE 8 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Same as C.A. and F.A.	see paragraph AGGREGATES	Use individual C.A. and F.A. gradations. Combine using batch ticket percentages (average of aggregate percentages from 3 before and 3 after sampling). Tolerances: plus or minus 3 points on WF; plus or minus 5 points on CF from approved adjusted mix design values; only the portion of the tolerance box within the parallelogram is available for use	Check batching tolerances, recalibrate scales
		Test result outside limits	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Concrete Mixture - Slump			
40 cubic meters50 cubic yards and when test specimens prepared	ASTM C143/C143M sample at point of discharge within the paving lane	At maximum allowable slump	Retest
		2nd slump failure	Reject concrete, stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Concrete Mixture - Air Content			
Same as slump	ASTM C231/C231M sample at point of discharge within the paving lane	Plus or minus 1.5 percent	Retest
		2nd air content failure	Reject concrete, stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving

TABLE 8 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Concrete Mixture - Temperature			
Same as slump	ASTM C1064/C1064M sample at point of discharge within the paving lane	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			
120 cubic meters150 cubic yards, minimum one test per day	ASTM C31/C31M sample at point of discharge within the paving lane	See paragraph ACCEPTANCE Perform fabrication of strength specimens and initial cure outside the paving lane and within 300 m 1,000 feet of the sampling point.	
Concrete Mixture - Unit Weight and Yield			
Same as concrete strength	ASTM C138/C138M sample at point of discharge within the paving lane	0 or plus 5 percent	Retest
		2nd unit weight and yield failure	Reject concrete, stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Concrete Thickness			
Same as concrete strength	ASTM C174/C174M	See paragraph ACCEPTANCE	

3.12.9 Contractor Quality Control Reports

Report informally and in writing daily the results of all tests and inspections conducted. Submit Contractor Quality Control reports on a daily basis using a format that is clear and allows for ready determination of compliance with specification. Use testing and inspections for early identification and correction of issues to production. These requirements do not relieve the obligation to report certain failures immediately as required in preceding paragraphs. Confirm such reports of failures and the action taken in writing in the routine reports. The Government has the right to examine all Contractor quality control records.

-- End of Section --