UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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SECTION 32 13 13.43

HIGH TEMPERATURE CONCRETE PAVING FOR AIRFIELDS USING LIGHTWEIGHT AND TRAPROCK AGGREGATES
02/18

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NOTE: This specification is for concrete pavements exposed to temperatures of 482 degrees C 900 degrees F or higher, referred to herein as High Temperature Concrete. Heat Resistant recommendations exist for concrete exposed to moderate temperatures of 149 to 482 degrees C 300 to 900 degrees F per ETL 14-2 but are also applicable to the specification. Those responsible for design and construction of High Temperature Concrete pavement should familiarize themselves with the most current criteria pertaining to High Temperature Concrete. The most current criteria may be obtained from the cognizant Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Command (NAVFAC, Echelon III) Pavement Engineer.

This specification is based on ETL 14-4, Vertical Landing Zone (VLZ) and Other Airfield Pavement Design and Construction Using High Temperature Concrete and NAVFAC EXWC Technical Report - traprock Aggregate Characterization for High Temperature Concrete.

Tailoring options are for both traprock & lightweight aggregates (TRAPROCK & LIGHTWEIGHT), traprock aggregate only (TRAPROCK), lightweight aggregate only (LIGHTWEIGHT), US customary and metric units. To properly tailor this specification, choose one of the three Tailoring options and hide the other two. For instance, if you chose TRAPROCK & LIGHTWEIGHT to show both, you would hide the individual Tailoring options for TRAPROCK and LIGHTWEIGHT. When tailoring for traprock or lightweight, check for bracketed items to edit. Use the traprock tailoring option whenever possible. Traprock aggregates require deleterious materials and Alkali-Silica Reaction testing similar to normal airfield concrete; lightweight aggregates are a manufactured product to ASTM C330/C330M

standards and do not require deleterious or Alkali-Silica Reaction testing.

This specification includes the ability to place the thigh temperature concrete via hand placement with a vibrating truss screed, or a fixed or slipform paver. Continuously reinforced concrete placements must always be performed with a vibrating truss screed. It is encouraged to avoid using a slipform paver, however there are some plain jointed applications where this method of placement would be advantageous.

This specification is to be used only with the written approval of the cognizant Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Command (NAVFAC, Echelon III) Pavement Engineer.

If used on Design/Build projects, this section must be prepared by the Government RFP preparer. Edit this guide specification for project specific requirements by deleting non applicable paragraphs only. For bracketed items, choose applicable items(s) or insert appropriate information. No further edited by the contractor's designer of record, unless specifically stated otherwise in the contract documents is authorized.

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

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

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

****

PART 1 GENERAL

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NOTE: 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 may not be used.

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 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: For Lump Sum payment, include concrete unit price from Government estimate in paragraph PAYMENTS to provide cost basis for calculating payment reduction.

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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 or Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT.

1.1.2 Payments

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NOTE: Use the applicable paragraph from the two choices below and delete the other.

If this specification is used for the to construct a certified F-35B landing or hover point, typical of Vertical Landing Pads and LHA Simulators, use Lump Sum.

This specification is not intended to be used as the primary pavement of Runways and Taxiways unless there is a specific operational need to do so. The use of Unit Price should be limited to large areas such as Aprons in support of MV-22 operations.
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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.

1.1.2.2 Lump Sum

The quantity of concrete will be paid for and included in the lump-sum contract price. If less than 100 percent payment is due based on the pay factors stipulated below, a unit price of [_____] per cubic meter yard will be used for purposes of calculating the payment reduction.

1.1.3 Payment of Lots

When a lot of material fails to meet the specification requirements, that lot will be accepted at a reduced price or be removed and replaced. The lowest computed percent payment determined for any pavement characteristic discussed below (for example, thickness, grade, and surface smoothness) becomes the actual percent payment for that lot. The actual percent payment will be applied to the unit price and the measured quantity of concrete in the lot to determine actual payment. Use results of strength tests to control concreting operations. Strength will be evaluated, but will not be considered for payment adjustment. Remove and replace any pavement not meeting the required 'Concrete Strength for Final Acceptance' at no additional cost to the Government.

1.1.4 Payment Adjustment for Smoothness

1.1.4.1 Straightedge Testing

Record location and deviation from straightedge for all measurements. When more than 5.0 and less than or equal to 10.0 percent of all measurements made within a lot exceed the tolerance specified in paragraph SURFACE SMOOTHNESS, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When more than 10.0 percent and less than or equal to 15.0 percent of all measurements exceed the tolerance, the computed percent payment will be 90 percent. When more than 15.0 and less than or equal to 20.0 percent of all measurements exceed the tolerance, the computed percent payment will be 75 percent. Remove and replace the lot when more than 20.0 percent of the measurements exceed the tolerance, at no additional cost to the Government.

1.1.4.2 Profilograph Testing

Record location and data from all profilograph measurements. When the Profile Index of a 0.1 km 0.1 mile segment of a lot exceeds the tolerance specified in paragraph SURFACE SMOOTHNESS by 16 mm per km 1.0 inch per mile but less than 32 mm per km 2.0 inches per mile, after any reduction of high spots or removal and replacement, the computed percent payment based on surface smoothness will be 95 percent. When the Profile Index exceeds the tolerance by 32 mm per km 2.0 inches per mile but less than 47 mm per km 3.0 inches per mile, the computed percent payment will be 90 percent. When the Profile Index exceeds the tolerance by 47 mm per km 3.0 inches per mile but less than 63 mm per km 4.0 inches per mile, the computed percent payment will be 75 percent. Remove and replace the lot when the Profile Index exceeds the tolerance by 63 mm per km 4.0 inches per mile or more, at no additional cost to the Government.

1.1.5 Payment Adjustment for Plan Grade

When more than 5.0 and less than or equal to 10.0 percent of all measurements made within a lot are outside the specified tolerance, the computed percent payment for that lot will be 95 percent. When more than 10.0 percent but less than 50 percent are outside the specified tolerances, the computed percent payment for the lot will be 75 percent. Remove and replace the deficient area where the deviation from grade exceeds the specified tolerances by 50 percent or more, at no additional cost to the Government.

1.1.6 Payment Adjustment for Thickness

Using the Average Thickness of the lot, determine the computed percent payment for thickness by entering the following table:

Computed Percent Payment for Thickness		
Deficiency in Thickness Determined by cores millimeters inches	Pavements Equal To or Greater Than 200 mm 8 inches Thick	Pavements Less Than 200 mm 8 inches Thick
0.00 to 6.2 0.00 to 0.24	100	100
6.3 to 12.5 0.25 to 0.49	75	65
12.6 to 18.9 0.50 to 0.74	50	0
19.0 0.75 or greater	0	0

Where 0 percent payment is indicated, remove the entire lot and replace at no additional cost to the Government. Where either of the two cores from a sublot show a thickness deficiency of 19 mm 0.75 inch or greater, [13 mm 0.50 inch for pavements 200 mm 8 inches or less in thickness] drill two more cores in the sublot and compute the average thickness of the four cores. If this average shows a thickness deficiency of 19 mm 0.75 inch or more [13 mm0.50 inch for pavements 200 mm 8 inches or less in thickness] remove the entire sublot.

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 211.2	(1998; R 2004) Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 213R	(2014; E2017) Guide for Structural Lightweight-Aggregate Concrete
ACI 305R	(2010) Guide to Hot Weather Concreting
ACI 306R	(2016) Guide to Cold Weather Concreting
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	(2020) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A722/A722M	(2015) Standard Specification for Uncoated High-Strength Steel Bar for Prestressing Concrete
ASTM A775/A775M	(2017) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A996/A996M	(2016) Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064/A1064M	(2017) Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31/C31M	(2019a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2020) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C78/C78M	(2018) 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	(2020) Standard Specification for Ready-Mixed Concrete
ASTM C117	(2017) Standard Test Method for Materials Finer than 75-um (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	(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	(2020) Standard Specification for Portland Cement
ASTM C171	(2020) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173/C173M	(2016) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231/C231M	(2017a) 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 C330/C330M	(2017a) Standard Specification for Lightweight Aggregates for Structural Concrete
ASTM C494/C494M	(2019) Standard Specification for Chemical Admixtures for Concrete
ASTM C618	(2019) 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 C881/C881M	(2020a) Standard Specification for

	Epoxy-Resin-Base Bonding Systems for Concrete
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 C1116/C1116M	(2010a; R 2015) Standard Specification for Fiber-Reinforced Concrete
ASTM C1231/C1231M	(2015) Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	(2013) Standard Test Method for Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	(2018) 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 D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2628	(1991; R 2016) Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
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
ASTM D5893/D5893M	(2016) Standard Specification for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements
ASTM E1274	(2018) Standard Test Method for Measuring Pavement Roughness Using a Profilograph

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

NEW YORK STATE DEPARTMENT OF TRANSPORTATION MATERIALS BUREAU (NYSDOT)

NY 703-19 E	(2008) Moisture Content of Lightweight Fine Aggregate

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 55	(1992) Test Method for Within-Batch Uniformity of Freshly Mixed Concrete
COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 143	(1962) Specifications for Meters for Automatic Indication of Moisture in Fine Aggregate
COE CRD-C 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

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-03 Product Data

Diamond Grinding Plan; G, [_____]

Dowels; G, [_____]

Dowel Bar Assemblies; G, [_____]

Equipment; G, [_____]

Proposed Techniques; G, [_____]

Forms; G, [_____]

Reinforcement; G, [_____]

Supports; G, [_____]

Curing Materials; G, [_____]

Surface Sealer Solution; G, [_____]

SD-05 Design Data

Preliminary Proposed Proportioning; G, [_____]

Proportioning Studies; G, [_____]

SD-06 Test Reports

Batch Plant Manufacturer's Inspection Report; G, [_____]

Slipform Paver Manufacturer's Inspection Report; G, [_____]

Sampling and Testing; G, [_____]

Diamond Grinding of PCC Surfaces; G, [_____]

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

Repair Recommendations Plan; G, [_____]

SD-07 Certificates

Contractor Quality Control Staff; G, [_____]

Laboratory Accreditation and Validation; G, [_____]

Commercial Laboratory; G, [_____]

NRMCA Certificate of Conformance;

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NOTE: A USACE validation letter is also required for Navy projects in regions where an accredited laboratory is not available.
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Commercial Laboratory; G, [_____]

NRMCA Certificate of Conformance; G, [_____]

1.4 QUALITY CONTROL

1.4.1 Contractor Quality Control Staff

Reference Section 01 45 00.00 10 QUALITY CONTROL for Contractor personnel qualification requirements. Submit American Concrete Institute certification for Contractor Quality Control Staff. Qualifications and resumes for petrographer, surveyor, concrete batch plant operator, and profilograph operator. All Contractor Quality Control personnel assigned to concrete construction are required to be American Concrete Institute (ACI) certified in the following grade:

a. The minimum requirements for the CQC System Manager consist of being a graduate engineer or a graduate of construction management, with a minimum of 5 years airfield construction experience and a minimum of 1 year experience as a CQC System Manager on an airfield construction project.

b. CQC personnel responsible for inspection of concrete paving operations: ACI Concrete Transportation Inspector. The ACI Concrete Transportation Inspector is required to be present at the paving site during all paving operations, with the exception of the initial saw cutting operation. The QC manager is required to be present during initial saw cutting operations.

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

d. Lead Foreman or Journeyman of the Concrete Placing, Finishing, and Curing Crews: ACI Concrete Flatwork Technician/Finisher.

e. Batch Plant Manufacturer's Representative: A representative from the batch plant manufacturer is required to be on-site to inspect and make necessary adjustments to all components of the batch plant including but not limited to aggregate bin weighing operations, water metering, cement and fly ash weighing devices. All necessary inspections and adjustments by the manufacturer representative is required to be performed prior to uniformity testing. Submit a written Batch Plant Manufacturer's Inspection Report signed by the representative noting all inspection items and corrections and stating the batch plant is capable of producing the volume of concrete as required herein.

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

g. Slipform Paving Equipment Manufacturer's Representative: A representative of the slipform paving equipment manufacturer is required to be on-site to inspect and make corrections to the paving equipment to ensure proper operations. Perform a complete and full hydraulic flow test of the vibrator system prior to the test section being placed. Submit a written Slipform Paver Manufacturer's Inspection Report signed by the manufacturer's representative noting all inspections, corrections, and flow tests have been performed and the paver is in a condition to perform the required work.

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

1.4.2 Other Staff

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

a. Petrographer: Bachelor of Science degree in geology or petrography, trained in petrographic examination of concrete aggregate according to ASTM C294 and ASTM C295/C295M and trained in identification of the specific deleterious materials and tests identified in this specification. Detail the education, training and experience related to the project-specific test methods and deleterious materials in the 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.

d. Profilograph Operator: Certification by equipment manufacturer or a state Department of Transportation.

1.4.3 Laboratory Accreditation and Validation

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NOTE: The USACE validation letter requirement does not apply to the Navy.

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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. 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 acceptance 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. Contact the MTC manager listed at http://www.erdc.usace.army.mil/Media/FactSheets/FactSheetArticleView/tabid/9254/Articl for costs and scheduling. Provide on-site temperature-controlled concrete curing facilities.

1.4.3.1 Aggregate Testing and Mix Proportioning

Aggregate testing and mixture proportioning studies are required to be performed by a commercial laboratory.

1.4.3.2 Acceptance Testing

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

1.4.3.3 Contractor Quality Control

All sampling and testing is required to be performed by an approved, on-site, independent, commercial laboratory, or for cementitious materials and admixtures, the manufacturer's laboratory.

1.4.3.4 Laboratory Inspection

The Government will inspect all laboratories requiring validation for equipment and test procedures prior to the start of any concreting operations for conformance to ASTM C1077. Schedule and provide payment for laboratory inspections. Additional payment or a time extension due to failure to acquire the required laboratory validation is not allowed. The laboratory is to maintain this certification for the duration of the project.

1.4.4 Preconstruction Testing of Materials

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NOTE: Designer must edit this paragraph and following subparagraphs as appropriate. For Design Build Contracts the testing must be performed by the Contractor utilizing an approved petrographer and commercial testing laboratory. Delete any subparagraphs which are not applicable. Fill in blanks as appropriate.

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All sampling and testing is required to be performed. Use an approved commercial laboratory or, for cementitious materials and chemical admixtures, 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 due to failure of any material to meet project requirements, or for any additional sampling or testing required is not allowed. Additional tests may be performed by the Government; such Government testing does not relieve any required testing responsibilities.

1.4.4.1 Aggregates

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NOTE: Delete 'test section' for Design-Bid-Build projects. Delete 'contract award' for Design-Bid projects.

****

Sample aggregates in the presence of a Government Representative. Obtain samples in accordance with ASTM D75/D75M and be representative of the materials to be used for the project. Perform all aggregate tests no earlier than 120 days prior to [contract award][test section]. Submit test results a minimum of 7 days before commencing mixture proportioning studies.

1.4.4.2 Chemical Admixtures, Curing Compounds and Epoxies

At least 30 days before the material is used, submit certified copies of test results for the specific lots or batches to be used on the project. Provide test results less than 6 months old prior to use in the work. 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 rejected if test results do not meet manufacturer requirements.

1.4.4.3 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 specification under which it is provided. Provide mill test reports no more than 1 month 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. Retest cementitious material that has not been used within 6 months after testing, and reject if test results do not meet manufacturer requirements.

[1.4.4.4 Multifilament Polypropylene Fibers

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NOTE: Retain this paragraph for High Temperature Concrete supporting F-35B operations. Delete this paragraph if High Temperature Concrete is only intended to be used by V-22 aircraft.

Deletion of this paragraph will preclude any F-35B vertical landing operations on this High Temperature Concrete.

****

Multifilament polypropylene fibers will be accepted on the basis of the manufacturer's certification of compliance, accompanied by test reports showing that the material in each shipment meets the requirements of the specification under which it is furnished. Test reports must be no older than 6 months, prior to use in the work. Fibers may be subjected to check testing by the Government from samples obtained at the manufacturer site, at transfer points, or at the project site. Promptly remove all unsatisfactory fiber material that has been delivered to the site. Retest fibers that have not been used within 6 months after initial testing at the Contractor's expense. The Government can reject fiber material if results are not satisfactory.

]1.4.5 Testing During Construction

During construction, the Contractor is responsible for sampling and testing aggregates, cementitious materials, and concrete as specified herein. The Government will sample and test concrete and ingredient materials as considered appropriate. Provide facilities and labor as may be necessary for procurement of representative test samples. Testing by the Government will in no way relieve the Contractor of the specified testing requirements.

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NOTE: Purpose of test batches and test sections is for Contractor to optimize mixture to placement conditions. Traprock usually will only require a few of the 10 test patches. Test batches are required, as it is important that the mix have sufficient paste to close concrete surface. Traprock mixtures are very similar to normal weight airfield concrete, with the exception of fibers influencing the finishing of the surface. Finishing concrete with lightweight aggregates requires additional mixture optimization efforts to meet requirements and will likely use all 10 batches. Test batches are not required to be cured. Test sections are vital for High Temperature Concrete as sequencing of forming, steel placement, use of telebelt and developing surface finishing techniques are critical prior to actual placement.

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1.4.6 Test Batches and Sections

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NOTE: Use Test Sections for Continuously Reinforced Concrete paragraph in areas where CRC is required, such as for F-35B Vertical Landing Pad Landing Zones or other areas that may experience high jet blast pressures. Seek Echelon III guidance where other areas may be applicable.

For continuously reinforced concrete used for isolated areas that necessitate an absence of

joints, such as vertical landing pads, use the first bracketed paragraph.

For plain jointed concrete used for large areas, such as aprons, use the second bracketed paragraph.

Coordinate with the End User regarding the location of the test batches and test sections. The intent for test batches and test sections is to simulate production paving, thus delivery distance, smoothness of the roads, access through ECP's, etc. may not be fully understood if the Test Batches and Test Sections are selected at a locations which do not represent what will be experienced during production paving.

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a. At least 10 days but not more than 90 days prior to construction of the concrete pavement, conduct trial batches and build two test sections as described herein. Provide a dedicated concrete batch plant for the Test Batch, Test Section and Production Paving production while batching is being conducted for that day. To avoid cross contamination, it is not permissible to produce other loads of other concrete between loads of High Temperature Concrete.

b. Prepare up to five, 3.8 cubic meter 5 cubic yard traprock batchesten, 3.8 cubic meter 5 cubic yard light weight batchesfive, 3.8 cubic meter 5 cubic yard traprock batches or ten, 3.8 cubic meter 5 cubic yard light weight batches of High Temperature Concrete to optimize mix proportions to field conditions. Start test Batches no sooner than 60 days and completed no later than 30 days prior to production paving. Prepare batches in the presence and to the satisfaction of the Government. Batches may be placed at or near batch plant to improve coordination of mix proportion adjustment. Conduct test batches at or near the batch plant to simulate travel time to site. Place batches in forms, nominally 3 m x 3 m 10 feet by 10 feet and 300 mm 12 inches thick. Provide hand-held vibrators, strike-off and hand floats similar to what will be used for production and paving. It is not required to cure test batch pads; this enables observation of time to any potential cracking.

c. Fabricate and cure six beams and six cylinders per test batch in accordance with ASTM C1231/C1231M, using 150 mm x 150 mm 6 x 6 inch steel forms and 150 mm x 300 mm 6 x 12 inch single-use or steel cylinder forms. Cure and test 2 beams and 2 cylinders at 3, 7 and 28 days. Test beams in accordance with ASTM C78/C78M, cylinders in accordance with ASTM C39/C39M. Extract two 150 mm 6 inch diameter cores from selected pads. Contracting Officer may reduce the amount of testing.

d. Concrete loads that are rejected due to noncompliance of this specification, including temperature, slump and water/cement ratio, do not count as part of the ten test batches.

[1.4.6.1 Test Sections - Continuously Reinforced Concrete

Construct two test sections near the job site at a location agreed upon with Contracting Officer, but not as part of the production pavement area. Commence test section paving after Government and Contractor have

agreed upon target proportions from Test Batches. Use the test sections to develop and demonstrate to the satisfaction of the Contracting Officer the proposed techniques of SSD stockpile moisture content determination during production paving, mixing, hauling, placing, consolidating, finishing, brooming, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. Include use of proposed conveyor at maximum extension necessary for production paving. Variations in mixture proportions can only be made in the presence of the Contracting Officer. Calibrate and operate the mixing plant prior to start of placing the test section. Use the same equipment, materials, and construction techniques on the test section as will be used in all subsequent work, including reinforcing steel. Provide base course preparation of six inch thick layer of the same granular base, concrete production, placing, consolidating, curing, construction of joints, and all testing in accordance with applicable provisions of this specification. Within three days after completion of each test section, provide up to six cores 150 mm 6 inch diameter by full depth cut from points selected in the test section by the Government. The cores will be evaluated by the Government. Construct the test section meeting all specification requirements and being acceptable to the Contracting Officer in all aspects, including surface texture. Failure to follow specification requirements will necessitate construction of additional test sections at no additional cost to the Government. Do not commence production paving until the results on aggregates and concrete, concrete has reached the specified 28 day strength, and evaluation of the cores, and all pavement measurements for actual plan grade, surface smoothness and thickness have been submitted and approved by the Contracting Officer.

a. First Test Section

Construct the first test section to consist of one paving lane at least 30 m 100 feet long and constructed 300 mm 12 inches thick on a 150 mm 6 inch thick layer of the same granular base prepared and compacted as required for the production paving. Provide a lane width of 20 feet. Wet cure pilot lane for 14 days.

b. Second Test Section

Construct a second test section lane adjacent to the first lane with the same dimensions as the first test lane after the minimum wet cure time of first lane per paragraph WET CURING. Purpose is to further evaluate joint construction methods, differential shrinkage and Contractor's work sequencing. Provide a header at the end of the lane. To demonstrate an unplanned transverse construction joint, provide a split header with reinforcement protruding. All requirements for the test section are applicable, as appropriate. Wet cure fill-in lane.

c. Cracks in Test Sections

Cracks are expected to, but do not always, develop in test sections. If cracks do occur in test section lanes, inform Contracting Officer to notify cognizant Corps of Engineers Transportation Systems Center (TSMCX), the Air Force Civil Engineer Center (AFCEC) pavement Subject Matter Expert (SME), or Naval Facilities Engineering Command (NAVFAC, Echelon III) Pavement Engineer.

][1.4.6.2 Test Section - Plain Jointed Concrete

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NOTE: Use Test Sections for Non-Continuously Reinforced Concrete paragraph for areas that only necessitate jointed heat resistant concrete. This may be applicable for F-35B Vertical Landing Pad Safety Zones, parking, warmup, and holding areas. Test section areas may be reduced to half a lot where areas are small like the F-35B Vertical Landing Zones.

If test section is not to be part of the production pavement area, delete the two bracketed sentences referring to test sections constructed as part of production pavement and production lot payment.

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Up to 10 days, but not more than 60 days, prior to construction of the concrete pavement, construct a test section [near the job site, but not as part of the production pavement area.][as part of the production paving area at an outer edge as indicated on the drawings .]Construct test section of the same depth as the course which it represents. The underlying grade or pavement structure upon which the test section is to be constructed is required to be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section is required to be the same equipment to be used on the remainder of the course represented by the test section. Use the test section to develop and demonstrate the proposed techniques of mixing, hauling, placing, consolidating, finishing, curing, initial saw cutting, start-up procedures, testing methods, plant operations, and the preparation of the construction joints. Perform variations in mixture proportions, other than water, if directed. Operate and calibrate the mixing plant prior to start of placing the test section. Use the same equipment, materials, and construction techniques on the test section proposed for use in all subsequent work. Perform base course preparation, concrete production, placing, consolidating, curing, construction of joints, and all testing in accordance with applicable provisions of this specification. Three days after completion of the test section, provide eight cores at least 150 mm 6 inches in diameter by full depth cut from points selected in the test section by the Government. Construct the test section meeting all specification requirements and being acceptable in all aspects, including surface texture, thickness, grade, and longitudinal and transverse joint alignment. Failure to construct an acceptable test section necessitates construction of additional test sections at no additional cost to the Government. [Remove test sections allowed to be constructed as part of the production pavement which do not meet specification requirements at no expense to the Government.] If slipform paving is performed and is unable to construct an acceptable test section, repair or replace the slipform paving equipment, or paving completed using fixed-forms and equipment compatible with them and allowed by the specification. Do not commence production paving until the results on aggregates and concrete, including evaluation of cores, and all pavement measurements for edge slump, joint face deformation, actual plan grade, surface smoothness and thickness have been submitted and approved.[Pavement accepted as a production lot will be evaluated and paid as specified in PART 1 GENERAL.]

1.4.6.2.1 Pilot Lane

Construct the test section consisting of one paving lane at least 130 m 400 feet long and to the same thickness as the thickest portion of pavement shown on the Drawings. Construct at the same lane width as that required for use in the project. Provide at least one transverse construction joint in the test section. If [keyed or]doweled longitudinal construction joints are required in any of the production pavements, install them full length along one side of the test lane throughout the test section. [If both keys and dowels are required, install each in half of the test section.]Construct the test section on two separate days.

1.4.6.2.2 Fill-In Lane

Consider the first 130 m 400 feet of the initial production fill-in lane as a fill-in lane test section for purposes of testing and evaluation. All requirements for the test section are applicable. Obtain cores from the fill-in lane side of the longitudinal construction joint with the pilot lane.

]1.4.7 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.

1.4.8 Acceptance Requirements

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NOTE: The lot size can be specified on the basis of time or volume of production. Normally, it is most practical for construction oversight if a lot is made equal to one shift, but not over 10 hours. If the lot size is based on the amount of production, it is to be selected to be approximately equal to the amount of concrete pavement produced in one shift (one day) of operation. The lot size must never exceed 750 cubic meters 1000 cubic yards. of concrete pavement. When the total job does not exceed 750 cubic meters 1000 cubic yards, the lot size becomes the total job. Edit the following paragraphs accordingly. Do not change terminology (for instance computed percent payment, actual percent payment).

For continuously reinforced concrete used for

isolated areas that necessitate an absence of joints, such as vertical landing pads, use the first bracketed paragraph.

For plain jointed concrete used for large areas, such as aprons, use the second bracketed paragraph.
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[1.4.8.1 Pavement Lots - Continually Reinforced Concrete

A lot will be that quantity of construction that will be evaluated for acceptance with specification requirements. A lot will be equal to one shift of production, not to exceed 76 cubic meters 100 cubic yards for continuously reinforced areas. For non-continuously reinforced areas, a lot is equal to one shift of production, not to exceed 230 cubic meters 300 cubic yards. Each lot will be divided into two equal sublots. Grade and surface smoothness determinations will be made on the lot as a whole. All samples locations are to be selected on a random basis in accordance with ASTM D3665.

][1.4.8.2 Pavement Lots - Plain Jointed Concrete

A lot is that quantity of construction to be evaluated for acceptance with specification requirements. A lot is equal to one shift of production not to exceed 750 cubic meters 1000 cubic yards. In order to evaluate thickness, divide each lot into four equal sublots. A sublot is equal to one shift of production not to exceed 190 cubic meters 250 cubic yards. Grade determinations will be made on the lot as a whole. Surface smoothness determinations will be made on every 0.1 km 0.1 mile segment in each lot. Select sample locations on a random basis in accordance with ASTM D3665. When operational conditions cause a lot to be terminated before the specified four sublots have been completed, use the following procedure to adjust the lot size and number of tests for the lot. Where three sublots have been completed, they constitute a lot. Where one or two sublots have been completed, incorporate them into the next lot (except for the last lot), and the total number of sublots used and acceptance criteria adjusted accordingly.

]1.4.8.3 Evaluation

Provide all sampling and testing required for acceptance and payment adjustment, including batch tickets with all required acceptance testing. Individuals performing sampling, testing and inspection duties are required to meet the Qualifications. 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 in addition to the sublot or lot testing, and the requirements for these areas are the same as those for a sublot or lot. Provide facilities for and, where directed, personnel to assist in obtaining samples for any Government testing.

1.4.8.4 Additional Sampling and Testing

The Contracting Officer reserves the right to direct additional samples and tests for any area which appears to deviate from the specification requirements. Testing in these areas will be in addition to the sublot or lot testing, and the requirements for these areas will be the same as those for a sublot or lot. Provide facilities for and, where directed, personnel to assist in obtaining samples for any Government testing.

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 in free-draining stockpiles. Provide a minimum 0.6 m 24 inch thick sacrificial layer left undisturbed for each aggregate stored on ground. Provide free-draining storage for fine aggregate and the smallest size coarse aggregate for at least 24 hours immediately prior to use. 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.

Any aggregate, coarse or fine, that is not approved for High Temperature Concrete, that is observed or detected in a stockpile must constitute rejection of the complete stockpile. Any debris, mud, dirt, organic matter, trash, garbage or any other material that Contracting Officer deems detrimental to the High Temperature Concrete, regardless of the quantity, must constitute rejection of the stockpile. Ensure that batch plant loaders, hoppers, conveyors, weigh hoppers, drums, mixers, conveyors, haul truck beds, delivery truck beds, rail cars, delivery containers, and other equipment are cleaned, washed and be free of any non-High Temperature Concrete aggregate. Any unapproved material in the High Temperature Concrete is considered noncompliant and rejection, removal and replacement of the entire affected lot is required at Contractor's expense. Instruct loader operators not to disturb the bottom 300 mm 12 inch layer of aggregate. Post a sign at the working face of each stockpile. If all the aggregate for the project will not be stockpiled at one time then access from all sides of the stockpile for charging the batch plant is required. Stockpile and continuously water all lightweight aggregates for a planned day's placement by sprinklers for 7 days prior to paving. Stockpile and continuously water manufactured traprock sands for a planned day's placement by sprinklers for 7 days prior to paving. Stockpile and continuously water all lightweight aggregates and manufactured traprock sands for a planned day's placement by sprinklers for 7 days prior to paving. Spraying by water trucks or hand-held hoses is supplemental but does not replace continuous sprinkler operation. Maintain sufficient watered aggregate at the site at all times to permit continuous uninterrupted operation of the mixing plant at the time concrete pavement is being placed. Tracked equipment is not permitted on aggregate stockpiles. Protect all aggregate from contamination of other stockpiles, materials or deleterious material considered objectionable to Government. Reject all unsatisfactory stockpiles.

[1.5.3 Multifilament Polypropylene Fibers

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NOTE: Retain this paragraph for High Temperature Concrete supporting F-35B operations. Delete this paragraph if High Temperature Concrete is only intended to be used by V-22 aircraft.

Deletion of this paragraph will preclude any F-35B vertical landing operations on this High Temperature Concrete.

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Furnish all fibers in bulk or water soluble bags added at the plant. Store fibers in a dry and protected location and protected from damage.

]1.5.4 Other Materials

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

PART 2 PRODUCTS

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NOTE: Delete any reference to any products which are not to be used on the project. Coordinate all product requirements with the appropriate agency's Pavements or Materials Engineer.

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2.1 SYSTEM DESCRIPTION

This section is intended to stand alone for construction of High Temperature Concrete airfield pavement for applied pavement temperatures of 482 degrees Celsius 900 degrees Fahrenheit or above. 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. Aggregates for High Temperature Concrete are defined as either lightweight (produced from expanded slate or shale) or traprock. This specification is for light weight aggregate only. This specification is for traprock aggregate only. This specification is for lightweight and traprock aggregates. Aggregates for High Temperature Concrete require additional modified testing and time for materials testing compared to normal weight concrete. High temperature concrete aggregates are very specific. Contractor to enact additional precautions to avoid cross-contamination with other materials during transportation (rail cars, trucks, containers clean of other materials), during stockpiling, and not laying tools directly on ground during placing and finishing. Contractor must note there are substantial scheduling requirements for test lanes, placing sequence, wet curing, joint sealing, sodium silicate application, and pavement markings. It requires approximately 100 days for materials sampling through test section paving and another 100 days for placement through sodium silicate application. Where the construction covered herein interfaces with other sections, the construction at each interface must conform to the requirements of either this section or the other section, whichever has the more stringent tolerances.

2.1.1 Surface Smoothness

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NOTE: Edit these paragraphs as appropriate to the project. If it is desired to restrict surface smoothness testing and evaluation to either straightedge method or profilograph method, retain the one and delete the other; otherwise, retain both as a Contractor's option. Require use of the profilograph method for airfield taxiways and runways. When the profilograph method is allowed, and there are areas with dimensions less than 60 m (200 feet) in any direction, retain the straightedge method for these short runs. Profilograph is typically used to measure longitudinal smoothness and straightedge for transverse smoothness. Aircraft arresting systems require straightedge for longitudinal and transverse smoothness.

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Use the profilograph method for all longitudinal testing, except for paving lanes less than 60 m 200 feet in length. Use the straightedge method for transverse testing, for longitudinal testing where the length of each pavement lane is less than 60 m 200 feet,[within 60 m 200 feet on both the approach and departure sides of an aircraft arresting gear,] and at the ends of the paving limits for the project. Smoothness requirements do not apply over crowns, drainage structures, or similar penetration. Maintain detailed notes of the testing results and provide a copy to the Government after each day's testing.

2.1.1.1 Straightedge Testing

2.1.1.1.1 For Certified Vertical Landing Spots

Provide the finished surfaces of the pavements with no abrupt change of 3 mm 1/8 inch or more, and all pavements within the limits specified when checked with an approved 4 m 12 foot straightedge. Provide vertical landing spots with a variation from the specified straight edge not greater than 3 mm 1/8 inch in the longitudinal direction and not greater than 3 mm 1/8 inch in the transverse direction.

2.1.1.1.2 For All Other Areas

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NOTE: Retain first and third bracketed statements for airfield projects. Retain second bracketed statement for projects with an aircraft arresting systems.

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Provide the finished surfaces of the pavements with no abrupt change of 6 mm 1/4 inch or more, and all pavements within the limits specified when checked with an approved 4 m 12 foot straightedge.[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 runway pavement within 60 m 200 feet on both the approach and departure sides of an aircraft arresting gear with a variation in the longitudinal direction from the specified straightedge not more than plus or minus 3 mm 1/8 inch.][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.]

2.1.1.2 Profilograph Testing

Provide the finished surfaces of the pavements with no abrupt change of 6 mm 1/4 inch or more, and each 0.1 km 0.1 mile segment of each pavement lot with a Profile Index not greater than specified when tested with an approved California-type profilograph.[Provide runways and taxiways with a Profile index not greater than 110 mm per km 7 inches per mile in the longitudinal direction. Provide runway and taxiway transverse smoothness measured with the straightedge method and the straightedge requirements apply. Provide all other airfield areas with a Profile Index not greater than 140 mm per km 9 inches per mile in the longitudinal direction.][Provide roads, streets, tank hardstands, vehicular parking areas and open storage areas with a Profile index not greater than 140 mm per km 9 inches per mile in the longitudinal direction.]

2.1.1.3 Bumps ("Must Grind" Areas)

Reduce any bumps ("must grind" areas) shown on the profilograph trace which exceed 10 mm 0.4 inch in height by diamond grinding in accordance with subparagraph DIAMOND GRINDING OF PCC SURFACES below until they do not exceed 7.5 mm 0.3 inch when retested. Taper such diamond grinding in all directions to provide smooth transitions to areas not requiring diamond grinding.

2.1.1.4 Testing Method

After the concrete has hardened sufficiently to permit walking thereon, but not later than 48 hours after placement, test the entire surface of the pavement in each lot in such a manner as to reveal all surface irregularities exceeding the tolerances specified above. If any pavement areas are diamond ground, retest these areas immediately after diamond grinding. Test the entire area of the pavement in both a longitudinal and a transverse direction on parallel lines. Perform the transverse lines 4.5 m 15 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 test other areas having obvious deviations. Perform longitudinal testing lines continuous across all joints. Perform transverse testing lines for pilot lanes carried to construction joint lines and for fill-in lanes carried 600 mm 24 inches across construction joints, and the readings in this area applied to the fill-in lane. Perform straightedge testing of the longitudinal edges of slipformed pilot lanes before paving fill-in lanes as specified below.

2.1.1.4.1 Straightedge Testing

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.

2.1.1.4.2 Profilograph Testing

Perform profilograph testing using approved California profilograph and procedures described in ASTM E1274. Utilize electronic recording and automatic computerized reduction of data equipment to indicate "must-grind" bumps and the Profile Index for each 0.1 km 0.1 mile segment of the pavement lot. Accommodate grade breaks on aprons [parking lots]by breaking the profile segment into short sections and repositioning the blanking band on each section. Provide the "blanking band" of 5 mm 0.2 inch wide and the "bump template" span 25 mm 1 inch with an offset of 10 mm 0.4 inch. Count the profilograph testing of the last 9.1 m 30 feet of a paving lane in the longitudinal direction from each day's paving operation on the following day's continuation lane. Compute the profile index for each pass of the profilograph (3 per lane) in each 0.1 km 0.1 mile segment. The profile index for each segment is the average of the profile indices for each pass in each segment. Scale and proportion profilograph's of unequal lengths to an equivalent 0.1 km 0.1 mile as outlined in the ASTM E1274. Provide a copy of the reduced tapes to the Government at the end of each day's testing.

2.1.2 Edge Slump and Joint Face Deformation

2.1.2.1 Edge Slump

When slip-form paving is used, provide a maximum of 15.0 percent of the total free edge of each pavement panel with a maximum edge slump of 6 mm 1/4 inch and none of the free edge of the pavement lot with an edge slump exceeding 9 mm 3/8 inch. (A pavement panel is defined as a lane width by the length between two adjacent transverse contraction joints. The total free edge of the pavement is the cumulative total linear measurement of pavement panel edge originally constructed as non-adjacent to any existing pavement; for example, 30 m 100 feet of pilot lane originally constructed as a separate lane, would have 60 m 200 feet of free edge; 30 m 100 feet of fill-in lane would have no free edge). The area affected by the downward movement of the concrete along the pavement edge is a maximum of 450 mm 18 inches back from the edge.

2.1.2.2 Joint Face Deformation

In addition to the edge slump limits specified above, provide a vertical joint face with a surface within the maximum limits shown below:

Offset from Straightedge Applied Longitudinally to Pavement Surface (a)	Offset from Straightedge Applied Longitudinally to Vertical Face (b)	Offset from Straightedge Applied Top to Bottom Against the Joint Face (c)	Abrupt Offset in Any Direction (d)	Offset of Joint Face from True Vertical (e)
Airfield Pavement				
3 mm 1/8 inch	6 mm 1/4 inch	9 mm 3/8 inch	3 mm 1/8 inch	8 mm per 100 mm 1 inch per 12 inches
All Other Pavement				

Offset from Straightedge Applied Longitudinally to Pavement Surface (a)	Offset from Straightedge Applied Longitudinally to Vertical Face (b)	Offset from Straightedge Applied Top to Bottom Against the Joint Face (c)	Abrupt Offset in Any Direction (d)	Offset of Joint Face from True Vertical (e)
6 mm 1/4 inch	All other items same as airfield pavement			
(a) Measurement is taken by placing the straightedge longitudinally on the pavement surface 25 mm 1 inch from the free edge				
(b) Measurement is taken by applying the straightedge longitudinally along the vertical joint face				
(c) Measurement places a 9.5 mm 3/8 inch spacer attached to a straightedge and spaced approximately equal to the thickness of the concrete being measured. The offset from straightedge with spacers is measured by placing the spacers against the top and bottom of the vertical concrete face.				
(d) An abrupt offset in the joint face occurring along a short distance. Check for abrupt offsets at any location that an abrupt offset appears to be a possible issue.				
(e) Measurement of the offset from the joint face to a level in the true vertical position against the joint face.				

2.1.2.3 Slump Determination

Test the pavement surface to determine edge slump immediately after the concrete has hardened sufficiently to permit walking thereon. Perform testing with a minimum 4 m 12 foot straightedge to reveal irregularities exceeding the edge slump tolerance specified above. Determine the vertical edge slump at each free edge of each slipformed paving lane constructed. Place the straightedge transverse to the direction of paving and the end of the straightedge located at the edge of the paving lane. Record measurements at 1.5 to 3.0 m 5 to 10 foot a spacing, as directed, commencing at the header where paving was started. Initially record measurements at 1.5 m 5 foot intervals in each lane. When no deficiencies are present after 5 measurements, the interval may be increased. The maximum interval is 3.0 m 10 feet. When any deficiencies exist, return the interval to 1.5 m 5 feet. In addition to the transverse edge slump determination above, at the same time, record the longitudinal surface smoothness of the joint on a continuous line 25 mm 1 inch back from the joint line using the minimum 4 m 12 foot straightedge advanced one-half its length for each reading. Perform other tests of the exposed joint face to ensure that a uniform, true vertical joint face is attained. Properly reference all recorded measurements in accordance with paving lane identification and stationing, and a report submitted within 24 hours after measurement is made. Identify areas requiring replacement within the report.

2.1.2.4 Excessive Edge Slump

When edge slump exceeding the limits specified above is encountered on either side of the paving lane, record additional straightedge measurements to define the linear limits of the excessive slump. Remove and replace concrete slabs having excessive edge slump or joint deformation to the next transverse joint in conformance with paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS. Discontinue

use of slip-form paving equipment and procedures that fail to consistently provide edges within the specified tolerances on edge slump and joint face deformation construct by means of standard paving procedures using fixed forms.

2.1.3 Plan Grade

Within 5 days after paving of each lot, test the finished surface of the pavement area by running 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 of each lot.[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.][Provide surfaces of [_____] that vary less than 19 mm 3/4 inch.] 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 appurtenant 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 plan alignment indicated.

2.1.4 Flexural Strength

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NOTE: Normally, concrete for airfield pavement is to be proportioned and accepted on the basis of 90-day flexural strength. If it is desired to use 28-day strength for design of airfield pavement, approval must be obtained through the TSMCX, AFCEC pavement SME, or NAVFAC.

The designer may choose the first Option "Cylinders/Beam" or the second Option "Beams" for strength testing.

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Submit certified copies of laboratory test reports and sources for cement, supplementary cementitious materials (SCM), aggregates, admixtures, curing compound, epoxy, and proprietary patching materials proposed for use on this project. Each lot of pavement will be evaluated for acceptance in accordance with the following procedures.

2.1.4.1 Sampling and Testing

For acceptance, obtain one composite sample of concrete from each sublot in accordance with ASTM C172/C172M from one batch or truckload.[Fabricate and cure test cylinders 152 x 305 mm 6 x 12 inches in accordance with ASTM C31/C31M, and tested in accordance with ASTM C39/C39M. Test two test cylinders per sublot (8 per lot) at 14 days.][Fabricate and cure test beams 152 x 152 mm 6 x 6 inches in accordance with ASTM C31/C31M; and tested in accordance with ASTM C78/C78M.]

2.1.4.2 Computations

Average the eight 14-day strength tests for the lot. Use the average strength in accordance with paragraph CONCRETE STRENGTH FOR FINAL ACCEPTANCE.

2.1.5 Thickness

Each lot of pavement will be evaluated for acceptance and payment adjustment in accordance with the following procedure:

a. Contractor must maintain positive control of grades, and Contractor must also use surveyed elevations at the top of concrete and the top of the layer directly beneath the concrete elevation. Measure elevations on a grid measuring a maximum of 6 m by 6 m 20 feet by 20 feet. Contracting Officer may require additional surveyed elevations.

b. Prior to placing concrete, stringline across forms and measure proposed thickness of concrete. Correct any deficiencies prior to placement. Stringline measurements must be on a maximum 6 m 20 foot spacing with at least 4 measurements between forms at each stringline position.

c. Do not extract cores from High Temperature Concrete production paving lanes unless explicitly directed in writing from Contracting Officer.

2.1.6 Evaluation of Cores

Record and submit testing, inspection, and evaluation of each core for surface paste, 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 of the core, rotating the core approximately 120 degrees between photographs. Include a ruler for scale in the photographs. Provide plan view of location for each core.

2.1.7 Diamond Grinding of PCC Surfaces

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. 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 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. The maximum area corrected by diamond grinding the surface of the hardened concrete is 10 percent of the total area of any sublot. The maximum depth of diamond grinding is 6 mm 1/4 inch. Provide diamond grinding machine equipped to flush and vacuum the pavement surface. Dispose of all debris from diamond grinding operations off Government property. Prior to diamond grinding, submit a Diamond Grinding Plan for review and approval. At a minimum, include the daily reports for the deficient areas, the location and extent of deficiencies, corrective actions, and equipment. 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.

2.2 CEMENTITIOUS MATERIALS

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NOTE: Edit these paragraphs as appropriate for the particular project. Guidance for use of cementitious materials should be sought from the Pavement Materials engineer or from the TSMCX, Air Force MAJCOM paving engineers, 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 consider requiring use of fly ash for partial replacement. Do not specify Type I or III cement. See UFC 3-250-04FA for guidance. Specify limit on false set if it is a problem in the area.

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

2.2.1 Portland Cement

Portland cement must conform to ASTM C150/C150M, Type I or II, low alkali including false set requirements.

2.2.2 Pozzolan

2.2.2.1 Fly Ash

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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.

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Provide fly ash that conforms to ASTM C618, Class F, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction with 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 3 percent.

2.2.3 Supplemental Cementitious Materials (SCM) Content

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NOTE: Use first tailoring option for Navy projects. Use second tailoring option for Army/Air Force projects.

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[Provide a concrete mix that contain one of the SCMs listed in Table 2 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with paragraph ALKALI SILICA REACTIVITY.][Use of one of the SCMs listed below is optional, unless the SCM is required to mitigate ASR. The use of SCMs is encouraged in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING.]

TABLE 2
SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT

Supplementary Cementitious Material	Minimum Content	Maximum Content
Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 > 70 percent	25 percent	35 percent
Si02 + A1203 + Fe203 > 80 percent	20 percent	35 percent
Si02 + A1203 + Fe203 > 90 percent	15 percent	35 percent

2.3 AGGREGATES

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NOTE: Provide aggregates meeting the requirements of this specification. If aggregate sources in the project area do not meet the requirements of this specification, provide aggregates from sources outside the project area that do meet the requirements of this specification.

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2.3.1 Aggregate Sources

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NOTE: Note that the workability box for lightweight aggregate is larger than for traprock and normal weight concrete. This is because more workability is necessary to close lightweight aggregate concrete mixture pavement surface.

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Conduct aggregate sampling for testing no more than 120 days prior to test batching unless otherwise stated.

2.3.1.1 Combined Aggregate Gradation

In addition to the grading requirements specified for coarse aggregate and for fine aggregate, the combined aggregate grading must meet the following requirements for Workability and Coarseness factors, Percent Retained Chart, and 0.45 Power Curve. Coarse, intermediate and fine aggregate gradations are commonly required. Deliver coarse and fine aggregate as

individual materials to batch plant.

a. The materials selected and the proportions used must be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in 3 3 3 and 4. below, the point thus determined must fall within the parallelogram described therein.

(1) Determine the Coarseness Factor (CF) from the following equation: CF = (cumulative percent retained on the 9.5 mm sieve)(100)/(cumulative percent retained on the 2.36 mm sieve)CF = (cumulative percent retained on the 3/8 in. sieve)(100)/(cumulative percent retained on the No. 8 sieve)

(2) The Workability Factor WF is defined as the percent passing the 2.36 mm No. 8 sieve based on the combined gradation. Adjust the WF upwards only, by 2.5 percentage points for each 42 kg 94 pounds of cementitious material per cubic meter yard greater than 335 kg per cubic meter 564 pounds per cubic yard.

(3) For light weight aggregate only, a diagram must be plotted 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 a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-43), (CF-45, WF-32.5), and (CF-45, WF-47.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

(3) For traprock aggregate only, a diagram must be plotted 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 a parallelogram must be plotted 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, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

(3) For light weight aggregate only, a diagram must be plotted 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 a parallelogram must be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-43), (CF-45, WF-32.5), and (CF-45, WF-47.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

(4) For traprock aggregate only, a diagram must be plotted 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 a parallelogram must be plotted 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, the grading of each size of aggregate used and the proportions selected must be changed as necessary.)

b. Percent Retained Chart. Design the percent retained chart to meet the following criteria:

(1) The highest peak (the maximum percent retained) must be on the 9.5 mm 3/8 inch sieve or larger. The proportions must also have at least 60 percent of the total aggregate mass be retained on the 4.75 mm No. 4 sieve.

(2) There can only be at least 4 points difference between the two highest peaks.

(3) There can be no more than one low point between any two peaks. If there are two low points, the mixture is gap graded; if there are three or more low points, the mixture is severely gap graded and will not function as an airfield concrete mixture.

c. 0.45 Power Curve. The 0.45 power curve upper limit is defined as a line from the origin (0,0) to 100 percent at the 19 mm 3/4 inch sieve. The 0.45 power curve lower limit is defined as a line starting at 21 percent at the 1.18 mm No. 16 sieve to 100 percent at the 37.5 mm 1.5 inch sieve. The combined gradation must plot within the upper and lower limits of the 0.45 Power Curve.

d. Some aggregate combinations may not be able to achieve all criteria. In this case, if the Workability and Coarseness factors plot correctly, the 0.45 Power Curve criteria is achieved, Criteria b.1 and b.2 of the Percent Retained Chart are achieved, and the mixture is demonstrated it can be placed, consolidated and finished to meet specification requirements, then the third Percent Retained Chart criteria, b.3, can be relaxed from specification requirements provided there are no more than two low points between any two peaks.

e. Combined gradation of all the aggregates, coarse and fine, must have no more than 10 percent passing the 0.150 mm No. 100 sieve.

2.3.1.2 Alkali-Silica Reactivity for Traprock

Evaluate and test fine and coarse traprock aggregates to be used in all concrete for alkali-aggregate reactivity. Test all coarse aggregate size groups.

a. Separately evaluate the fine and coarse aggregates using ASTM C1260. Test results of the individual aggregates must have a measured expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Should the test data indicate an expansion of greater than 0.08 percent, reject the aggregate(s) or additional testing must be performed as follows: utilize the Contractor's proposed low alkali portland cement, blended cement, and/or SCM in combination with each individual aggregate. If only SCMs are being evaluated, the testing accordance with ASTM C1567. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.3.1.3 Durability Testing for Traprock

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NOTE: Use first Tailoring Option for Army and Air Force; second option is for Navy projects only.
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[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. 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, when a coarse aggregate size group or source proposed for use does not have a satisfactory demonstrable service record. Test all coarse aggregate size groups and sources proposed for use individually.][Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles if Sodium Sulfate is used.]

2.3.1.4 Alkali-Silica Reactivity for Traprock

Evaluate and test fine and coarse traprock aggregates to be used in all concrete for alkali-aggregate reactivity. Test both coarse aggregate size groups.

a. Separately evaluate the fine and coarse aggregates using ASTM C1260. Test results of the individual aggregates must have a measured expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Should the test data indicate an expansion of greater than 0.08 percent, reject the aggregate(s) or additional testing must be performed as follows: utilize the Contractor's proposed low alkali portland cement, blended cement, and/or SCM in combination with each individual aggregate. If only SCMs are being evaluated, the test in accordance with ASTM C1567. Determine the quantity that will meet all the requirements of these specifications and that will lower the expansion equal to or less than 0.08 percent after 28 days of immersion in a 1N NaOH solution. Base mixture proportioning on the highest percentage of SCM required to mitigate ASR-reactivity.

b. If any of the above options does not lower the expansion to less than 0.08 percent after 28 days of immersion in a 1N NaOH solution, reject the aggregate(s) and submit new aggregate sources for retesting. Submit the results of testing to the Contracting Officer for evaluation and acceptance.

2.3.1.5 Durability Testing for Traprock

****
NOTE: Use first Tailoring Option for Army and Air Force; second option is for Navy projects only.
****

[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. 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, when a coarse aggregate size group or source proposed for use does not have a satisfactory demonstrable service record. Test all coarse aggregate size groups and sources proposed for use individually.][Evaluate and test all fine and coarse aggregates to be used in all concrete for durability in accordance with ASTM C88. Provide fine and coarse aggregates with a maximum of 18 percent loss when subjected to 5 cycles using Magnesium Sulfate or a maximum of 12 percent loss when subjected to 5 cycles if Sodium Sulfate is used.]

2.3.2 Coarse Aggregate

Aggregates, as delivered to the mixers, must consist of clean, uncoated particles. Contractor is required to conduct all testing identified in this specification.

2.3.2.1 Material Composition

Coarse aggregate used for High Temperature Concrete must consist of lightweight aggregate. Lightweight aggregate is defined as expanded slate or expanded shale meeting the requirements at the manufacturing facility of ASTM C330/C330M and is produced in a rotary kiln operated at 1,149 degrees C 2,100 degrees F or more. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Freeze-thaw specimens can be coated on all sides using the same sodium silicate solution that will be used in on the pavement. Coarse aggregate must not show more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. The sodium sulfate soundness loss must not exceed 12 percent, or the magnesium sulfate soundness loss must not exceed 18 percent after five cycles when tested in accordance with ASTM C88.Coarse aggregate used for High Temperature

Concrete consist of a fine-grained aggregate composed of unweathered diabase or basalt as classified per ASTM C294 and meeting the requirements of ASTM C33/C33M except as specified herein. Identify and confirm coarse aggregate material meets the material specifications via ASTM C295/C295M and be coarse aggregate must not show more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M. The sodium sulfate soundness loss must not exceed 12 percent, or the magnesium sulfate soundness loss must not exceed 18 percent after five cycles when tested in accordance with ASTM C88.Coarse aggregate used for High Temperature Concrete must have Coarse aggregate showing no more than 40 percent loss when subjected to the Los Angeles abrasion test in accordance with ASTM C131/C131M, sodium sulfate soundness loss must not exceed 12 percent, or the magnesium sulfate soundness loss must not exceed 18 percent after five cycles when tested in accordance with ASTM C88 and must consist of one of the following materials:

a. Coarse aggregate used for High Temperature Concrete must consist of lightweight aggregate. Lightweight aggregate is defined as expanded slate or expanded shale meeting the requirements at the manufacturing facility of ASTM C330/C330M and is produced in a rotary kiln operated at 1,149 degrees C 2,100 degrees F or more. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Freeze-thaw specimens can be coated on all sides using the same sodium silicate solution that will be used in on the pavement.

b. Coarse aggregate used for High Temperature Concrete must consist of a fine-grained trap rock aggregate composed of unweathered diabase or basalt as classified per ASTM C294 and meeting the requirements of ASTM C33/C33M except as specified herein. Coarse aggregate material must be identified and confirmed that it meets the material specifications via ASTM C295/C295M.

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: Designer must research lightweight aggregate manufacturers and specify the largest nominal aggregate size available. Normally in CONUS, expanded slate is currently only available in eastern US with a 19 mm 3/4 inch nominal maximum size. Expanded shales are commonly available elsewhere CONUS with a 12.5 mm 1/2 inch nominal maximum size. All sizes are based on the nominal maximum size and all aggregates must meet the individual grading requirements of ASTM C33/C33M and ASTM C330/C330M. OCONUS sources need to be researched. Industry website is

http://www.escsi.org.

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For traprock aggregate, the Contractor must select either a 19 mm 3/4 inch or 25 mm 1 inch nominal maximum size aggregate. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C33/C33M. For lightweight aggregate the nominal maximum size is [19 mm3/4 inch][12.5 mm1/2 inch]. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C330/C330M.For traprock aggregate, the Contractor must select either a 19 mm 3/4 inch or 25 mm 1 inch nominal maximum size aggregate. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C33/C33M.For lightweight aggregate, the nominal maximum size is [19 mm3/4 inch][12.5 mm 1/2 inch]. Grade and provide the individual aggregates in two size groups meeting the individual grading requirements of ASTM C330/C330M. Nominal maximum size is defined as the largest standard sieve size with 3 to 10 percent retained by weight. The individual aggregates are required to be graded and furnished in size groups to meet the coarseness and workability factor criteria for the Contractor-proposed combined gradation.

2.3.2.4 Deleterious Materials - Traprock

****

NOTE: In Table 5 select columns showing appropriate percentage by weight in accordance with the following. Delete the inapplicable column in the table and the heading of the column used.

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
(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.		
(c) For Navy projects, select "Severe Weather" column of Table 5. Delete "Moderate Weather" and associated limits.		

****

Do not exceed the amount of deleterious material in each size group of

coarse aggregate 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
Percentage by Mass

Materials [h]	Severe Weather	Moderate Weather
Clay lumps and friable particles (ASTM C142/C142M)	0.2	0.2
Shale (a) (ASTM C295/C295M)	0.1	0.2
Material finer than 0.075 mmNo. 200 sieve (b) (ASTM C117)	0.5	0.5
Lightweight particles (c) (ASTM C123)	0.2	0.2
Clay ironstone (d) (ASTM C295/C295M)	0.1	0.5
Chert and cherty stone (less than 2.40 Mg/cubic meter2.40 Sp. Gr. density SSD) (e) (ASTM C123 and ASTM C295/C295M)	0.1	0.5
Claystone, mudstone, and siltstone (f) (ASTM C295/C295M)	0.1	0.1
Shaly and argillaceous limestone (g) (ASTM C295/C295M)	0.2	0.2
Other soft particles (COE CRD-C 130)	1.0	1.0
Total of all deleterious substances exclusive of material finer than 0.075 mm No. 200 sieve	1.0	2.0

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

b. Limit for material finer than 0.075 mm No. 200 sieve 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 XRD or other appropriate techniques as determined by petrographer to quantify amount and justify increase.

c. The separation medium must have a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0.

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

e. 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.

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

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

h. Perform testing in accordance with the referenced test methods, except that the minimum sample size is specified below.

2.3.2.5 Testing Sequence/Deleterious Materials - Traprock Only

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 90 kg 200 pounds for the 19 mm 3/4 inch and larger maximum size and 12 kg 25 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. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials is as follows:

Step 1: Wash each full sample of coarse aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.

Step 2: Test remaining full sample for clay lumps and friable particles and remove.

Step 3. Test remaining full sample for chert and cherty stone with SSD density of less than 2.40 specific gravity. Remove lightweight chert and cherty stone. Retain other materials less than 2.40 specific gravity for Step 4.

Step 4: Test the materials less than 2.40 specific gravity from Step 3 for lightweight particles (Sp. GR. 2.0) and remove. Restore other

materials less than 2.40 specific gravity to the sample.

Step 5: Test remaining sample for clay-ironstone, shale, claystone, mudstone, siltstone, shaly and argillaceous limestone, and remove.

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

2.3.2.6 Deleterious Materials - Traprock

****

NOTE: In Table 5 select columns showing appropriate percentage by weight in accordance with the following. Delete the inapplicable column in the table and the heading of the column used.

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
(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.		
(c) For Navy projects, select "Severe Weather" column of Table 5. Delete "Moderate Weather" and associated limits.		

****

Do not exceed the amount of deleterious material in each size group of coarse aggregate 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
Percentage by Mass

Materials (h)	Severe Weather	Moderate Weather

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Clay lumps and friable particles (ASTM C142/C142M)	0.2	0.2
Shale (a) (ASTM C295/C295M)	0.1	0.2
Material finer than 0.075 mmNo. 200 sieve (b) (ASTM C117)	0.5	0.5
Lightweight particles (c) (ASTM C123)	0.2	0.2
Clay ironstone (d) (ASTM C295/C295M)	0.1	0.5
Chert and cherty stone (less than 2.40 Mg/cubic meter2.40 Sp. Gr. density SSD) (e) (ASTM C123 and ASTM C295/C295M)	0.1	0.5
Claystone, mudstone, and siltstone (f) (ASTM C295/C295M)	0.1	0.1
Shaly and argillaceous limestone (g) (ASTM C295/C295M)	0.2	0.2
Other soft particles (COE CRD-C 130)	1.0	1.0
Total of all deleterious substances exclusive of material finer than 0.075 mm No. 200 sieve	1.0	2.0

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

b. Limit for material finer than 0.075 mm No. 200 sieve 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 XRD or other appropriate techniques as determined by petrographer to quantify amount and justify increase.

c. The separation medium must have a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0.

d. Clay ironstone is defined as an impure variety of iron carbonate, iron oxide, hydrous iron oxide, or combinations thereof, commonly mixed with clay, silt, or sand. It commonly occurs as dull, earthy

particles, homogeneous concretionary masses, or hard-shell particles with soft interiors. Other names commonly used for clay ironstone are "chocolate bars" and limonite concretions.

e. 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.

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

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

h. Perform testing in accordance with the referenced test methods, except that the minimum sample size is specified below.

2.3.2.7 Testing Sequence/Deleterious Materials - Traprock Only

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 90 kg 200 pounds for the 19 mm 3/4 inch and larger maximum size and 12 kg 25 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. The testing procedure on each sample of coarse aggregate for compliance with limits on deleterious materials is as follows:

Step 1: Wash each full sample of coarse aggregate for material finer than the 0.075 mm No. 200 sieve. Discard material finer than the 0.075 mm No. 200 sieve.

Step 2: Test remaining full sample for clay lumps and friable particles and remove.

Step 3. Test remaining full sample for chert and cherty stone with SSD density of less than 2.40 specific gravity. Remove lightweight chert and cherty stone. Retain other materials less than 2.40 specific gravity for Step 4.

Step 4: Test the materials less than 2.40 specific gravity from Step 3 for lightweight particles (Sp. GR. 2.0) and remove. Restore other materials less than 2.40 specific gravity to the sample.

Step 5: Test remaining sample for clay-ironstone, shale, claystone,

mudstone, siltstone, shaly and argillaceous limestone, and remove.

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

2.3.3 Fine Aggregate

2.3.3.1 Composition

****

NOTE: For TRAPROCK and TRAPROCK & LIGHTWEIGHT tailoring options; use the bracketed sentence for High Temperature Concrete supporting F-35B aircraft.

The use of natural sands will preclude any future utilization of the High Temperature Concrete for F-35B vertical landing operations. Delete bracket reference to the use of natural sand if intended use of pavement is for F-35B Aircraft.

****

Lightweight fine aggregate must consist of the same high temperature material as the coarse aggregates, and composed of clean, hard, durable particles meeting the requirements at the manufacturing facility of ASTM C330/C330M for expanded slate or expanded shale. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Each type of fine aggregate is required to be stockpiled and batched separately. Produce fine aggregate in a rotary kiln operated at 1,149 degrees C 2,100 degrees F. Particles of the fine aggregate are required to be generally spherical or cubical in shape. [Traprock fine aggregate must meet requirements of paragraph DELETERIOUS MATERIALS FOR TRAPROCK FINE AGGREGATE to include the parent material consisting of a fine-grained trap rock aggregate composed of unweathered diabase or basalt as classified per ASTM C294][Provide fine aggregate consisting of manufactured sand[, natural sand, or a combination of the two,] and 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.Lightweight fine aggregate must consist of the same high temperature material as the coarse aggregates, and composed of clean, hard, durable particles meeting the requirements at the manufacturing facility of ASTM C330/C330M for expanded slate or expanded shale. Conduct ASTM C330/C330M tests within 30 days prior to delivery to batch plant, except for freeze/thaw testing which must have been completed within 12 months prior to delivery. Each type of fine aggregate is required to be stockpiled and batched separately. Produce fine aggregate in a rotary kiln operated at 1,149 degrees C 2,100 degrees F. Particles of the fine aggregate are required to be generally spherical or cubical in shape.

[Traprock fine aggregate must meet requirements of paragraph DELETERIOUS MATERIALS FOR TRAPROCK FINE AGGREGATE to include the parent material consisting of a fine-grained trap rock aggregate composed of unweathered diabase or basalt as classified per ASTM C294][Provide fine aggregate consisting of manufactured sand[, natural sand, or a combination of the two,] and 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.

2.3.3.2 Grading

Grading of the fine aggregate, as delivered to the mixer, must conform to the requirements of ASTM C33/C33M for traprock and ASTM C330/C330M for lightweight aggregate ASTM C33/C33M for traprock ASTM C330/C330M for lightweight aggregate. Select a gradation not to exceed the combined gradation limits for the amount passing the 0.150 mm No. 100 sieve.

2.3.3.3 Deleterious Materials for Traprock Fine Aggregate

The amount of deleterious material in the fine aggregate must not exceed the following limits by mass:

Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm ASTM C117	3.0
Material finer than No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123 using a medium with a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.3.3.4 Deleterious Materials[for Traprock] Fine Aggregate

The amount of deleterious material in the fine aggregate must not exceed the following limits by mass:

Material	Percentage by Mass
Clay lumps and friable particles ASTM C142/C142M	1.0
Material finer than 0.075 mm ASTM C117	3.0
Material finer than No. 200 sieve ASTM C117	3.0
Lightweight particles ASTM C123 using a medium with a density of 2.0 Mg/cubic meter Sp. Gr. of 2.0	0.5
Total of all above	3.0

2.4 CHEMICAL ADMIXTURES

2.4.1 General Requirements

Chemical admixtures may only be used 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. An accelerating admixture conforming to ASTM C494/C494M, Type C, may be used only 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. ASTM C494/C494M, Type F and G high range water reducing admixtures and Type S specific performance admixtures are not allowed. ASTM C1017/C1017M flowable admixtures are not allowed.

[2.5 MULTIFILAMENT POLYPROPYLENE FIBERS

****

NOTE: Retain this paragraph for High Temperature Concrete supporting F-35B operations. Delete this paragraph if High Temperature Concrete is only intended to be used by V-22 aircraft.

Deletion of this paragraph will preclude any F-35B vertical landing operations on this High Temperature Concrete.

****

Multifilament polypropylene fibers must have a length between 9.5 and 19 mm 0.375 and 0.75 inches and either a maximum diameter of 0.4 mm 0.0157 inches or maximum average 10 denier weight. The concrete mix must contain 1.78 kg per cubic meter 3 lb per cubic yard to prevent spalling. Add the fibers to the concrete mixture at the batch plant. Fibers must be multifilament polypropylene meeting ASTM C1116/C1116M, Standard Specification for Fiber-Reinforced Concrete. Submit certified copies of the laboratory test results showing length, and diameter or denier.

]2.6 CURING MATERIALS

2.6.1 Impervious Sheet

Impervious sheet materials must conform to ASTM C171.

2.6.2 Burlap and Cotton Mat

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

2.6.3 Membrane Forming Curing Compound

Membrane forming curing compound is prohibited from use where ever sodium silicate surface sealer is to be applied. Therefore membrane forming curing compound is limited only to vertical faces of pilot lane paving. Provide membrane forming curing compound that conforms to COE CRD-C 300 and is white pigmented.

2.7 WATER

Water for mixing and curing is required to be 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, may be used if it meets the requirements of ASTM C1602/C1602M.

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 A 706/A 706M) when required by design.

****

All reinforcement is required to be 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 must not be used.

[2.8.1 Reinforcing Bars for Continuously Reinforced Concrete

a. Reinforcing bars must conform to ASTM A722/A722M Type 2, 25 mm 1 inch nominal diameter threaded bars with a minimum yield strength of 827 MPa 120,000 psi (Dywidag, Williams and Skylinesteel are possible sources, Grade 150) and conform to requirements shown on plans.

b. Reinforcement support is required to be continuous mesh supports or numerous chairs, and is required to be steel and support to height as shown on plans. Any sag or displacement of steel reinforcement during concrete placement is cause for rejection of paving lane with removal and replacement at Contractor's expense.

][2.8.2 Reinforcing Bars and Bar Mats for Non-Continuously Reinforced Concrete

Provide reinforcing bars conforming to [ASTM A615/A615M, billet-steel] [ASTM A996/A996M, rail and axle steel], Grade 60 [_____]. Provide bar mats conforming to ASTM A184/A184M. The bar members may be billet rail or axle steel.

][2.8.3 Welded Wire Reinforcement for Non-Continuously Reinforced Concrete

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

]2.9 JOINT MATERIALS

****

NOTE: Studies have shown that various joint sealant techniques perform better with varying degrees of temperature and pressure exposure. In Vertical Landing Pad Safety Zones self-leveling silicone sealant meeting ASTM D5893/D5893M perform better whereas elastomeric joint sealant ignites under the extreme heat. However, elastomeric joint sealant meeting ASTM D2628/D2628M tends to perform better than self-leveling silicone sealant when exposed to temperatures less than 500 degrees Fahrenheit.

Use first bracket for self-leveling silicone sealant meeting ASTM D5893/D5893M for the vicinity to extreme temperature exposure like the Vertical Landing Pad Safety Zone.

Use second bracket for elastomeric joint sealant meeting ASTM D2628/D2628M temperature exposure less than 500 degrees Fahrenheit like parking aprons, warm up areas, etc.

****

[Joint filler and sealant materials is required as shown on plans and

Specification 32 01 19.61 SEALING OF JOINTS IN RIGID PAVEMENT. Use only self-leveling silicone sealant meeting ASTM D5893/D5893M. Submit proposed methods and/or sacrificial materials for forming joint seal reservoir above expansion board.]
[Joint filler and sealant materials is required as shown on plans and Specification 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT. Use only elastomeric joint sealant meeting ASTM D2628.]

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 plain (non-deformed) steel bars conforming to ASTM A615/A615M, Grade 40 or 60; ASTM A996/A996M, Grade 50 or 60. Dowel bars are required to be epoxy coated in conformance with ASTM A775/A775M, 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.

2.9.3 Expansion Joint Materials

Expansion joint filler is required to be a preformed material conforming to ASTM D1752 Type II or Type III. Expansion joint filler is required to be 19 mm 3/4 inch thick, unless otherwise indicated. Expansion joint filler is required to be furnished in a single full depth piece.

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

b. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar be Type III, Grade as approved.

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

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

2.11 EQUIPMENT

All plant, equipment, tools, and machines used in the work are required to be maintained 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.

****

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

****

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.[Include detailed information on automatic laser controlled systems if proposed for use.]

2.11.1 Batching and Mixing Plant

****

NOTE: The batching and mixing plant must be on the construction site or as close as possible, but must be no farther than 15 minutes haul time from the placing site during all periods of the work day. Verify the availability of water and electrical power for sites on Government land. On Navy projects, specify an off-site batch plant. Edit bracketed items as appropriate.

Plant capacity must be governed by the laydown pattern or the size of the job to prevent delay of paving operations.

****

2.11.1.1 Location

Locate the batching and mixing plant [on project site as indicated on the drawings][off Government premises no more than 15 minutes haul time from

the placing site].[Water and electrical power [are][are not] available on the project site.] Provide operable telephonic or radio communication between the plant and the placing site at all times concreting is taking place.

2.11.1.2 Type and Capacity

Provide a batching and mixing plant consisting of a stationary-type central mix plant, including permanent installations and portable or relocatable plants installed on stable foundations. Provide a plant designed and operated to produce concrete within the specified tolerances, with a minimum capacity of 200 cubic meters 250 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 Tolerances

Materials	Percentage of Required Mass
Cementitious Materials	plus or minus 1
Aggregate	plus or minus 2
Water	plus or minus 1
Admixture	plus or minus 3

For volumetric batching equipment for water and admixtures, the above numeric tolerances apply to the required volume of material being batched. Dilute concentrated admixtures uniformly, if necessary, to provide sufficient volume per batch to ensure that the batchers consistently operate within the above tolerance.

2.11.1.4 Moisture Control

Provide a plant capable of ready adjustment to compensate for the varying moisture contents of the aggregates and to change the quantities of the materials being batched.[Provide an electric moisture meter complying with the provisions of COE CRD-C 143 for measuring of moisture in the fine aggregate. Provide a sensing element arranged so that measurement is made near the batcher charging gate of the fine aggregate bin or in the fine aggregate batcher.]

2.11.2 Concrete Mixers

Stationary or truck mixers or approved horizontal shaft concrete mixers are permitted. Pugmills are not allowed. Mixers are required to be capable of combining the materials into a uniform mixture and of discharging this mixture without segregation. The mixers are not be charged in excess of the capacity recommended by the manufacturer. Operate the drum or or mixing blade speed designated by the manufacturer. Maintain the mixers in satisfactory operation condition. Keep mixer drums free of hardened concrete. Replace mixer blades or paddles when worn down

more than 10 percent of their depth when compared with the manufacturer's dimension for new blades or paddles.

2.11.2.1 Stationary

Stationary mixers are required to be drum mixers. Mixers with a device to lock the discharge mechanism until the prescribed mixing time has elapsed in required.

2.11.2.2 Mixing Time and Uniformity for Stationary Mixers

For stationary mixers, the mixing time for each batch after all solid materials are in the mixer[, including fibers,] is determined in accordance with CRD-C-55 for stationary mixers and ASTM C 94 for truck mixers. For all mixtures, the minimum mixing time is 65 seconds; extend as necessary to achieve uniformity[, and dispersal of multifilament polypropylene fiber]. Immediately prior to any change in mixing time a mixer performance tests at the new mixing times is required. If using traprock, conduct the Regular Test sequence with approved mix; if using lightweight aggregate, conduct the Regular Test sequence on normal weight concrete (or provide results from normal weight concrete on this project if using the same approved batch plant). For initial determination of the mixing time conduct the Regular Test sequence first. When regular testing is performed, the concrete must meet the limits of any five of the six uniformity requirements listed in Table 1 below. Before batching of High Temperature Concrete per paragraph TEST BATCHES uniformity testing for normal weight concrete is required to conducted, submitted and approved.

2.11.2.3 Abbreviated Test

Conduct the Abbreviated Test sequence for production concrete verification at the frequency specified in Table 6. When abbreviated testing is performed, the concrete is required to meet only those requirements listed for abbreviated testing. Use the projects approved mix design proportions for uniformity testing. For regular testing perform all six tests on three batches of concrete. The range for regular testing is the average of the ranges of the three batches. Abbreviated testing consists of performing the three required tests on a single batch of concrete. The range for abbreviated testing is the range for one batch. If more than one mixer is used and all are identical in terms of make, type, capacity, condition, speed of rotation, the results of tests on one of the mixers apply to the others, subject to the approval. Perform all mixer performance (uniformity) testing in accordance with COE CRD-C 55 and with paragraph TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL in PART 3.

TABLE 1
UNIFORMITY REQUIREMENTS--STATIONARY MIXERS
NORMAL WEIGHT CONCRETE

Parameter	Regular Tests Allowable Maximum Range for Average of 3 Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Unit weight of air-free mortar	32 kg/cubic m	32 kg/cubic m
Unit weight of air-free mortar	2.0 lbs/cubic ft	2.0 lbs/cubic ft
Air content	1.0 percent	--

TABLE 1
UNIFORMITY REQUIREMENTS--STATIONARY MIXERS
NORMAL WEIGHT CONCRETE

Parameter	Regular Tests Allowable Maximum Range for Average of 3 Batches	Abbreviated Tests Allowable Maximum Range for 1 Batch
Slump	25 mm	25 mm
Slump	1.0 inch	1.0 inch
Coarse aggregate	6.0 percent	6.0 percent
Compressive strength at 7 days,	10.0 percent	10.0 percent
Water content	1.5 percent	

2.11.2.4 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 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

Transport slipform concrete to the paving site in non-agitating equipment conforming to ASTM C94/C94M or in approved agitators. Transport fixed form concrete in approved truck mixers designed with extra large blading and rear opening specifically for low slump concrete. Provide transporting equipment designed and operated to deliver and discharge the required concrete mixture completely without segregation.

2.11.4 Transfer and Spreading Equipment

****
NOTE: A transfer spreader is required for all paving projects.
****

A telescoping conveyor for conveying concrete (transfer spreader belt placers not allowed)is required equipment for transferring concrete from the transporting equipment to the paving lane in front of the vibrating truss. The telescoping conveyor will accept the concrete outside the paving lane and will transfer and deposit it evenly across the paving lane in front of the vibrating truss to a depth which permits the vibrating truss to operate efficiently. High Temperature Concrete may also be discharged directly from ready mix trucks provided the concrete is deposited in its final location within 1 m 3.28 feet radially from the end of the chute. Direct discharge from mixer trucks with specified low slump requires coordination of formwork and placement phasing. Do not allow haul trucks or equipment onto High Temperature Concrete unless joints have temporary backer rod inserted, surface is clean from any debris, concrete has reached 28 day strength, and protective matting is placed between truck wheels and concrete surface (curing materials are insufficient protective matting).

2.11.5 Vibrating Truss - For Continuously Reinforced Concrete

a. General: It is required that the vibrating truss screed has a triangular cross-section using a rotating eccentric weight type vibrator. Use three, 37.5 mm 1.5 inch diameter or larger spud vibrators, with a fourth vibrator at the site on standby to achieved or supplement consolidation of High Temperature Concrete. Ensure a vibrator is inserted between every grid of reinforcement and where workers have stepped in fresh concrete. Roller screeds or other types of paving and finishing equipment are not permitted.

2.11.6 Paver-Finisher - For Non-Continuously Reinforced Concrete

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NOTE: The following subparagraphs apply to both fixed-form and slip-form paver-finishers. FIXED FORMS is applicable to fixed-form paver-finishers and SLIPFORM is applicable to slip-form paver-finishers.
****

Provide paver-finisher consisting of a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement, with a minimum weight of 3280 kg per m 2200 pounds per foot of lane width, and powered by an engine having a minimum 15,000 W per m 6.0 horsepower per foot of lane width. The paver-finisher is required to spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The mechanisms for forming the pavement are required to be easily adjustable in width and thickness and for required crown. In addition to other spreaders required by paragraph above, the paver-finisher equipped with a full width knock-down auger or paddle mechanism, capable of operating in both directions, which evenly spreads the fresh concrete in front of the screed or extrusion plate.

2.11.6.1 Vibrators

****
NOTE: Retain bracketed electronic vibrator monitoring equipment statement for airfield paving.
****

Provide gang mounted immersion vibrators at the front of the paver on a frame equipped with suitable controls so that all vibrators can be operated at any desired depth within the slab or completely withdrawn from the concrete, as required. Provide vibrators that are automatically controlled to immediately stop as forward motion of the paver ceases. [Equipped the paver-finisher with an electronic vibrator monitoring device displaying the operating frequency of each individual internal vibrator with a readout display visible to the paver operator that operates continuously while paving, and displays all vibrator frequencies with manual or automatic sequencing among all individual vibrators. Discontinue paving if the vibrator monitoring system fails to operate properly during the paving operation.] Provide the spacing of the 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 and outside vibrators a maximum of 300 mm 12 inches from the lane edge. Operate spud vibrators at a minimum frequency of 135 Hz 8000 impulses per minute and a minimum amplitude of 0.75 mm 0.03 inch, as determined by COE CRD-C 521.

2.11.6.2 Screed or Extrusion Plate

Equipped the paver-finisher with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface and finish the surface that no significant amount of hand finishing, except use of cutting straightedges, is required. Provide a screed or extrusion plate constructed to adjust for crown in the pavement. Provide adjustment for variation in lane width or thickness and to prevent more than 200 mm 8 inches of the screed or extrusion plate extending over previously placed concrete on either end when paving fill-in lanes. Repair or replace machines that cause displacement of properly installed forms or cause ruts or indentations in the prepared underlying materials and machines that cause frequent delays due to mechanical failures as directed.

2.11.6.3 Longitudinal Mechanical Float

A longitudinal mechanical float may be used. If used, provide a float that is specially designed and manufactured to smooth and finish the pavement surface without working excess paste to the surface that is rigidly attached to the rear of the paver-finisher or to a separate self-propelled frame spanning the paving lane. Provide float plate at least 1.5 m 5 feet long by 200 mm 8 inches wide and automatically be oscillated in the longitudinal direction while slowly moving from edge to edge of the paving lane, with the float plate in contact with the surface at all times.

2.11.6.4 Other Types of Finishing Equipment

Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to approval. Provide bridge deck finishers with a minimum operating weight of 3400 kg 7500 pounds that have a transversely operating carriage

containing a knock-down auger and a minimum of two immersion vibrators. Only use vibrating screeds or pans for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

2.11.6.5 Fixed Forms

Provide paver-finisher equipped with wheels designed to ride the forms, keep it aligned with the forms, and spread the load so as to prevent deformation of the forms. Provide paver-finishers traveling on guide rails located outside the paving lane that are equipped with wheels when traveling on new or existing concrete to remain. Alternatively, a modified slipform paver that straddles the forms may be used. Provide a modified slipform paver which has the side conforming plates removed or rendered ineffective and travels over or along pre-placed fixed forms.

2.11.6.6 Slipform

The slipform paver-finisher is required to be automatically controlled and crawler mounted with padded tracks so as to be completely stable under all operating conditions and provide a finish to the surface and edges so that no edge slump beyond allowable tolerance occurs. Provide suitable moving side forms that are adjustable and produce smooth, even edges, perpendicular to the top surface and meeting specification requirements for alignment and freedom from edge slump.

2.11.7 Texturing Equipment

****

NOTE: Designer must select type of texturing desired, retain that subparagraph, and delete the others. A genuine effort must be made to determine the type of texturing, if any, desired by the using service. If no guidance is given, the usual default method must be burlap drag. If other than a burlap drag textured finish is required, edit the appropriate paragraph(s) as shown below.

For Air Force airfield paving projects, do not specify artificial turf, wire comb, or surface grooving textures. For Navy airfield paving projects, do not specify wire comb or surface grooving textures. Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING, to specify saw-cut grooves.

Spring tine grooving is limited to use on roads and streets only.

****

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 saturated with water before attachment to the frame, always re-saturate before start of use, and kept clean and saturated during use. Provide burlap conforming to AASHTO M 182, Class 3 or 4.

][2.11.7.2 Broom

Apply surface texture using an approved mechanical stiff bristle broom drag of a type that provides a uniformly scored surface transverse to the pavement center line. Provide broom capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure that results in scores uniform in appearance and approximately 1.5 mm 1/16 inch in depth but not more than 3 mm 1/8 inch in depth.

][2.11.7.3 Artificial Turf

Provide full-width artificial turf drag with the leading transverse edge securely fastened to a lightweight pole on a traveling bridge. Provide a minimum of 600 mm 2 feet of the artificial turf in contact with the concrete surface during texturing operations that results in corrugations uniform in appearance and approximately 2 mm 1/16 inch in depth. A variety of different types of artificial turf are available and approval of any one type will be done only after it has been demonstrated to provide a satisfactory texture. One type that has provided satisfactory texture consists of 7,200 approximately 0.85-inch-long polyethylene turf blades per square foot.

][2.11.8 Sawing Equipment

****
NOTE: Retain bracketed sentence as necessary to correlate with paragraph REMOVAL OF EXISTING PAVEMENT SLAB in PART 3. Otherwise delete. Also delete wheel saw option on Navy projects.
****

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. If demonstrated to operate properly, abrasive blades may be used. Provide spares as required to maintain the required sawing rate. [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.]Provide saws capable of sawing to the full depth required. Early-entry saws may be used, subject to demonstration and approval. No change to the initial sawcut depth is permitted.

]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.

2.12 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

****

NOTE: Specified concrete strength of 550 psi is readily attainable with lightweight aggregates at 28 days. Do not specify higher strength as that may not be achieved in 28 days. Although traprock mixtures are similar to normal weight concrete with higher strengths of 650 psi common, do not specify higher strength.

****

2.12.1 Specified Flexural Strength - For Lightweight Aggregate

Specified flexural strength, R, for High Temperature Concrete is 3.8 MPa 550 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be 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 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches.

2.12.2 Specified Flexural Strength - For Traprock Aggregate

Specified flexural strength, R, for High Temperature Concrete is 4.5 MPa 650 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be 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 and ACI 325.14R. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches,

2.12.3 Specified Flexural Strength - For Lightweight Aggregate

Specified flexural strength, R, for High Temperature Concrete is 3.8 MPa 550 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be 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 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches.

2.12.4 Specified Flexural Strength - For Traprock Aggregate

Specified flexural strength, R, for High Temperature Concrete is 4.5 MPa 650 psi at 28 days. Maximum allowable water-cementitious material ratio is 0.45. The water-cementitious material ratio will be 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 and ACI 325.14R. The concrete must have air-entrained with a total air content of 6 percent plus or minus 1.5 percentage points, at the point of placement. Determine air content in accordance with ASTM C173/C173M. The required slump of the concrete at the point of placement is 50 to 100 mm 2 to 4 inches.

2.12.5 Water-Cementitious Materials Ratio

Maximum allowable water-cementitious material ratio is 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.

2.12.6 Air Content

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.

2.12.7 Slump

The maximum allowable slump of the concrete at the point of placement is 50 mm 2 inches for pavement constructed with fixed forms. For slipformed pavement, at the start of the project, select a slump which produces in-place pavement meeting the specified tolerances for control of edge slump. The selected slump is applicable to both pilot and fill-in lanes.

2.12.8 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.

2.12.9 Concrete Strength for Final Acceptance

The strength of the concrete will be considered acceptable when the average 28-day flexural strengths for each lot is above the 'Specified Flexural Strength', and no individual beam in the lot is 170 kPa 25 psi or more below the equivalent 'Specified Flexural Strength'. Removed and replaced at no additional cost to the Government any lot or sublot, respectively, that fails to meet the above criteria.

2.13 MIXTURE PROPORTIONS

2.13.1 Composition

Allowable constituents of concrete are cementitious material, water, fine and coarse aggregates, [fibrillated polypropylene fibers,]and admixtures. Supplementary Cementitious Materials (SCM) choice and usage must conform with paragraph SUPPLEMENTAL CEMENTITIOUS MATERIALS (SCM) CONTENT. The total cementitious material content is required to be at

least 310 kg per cubic meter 517 pounds per cubic yard for traprock and 447 kg per cubic meter 752 pounds per cubic yard for lightweight aggregate 310 kg per cubic meter 517 pounds per cubic yard for traprock 447 kg per cubic meter 752 pounds per cubic yard for lightweight aggregate. Admixtures consist of air entraining admixture and may also include, as approved, accelerator, retarder, and water-reducing admixture.

2.13.2 Proportioning Studies

Trial design batches, mixture proportioning studies, and testing requirements are the responsibility of the Contractor. 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. Trial mixtures having proportions, slumps, and air content suitable for the work based on methodology described in ACI 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale, modified as necessary by manufacturer's recommendations to accommodate flexural strength and workability.Trial mixtures having proportions, slumps, and air content suitable for the work based on methodology described in ACI 211.2, ACI 213R and ACI 325.14R for expanded slate or expanded shale, or ACI 211.1 and ACI 325.14R for trap rock, modified as necessary by manufacturer's recommendations to accommodate flexural strength and workability.Trial mixtures having proportions, slumps, and air content suitable for the work based on methodology described in ACI 211.1 and ACI 325.14R for trap rock, modified as necessary by manufacturer's recommendations to accommodate flexural strength and workability.

2.13.2.1 Determination of Moisture Properties Coarse and Fine Lightweight Aggregates and Fine Traprock Aggregate

Use the following procedures to determine the moisture properties of lightweight aggregate, coarse and fine, and manufactures traprock fines:

Saturated Surface Dry (SSD) Specific Gravity:

a. Obtain sample and oven dry (not microwave) at 110 degrees C 230 degrees F until constant weight, which may take several days.

b. Submerge sample in water container for 7 days

c. Determine soaked sample Bulk Specific Gravity

d. Towel dry, no water sheen, determine SSD Specific Gravity

Free Water on Aggregates (NY 703-19 E):

Conduct the following procedures a minimum of three times for the project: prior to developing the laboratory mixtures, when build stockpiles, and when replenish stockpiles.

a. Obtain minimum of two stockpile samples after continuous watering has ensured aggregates have reached 100 percent absorption.

b. Determine moisture content of one sample by drying to constant weight.

c. Determine moisture content of second sample after first towel drying to surface dry condition.

d. Difference of two moisture contents is free water on aggregates.

e. General targets for production are 1-3 percent free moisture on coarse aggregate and 6-10 percent free moisture on fine aggregate.

Prior to conducting any High Temperature Concrete batching, determine the stockpile free moisture content prior to first batch of day and at frequency indicated in paragraph TESTING AND INSPECTION REQUIREMENTS.

2.13.2.2 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 allowable water-cementitious material ratio required in paragraph SPECIFIED FLEXURAL STRENGTH, above is the equivalent water-cementitious materials ratio. 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.

2.13.2.3 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 combination of either 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 may be used without separate trial mixture study. Perform separate trial mixture studies for each placing method (slip form, 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.

2.13.3 Example High Temperature Concrete Mix Designs

The Contractor is responsible to develop the High Temperature Concrete mixture proportions for the project. The Contractor must select the aggregates for use, develop and adapt the mixture based upon mixing and paving methods, site temperature and humidity for time of placement. Government personnel resources are available at no charge to Contractor for consultation after contract award, and will be present during test batches, test sections and production paving. The following mix design was used with 100 percent expanded slate lightweight aggregates at Eglin AFB in December 2010. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

2.13.3.1 Example Traprock Aggregate Mix Design

The following mix design was used for laboratory studies by NAVFAC EXWC. It uses the Carolina Sunrock aggregates. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 4

Material	Quantity per Cubic Yard
Type I/II Portland Cement	307 kg 517 pounds
Class F Fly Ash	77 kg 129 pounds
Water	148 kg 250 pounds
Course Aggregate (25 mm to 4.75 mm 1 to No. 4)	905 kg 1525 pounds
Medium Course Aggregate (9.5 mm to 4.75 mm 3/8 to No. 4)	317 kg 534 pounds
Fine Aggregate (minus 4.75 mm No. 4)	739 kg 1245 pounds
Air admix	0.18 kg 4.72 fl. ounces
Super plasticizer	0.77 kg 20.68 fl. ounces
Fibers	1.8 kg 3 pounds

2.13.3.2 Example Lightweight Aggregate Mix Design

The following mix design in Table 5 was used with 100 percent expanded slate lightweight aggregates at Eglin AFB in December 2010. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 5
High Temperature Mix Design using Expanded Slate at Eglin AFB

Material	Quantity per Cubic Meter (Cubic Yard)
Type I/II Portland Cement	334 kg 564 pounds
Class F Fly Ash	112 kg 188 pounds
Water	174 kg 294 pounds
19 mm3/4 inch Lightweight Aggregate	459 kg 773 pounds
9.5 mm3/8 inch Lightweight Aggregate	188 kg 317 pounds
Fine Lightweight Aggregate	388 kg 654 pounds
Darex AEA	0.15 kg 4.14 fl. ounces
WRDA 64	1.67 kg 45.12 fl. ounces
Fibers	1.8 kg 3 pounds

Mixture Results

W/C Ratio	0.39
WF	41
CF	61

2.13.3.3 Example Traprock Aggregate Mix Design

The following mix design was used for laboratory studies by NAVFAC EXWC. It uses the Carolina Sunrock aggregates. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

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Medium Course Aggregate (9.5 mm to 4.75 mm 3/8 to No. 4)	317 kg 534 pounds
Fine Aggregate (minus 4.75 mm No. 4)	739 kg 1245 pounds
Air admix	0.18 kg 4.72 fl. ounces
Super plasticizer	0.77 kg 20.68 fl. ounces
Fibers	1.8 kg 3 pounds

2.13.3.4 Example Lightweight Aggregate Mix Design

The following mix design in Table 3 was used with 100 percent expanded slate lightweight aggregates at Eglin AFB in December 2010. This mixture design is only provided for information and is not a project requirement nor assurance that it will meet project specifications for any particular material, method, site or climate.

TABLE 3
High Temperature Mix Design using Expanded Slate at Eglin AFB

Material	Quantity per Cubic Meter (Cubic Yard)
Type I/II Portland Cement	334 kg 564 pounds
Class F Fly Ash	112 kg 188 pounds
Water	174 kg 294 pounds
19 mm3/4 inch Lightweight Aggregate	459 kg 773 pounds
9.5 mm3/8 inch Lightweight Aggregate	188 kg 317 pounds
Fine Lightweight Aggregate	388 kg 654 pounds
Darex AEA	0.15 kg 4.14 fl. ounces
WRDA 64	1.67 kg 45.12 fl. ounces
Fibers	1.8 kg 3 pounds

Mixture Results

W/C Ratio	0.39
WF	41
CF	61

[2.14 SURFACE CLEANING SOLUTIONS

****
NOTE: In order to prepare the surface of existing concrete or new concrete which has POL spillage, POL stains must be removed to ensure penetration of surface sealer solution. This paragraph is optional for new construction and may be deleted.
****

To remove existing POL stains from the concrete surface prior to surface sealer solution application, use one of the following:

a. A mixture of dishwashing (Dawn or Simple Green) detergent and hot water

b. Trisodium phosphate (TSP)

c. Sodium hydroxide if TSP is not available or permitted

d. Sodium carbonate (washing soda)

e. Phosphoric acid cleaner

f. Bio-remediation via Eximo (CAF Environmental Solutions) or G Force (Winsol Laboratories)

]2.15 SURFACE SEALER SOLUTION

Surface sealer is required to be a colorless, water-based solution containing at least 9 percent sodium silicate at time of application.

PART 3 EXECUTION

3.1 PREPARATION FOR PAVING

Before commencing paving, perform the following. If used, place cleaned, coated, and adequately supported forms. Have any reinforcing steel needed at the paving site; all transporting and transfer equipment ready for use, clean, and free of hardened concrete and foreign material; equipment for spreading, consolidating, screeding, finishing, and texturing concrete at the paving site, clean and in proper working order; and all equipment and material for curing and for protecting concrete from weather or mechanical damage at the paving site, in proper working condition, and in sufficient amount for the entire placement.

3.1.1 Weather Prevention

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.

3.1.2 Proposed Techniques

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

Delete requirement for profilograph if not required.

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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 reinforcing bar size and spacing; and identifying pilot lanes and hand placement areas. Place the five continuously reinforced High Temperature Concrete lanes in a minimum of three pours and in the following sequence: place the center lane first; then the two adjacent lanes, then the two outside lanes. This paving sequence allows installation of threaded reinforcing steel and couplers. Without written approval of the Contracting Officer, no deviation from the jointing pattern shown on the drawings are allowed.

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

[f. Data on profilograph and methods to measure pavement smoothness.

]3.2 CONDITIONING OF UNDERLYING MATERIAL

3.2.1 General Procedures

Verify the underlying material, upon which concrete is to be placed is clean, damp, and free from debris, waste concrete or cement, frost, ice, and standing or running water. Prior to setting forms or placement of concrete, verify the underlying material is well drained and have been satisfactorily graded by string-line controlled, automated, trimming machine and uniformly compacted in accordance with the applicable Section of these specifications. Test the surface of the underlying material to crown, elevation, and density in advance of setting forms or of concrete placement using slip-form techniques. Trim high areas to proper elevation. Fill and compact low areas to a condition similar to that of surrounding grade, or filled with concrete monolithically with the pavement. Low areas filled with concrete are not to be cored for thickness to avoid biasing the average thickness used for evaluation and payment adjustment. Rework and compact any underlying material disturbed by construction operations to specified density immediately in front of the paver. If a slipform paver is used, continue the same underlying material under the paving lane beyond the edge of the lane a sufficient distance that is thoroughly compacted and true to grade to provide a suitable trackline for the slipform paver and firm support for the edge of the paving lane.

3.2.2 Traffic on Underlying Material

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NOTE: Transporting equipment must not be allowed to operate on the prepared underlying material for airfield paving. Operating hauling equipment in the paving lane will cause the paver to stop frequently, producing a discontinuity in the pavement surface. Edit bracketed items as appropriate and coordinate with Part 2, subparagraph TRANSFER AND SPREADING EQUIPMENT.

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After the underlying material has been prepared for concrete placement, equipment is not permitted thereon with exception of the paver. 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.[Transporting equipment is not to be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher.][Equipment may be allowed to operate on the underlying material only if approved and only if no damage is done to the underlying material and its degree of compaction. Correct any disturbance to the underlying material that occurs, as approved, before the paver-finisher or the deposited concrete reaches the location of the disturbance and replace the equipment or change procedures to prevent any

future damage.]

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. Suspend placement of concrete whenever rain, high winds, or other damaging 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. Immediately cover and protect all unhardened concrete from the rain or other damaging weather. Completely remove any slab damaged by rain or other weather full depth, by full slab width, to the nearest original joint, and replaced as specified in paragraph REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS below, at no expense to the Government.

3.3.2 Paving in Hot Weather

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NOTE: Additional information concerning hot weather concreting may be obtained from ACI 305R. Do not delete this paragraph or the next paragraphs dealing with weather.
****

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 the temperature shown in the table below when measured in accordance with ASTM C1064/C1064M at the time of delivery. Cooling of the mixing water or aggregates or placing in the cooler part of the day may be required 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.

Maximum Allowable Concrete Placing Temperature

Relative Humidity, Percent, During Time of Concrete Placement	Maximum Allowable Concrete Temperature in Degrees C F
Greater than 60	33 90
40-60	30 85
Less than 40	27 80

3.3.3 Prevention of Plastic Shrinkage Cracking

During weather with low humidity, and particularly with high temperature and appreciable wind, develop and institute measures to prevent plastic shrinkage cracks from developing. If plastic shrinkage cracking occurs, halt further placement of concrete 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, the concrete placement may be further protected by erecting shades and windbreaks and by applying fog sprays of water, the addition of mono-molecular films, or wet covering. Apply mono-molecular films after finishing is complete, do not use 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. 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. Materials entering the mixer are required to be 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, an accelerating admixture may be used 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

****

NOTE: Designer must correlate these paragraphs with paragraph EQUIPMENT. Delete item in brackets if truck mixers are not permitted.

****

Provide batching, mixing, and transporting equipment with a capacity sufficient to maintain a continuous, uniform forward movement of the paver of not less than 0.8 m 2.5 feet per minute. Deposit concrete transported in non-agitating equipment in front of the paver within 45 minutes from the time cement has been charged into the mixing drum, except that if the ambient temperature is above 32 degrees C 90 degrees F, the time is reduced to 30 minutes. 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 as part of the lot acceptance package to the placing foreman to maintain on file and deliver them 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

Operate non-agitating equipment only on smooth roads and for haul time less than 15 minutes. 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. No transfer or spreading operation which requires the use of front-end loaders, dozers, or similar equipment to distribute the concrete are permitted.

3.5 PAVING - FOR CONTINUOUSLY REINFORCED CONCRETE

3.5.1 General Requirements - for Continuously Reinforced Concrete

Construct pavement with paving and finishing equipment utilizing rigid fixed forms. Utilize paving and finishing equipment and procedures capable of constructing paving lanes of the required width. Control and coordinate paving equipment and its operation with all other operations, such that the vibrating truss has a continuous forward movement, at a reasonably uniform speed, from beginning to end of each paving lane, except for inadvertent equipment breakdown. Failure to achieve this must require the Contractor to halt operations, regroup, and modify operations to achieve this requirement. Workmen with foreign material on their footwear or construction equipment that might deposit foreign material are not permitted to walk or operate in the plastic concrete. Provide clean matting to lay tools not in use and workers to stand to prevent contamination of the High Temperature Concrete.

3.5.2 Consolidation - for Continuously Reinforced Concrete

Consolidate concrete with three hand-held spud vibrators across the paving lane. Insert the vibrators into the concrete to a depth that will provide the best full-depth consolidation. Insert a vibrator into every reinforcement grid and in worker's footsteps. Vibrators may be used and operated from a bridge spanning the area. Vibrators are not to be used to transport or spread the concrete. Hand-operated vibrators are not to be operated in the concrete at one location for more than 20 seconds. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) must require the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.5.3 Operation - for Continuously Reinforced Concrete

When the vibrating truss approaches a header at the end of a paving lane, maintain a sufficient amount of concrete ahead of the vibrating truss to

provide a roll of concrete which will spill over the header. Ensure the required amount of extra concrete sufficient to prevent any slurry that is formed and carried along ahead of the vibrating truss from being deposited adjacent to the header is present. Provide additional consolidation adjacent to the headers by hand-held vibrators. When the vibrating truss is operated between or adjacent to previously constructed pavement (fill-in lanes), make provisions to prevent damage to the previously constructed pavement. At all times, keep the overlapping area of existing pavement surface completely free of any loose or bonded foreign material as the vibrating truss operates across it.

3.5.4 Required Results - for Continuously Reinforced Concrete

Adjust, operate, and coordinate the vibrating truss, and its hand placed equipment together with its operating procedures with the concrete mixture being used to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The vibrating truss operation must produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. The vibrating truss must make only one pass across the pavement; multiple passes will not be permitted. The equipment and its operation must produce a finished surface as specified and requiring no excessive hand finishing other than the use of cutting straightedges. If any equipment or operation fails to produce the above results, stop the paving, replace or properly adjust the equipment. Appropriately modify the operation or mixture proportions in order to produce the required results before recommencing paving. Apply no water, other than approved fog sprays, to the concrete or the concrete surface during paving and finishing.

3.5.5 Forms for Fixed-Form Paving - for Continuously Reinforced Concrete

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NOTE: Fixed-form paving is mandatory for high temperature concrete with fibers and continuous reinforcement.

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a. Furnish straight forms made of steel in sections not less than 3 m 10 feet in length. Use flexible or curved forms of proper radius for curves of 31 m 100-foot radius or less. Make wood forms for curves and fillets of well-seasoned, surfaced plank or plywood, straight, and free from warp or bend. Furnish wood forms adequate in strength and rigidly braced. Forms must have a depth equal to the pavement thickness at the edge. Where the project requires several different slab thicknesses, forms may be built up 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 and provide an increase in depth of not more than 25 percent. The base width of the one-piece or built-up form cannot be less than eight-tenths of the vertical height of the form, except than forms 200 mm 8 inches or less in vertical height must have a base width not less than the vertical height of the form. Maximum vertical deviation of top of any side form, including joints, must not vary from a true plane more than 3 mm 1/8 inch in 3 m 12 feet, and the upstanding leg must not vary more than 6 mm 1/4 inch.

b. Tightly lock form sections. Restrict form sections from play or movement in any direction. Provide forms with adequate devices for secure settings so that when in place they will 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 will 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. Immediately make necessary corrections prior to placing the concrete. Clean and oil the forms each time before concrete is placed. Do not place concrete until setting of forms has been checked and approved by the CQC team.

3.5.5.1 Form Removal - for Continuously Reinforced Concrete

Remove forms for preparation to place adjacent lanes at a time in accordance with paragraph WET CURING, but no sooner than 24 hours after the end of the placement. Cover in burlap and polyethylene and keep wet concrete edges exposed after form removal until the adjacent concrete is placed or the 14 day wet curing period is achieved, as appropriate for the edge location. When conditions are such that the early strength gain of the concrete is delayed, leave the forms in place for a longer time, as directed. Remove forms by procedures that do not injure 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 hereinafter or as directed.

3.5.6 Placing Reinforcing Steel - for Continuously Reinforced Concrete

Use the type and amount of steel reinforcement shown on the drawings.

3.5.6.1 Reinforcement Support - for Continuously Reinforced Concrete

Position the reinforcement on approved continuous mesh support devices or numerous chairs securely fastened to the subgrade prior to concrete placement. Support and anchor reinforcement to maintain proper position in final concrete pavement on a maximum 1.2 m by 1.2 m 4 foot by 4 foot grid, including at edges if steel does not penetrate forms. Vibrate concrete after the steel has been placed. Regardless of placement procedure, use reinforcing steel free from coatings which could impair bond between the steel and concrete, and laps in the reinforcement must be as indicated. Regardless of the equipment or procedures used for installing reinforcement, ensure that the entire depth of concrete is adequately consolidated.

3.6 PAVING - FOR NON-CONTINUOUSLY REINFORCED CONCRETE

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NOTE: Designer must correlate these paragraphs with paragraph EQUIPMENT.

****

3.6.1 General Requirements - for Non-Continuously Reinforced Concrete

Construct pavement with paving and finishing equipment utilizing rigid fixed forms or by use of slipform paving equipment. Provide paving and finishing equipment and procedures capable of constructing paving lanes of the required width at a rate of at least 0.8 m 2.5 feet of paving lane per minute on a routine basis. Control paving equipment and its operation,

and coordinated 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, except for inadvertent equipment breakdown. Backing the paver and refinishing a lane is not permitted. Remove and replace concrete refinished in this manner. Failure to achieve a continuous forward motion requires halting operations, regrouping, and modifying operations to achieve this requirement. Personnel are not permitted to walk or operate in the plastic concrete at any time. Where an open-graded granular base is required under the concrete, select paving equipment and procedures which operate properly on the base course without causing displacement or other damage.

3.6.2 Consolidation - for Non-Continuously Reinforced Concrete

Consolidate concrete with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. 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. Excessive vibration is not permitted. Discontinue paving operations if vibrators cause visible tracking in the paving lane, until equipment and operations have been modified to prevent it. Vibrate concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Do not use vibrators to transport or spread the concrete. Do not operate hand-operated vibrators in the concrete at one location for more than 20 seconds. Insert hand-operated vibrators between 150 to 400 mm 6 to 15 inches on centers. For each paving train, provide at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) requires the immediate stopping of the paving operation and approved adjustment of the equipment or procedures.

3.6.3 Operation - for Non-Continuously Reinforced Concrete

When the paver approaches a header at the end of a paving lane, 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 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. When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provide provisions to prevent damage to the previously constructed pavement. Electronically control screeds or extrusion plates from the previously placed pavement so as to prevent them from applying 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. When the paver travels on existing pavement, maintain approved provisions to prevent damage to the existing pavement. Pavers using transversely oscillating screeds are not allowed to form fill-in lanes that have widths less than a full width for which the paver was designed or adjusted.

3.6.4 Required Results - for Non-Continuously Reinforced Concrete

Adjust and operate the paver-finisher, its gang-mounted vibrators and operating procedures coordinated with the concrete mixture being used, to produce a thoroughly consolidated slab throughout that is true to line and grade within specified tolerances. Provide a paver-finishing operation that produces a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities in a single pass across the pavement; multiple passes are not permitted. Provide equipment and its operation that produce a finished surface requiring no hand finishing other than the use of cutting straightedges, except in very infrequent instances. Stop paving if any equipment or operation fails to produce the above results. Prior to recommencing paving, properly adjust or replace the equipment, modify the operation, or modify the mixture proportions, in order to produce the required results. No water, other than fog sprays (mist) as specified in paragraph PREVENTION OF PLASTIC SHRINKAGE CRACKING above, is allowed to be applied to the concrete or the concrete surface during paving and finishing.

3.6.5 Fixed Form Paving - for Non-Continuously Reinforced Concrete

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NOTE: Fixed-form paving should always be included as an option or mandatory item as appropriate. Edit bracketed items in subparagraph a. Keys are only permitted for roads and streets with a thickness of 230 mm 9 inches or greater. Do not permit keys for airfield pavements.

****

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

3.6.5.1 Forms for Fixed-Form Paving - for Non-Continuously Reinforced Concrete

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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 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 and provide an increase in depth of not more than 25 percent. 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.[Where keyway forms are required, rigidly attach the keyway form to the main form so no displacement can take place. Tack-weld metal keyway forms to steel forms. Align keyway forms so that there is no variation over 6 mm 1/4 inch either vertically or horizontally, when tested with a 4 m 12 foot template after forms are set, including tests across form joints.]

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. Securely hold forms for overlay pavements and for other locations where forms set on existing pavements in place with stakes or by other approved methods. 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.

]3.6.5.2 Form Removal - for Non-Continuously Reinforced Concrete

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, as directed. 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.

3.6.6 Slipform Paving - for Non-Continuously Reinforced Concrete

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NOTE: Retain slipform paving as an option unless there are specific, valid reasons for deleting it.

Be sure all other paragraphs correlate with choice made here.
****

3.6.6.1 General - for Non-Continuously Reinforced Concrete

Provide paving equipment for slipform paving and the operation thereof that conforms to the requirement of paragraph EQUIPMENT, and all requirements specified herein. Provide a slipform paver capable of shaping the concrete to the specified and indicated cross section, meeting all tolerances, with a surface finish and edges that require only a very minimum isolated amount of hand finishing, in one pass. If the paving operation does not meet the above requirements and the specified tolerances, immediately stop the operation, and regroup and replace or modify any equipment as necessary, modify paving procedures or modify the concrete mix, in order to resolve the problem. Provide a slipform paver that is automatically electronically controlled from a taut wire guideline for horizontal alignment and on both sides from a taut wire guideline for vertical alignment, except that electronic control from a ski operating on a previously constructed adjoining lane is required where applicable for either or both sides. Automatic, electronic controls are required for vertical alignment on both sides of the lane. Control from a slope-adjustment control or control operating from the underlying material is not allowed. Properly adjust side forms on slipform pavers so that the finished edge of the paving lane meets all specified tolerances. Install dowels in longitudinal construction joints as specified below. The installation of these dowels by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete is not permitted.[If a keyway is required, install a 0.45 to 0.55 mm 26 gauge thick metal keyway liner as the keyway is extruded. Provide keyway forms that do not vary more than plus or minus 3 mm 1/8 inch from the dimensions indicated and do not deviate more than plus or minus 6 mm 1/4 inch from the mid-depth of the pavement. An abrupt offset either horizontally or vertically in the completed keyway is not allowed. Maintain the keyway liner to remain in place and become part of the joint.]

3.6.6.2 Guideline for Slipform Paving - for Non-Continuously Reinforced Concrete

Accurately and securely install guidelines well in advance of concrete placement. Provide supports at necessary intervals to eliminate all sag in the guideline when properly tightened. Provide guideline consisting of high strength wire set with sufficient tension to remove all sag between supports. Provide supports that are securely staked to the underlying material or other provisions made to ensure that the supports are not displaced when the guideline is tightened or when the guideline or supports are accidentally touched by workmen or equipment during construction. Provide appliances for attaching the guideline to the supports that are capable of easy adjustment in both the horizontal and vertical directions. When it is necessary to leave gaps in the guideline to permit equipment to use or cross underlying material, provide provisions for quickly and accurately replacing the guideline without any delay to the forward progress of the paver. Provide supports on either side of the gap that are secured in such a manner as to avoid disturbing the remainder of the guideline when the portion across the gap is positioned and tightened. Check the guideline across the gap and adjacent to the gap for a distance of 60 m 200 feet for horizontal and vertical alignment after the guideline across the gap is tightened. Provide vertical and horizontal positioning of the guideline such that the

finished pavement conforms to the alignment and grade elevations shown on the drawings within the specified tolerances for grade and smoothness. The specified tolerances are intended to cover only the normal deviations in the finished pavement that may occur under good supervision and do not apply to setting of the guideline. Set the guideline true to line and grade.

3.6.6.3 Stringless Technology - for Non-Continuously Reinforced Concrete

If the use of any type of stringless technology is proposed, submit a detailed description of the system and perform a trial field demonstration at least one week prior to start of paving. Approval of the control system will be based on the results of the demonstration and on continuing satisfactory operation during paving.

3.6.7 Placing Reinforcing Steel - for Non-Continuously Reinforced Concrete

Provide the type and amount of steel reinforcement indicated.

3.6.7.1 Pavement Thickness Greater Than 300 mm 12 inches - for Non-Continuously Reinforced Concrete

For pavement thickness of 300 mm 12 inches or more, install the reinforcement steel by the strike-off method wherein a layer of concrete is deposited on the underlying material, consolidated, and struck to the indicated elevation of the steel reinforcement. Place the reinforcement upon the pre-struck surface, followed by placement of the remaining concrete and finishing in the required manner. When placement of the second lift causes the steel to be displaced horizontally from its original position, provide provisions for increasing the thickness of the first lift and depressing the 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 bottom layer of concrete that have been placed more than 30 minutes without being covered with the top layer with newly mixed concrete without additional cost to the Government.

3.6.7.2 Pavement Thickness Less Than 300 mm 12 Inches - for Non-Continuously Reinforced Concrete

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

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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. 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, ensure that the entire depth of concrete is adequately consolidated.[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.]

3.6.8 Placing Dowels - for Non-Continuously Reinforced Concrete

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NOTE: Delete references to slipform paving installation of dowels if slipform paving is not allowed. Delete references to installation in contraction joints if not required.

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Ensure the method used to install and hold dowels in position result in dowel alignment within the maximum allowed horizontal and vertical tolerance of 3 mm per 300 mm 1/8 inch per foot after the pavement has been completed. Except as otherwise specified below, maintain the horizontal spacing of dowels within a tolerance of plus or minus 15 mm 5/8 inch. Locate the dowel vertically on the face of the slab within a tolerance of plus or minus 13 mm 1/2 inch. 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. Check horizontal alignment perpendicular to the joint edge with a framing square. 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 deleting 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.

3.6.8.1 Contraction Joints - for Non-Continuously Reinforced Concrete

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.

3.6.8.2 Construction Joints-Fixed Form Paving - for Non-Continuously Reinforced Concrete

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.

3.6.8.3 Dowels Installed in Hardened Concrete - for Non-Continuously Reinforced Concrete

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NOTE: The first Tailoring Option is for "Cylinders/Beams" and the second option is for "Beams".

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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 [compressive strength of 17 MPa 2500 psi][flexural strength of 3.1 MPa 450 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 occur to 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. Continuing damage requires modification of the equipment and operation. Drill depth of dowel hole within a tolerance of plus or minus 13 mm 1/2 inch of the dimension shown on the drawings. Upon completion of the drilling operation, blow out the dowel hole with oil-free, compressed air. Bond dowels in the drilled holes using epoxy resin. Inject epoxy resin at the back of the hole before installing the dowel and extruded 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.

3.6.8.4 Lubricating Dowel Bars - for Non-Continuously Reinforced Concrete

Wipe the portion of each dowel intended to move within the concrete clean and coat with a thin, even film of lubricating oil or light grease before the concrete is placed.

3.7 FINISHING

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NOTE: Edit bracketed items as appropriate. Retain slipform paving subparagraph except when it is prohibited elsewhere. Delete Other Types of Finishing Equipment here and in PART 2, if not wanted. Hand finishing is to be allowed only for isolated, small, odd-shaped slabs or places inaccessible to the paver.

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Provide finishing operations as a continuing part of placing operations starting immediately behind the strike-off of the paver. Provide initial finishing by the transverse screed or extrusion plate. Provide the sequence of operations consisting of transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Provide finishing by the machine method. Provide a work bridge as necessary for consolidation and hand finishing operations. Use the hand method only on 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. Prior to recommencing machine finishing, properly adjust or replace the equipment. 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 the equipment, mixture, or procedures modified as necessary. Compensate for

surging behind the screeds or extrusion plate and settlement during hardening and take care to ensure that paving and finishing machines are properly adjusted 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 clean and in an approved condition. Water is not allowed to be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

3.7.1 Machine Finishing With Fixed Forms

Replace machines that cause displacement of the forms. Only one pass of the finishing machine is allowed over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, immediately stop the operation and the equipment, mixture, and procedures adjusted as necessary.

3.7.2 Machine Finishing with Slipform Pavers

Operate the slipform paver so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Immediately modify or replace any equipment or procedure that fails to meet these specified requirements as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float is allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, immediately stop the paving operation and the equipment, mixture, or operation modified to prevent formation of such slurry. Immediately remove any slurry which does run down the vertical edges by hand, using stiff brushes or scrapers. Slurry, concrete or concrete mortar is not allowed to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

3.7.3 Surface Correction and Testing

After all other finishing is completed but while the concrete is still plastic, eliminate minor irregularities and score marks in the pavement surface by means of cutting straightedges. Provide cutting straightedges with a minimum length of 4 m 12 feet that are operated from the sides of the pavement or from bridges. Provide cutting straightedges operated from the side of the pavement equipped with a handle 1 m 3 feet longer than one-half the width of the pavement. Test the surface for trueness with a straightedge held in successive positions parallel and at right angles to the center line of the pavement, and the whole area covered as necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one-half the length of the straightedge. Immediately fill depressions with freshly mixed concrete, 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 straight edging is not allowed to be used as a replacement for the straightedge testing of paragraph SURFACE SMOOTHNESS. Use long-handled, flat bull floats very sparingly and only as necessary to correct minor, scattered surface defects. If frequent use of bull floats is necessary, stop the paving operation and the equipment, mixture or procedures adjusted to eliminate the surface defects. 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.

3.7.4 Hand Finishing

Use hand finishing operations only as specified below. Provide a work bridge to be used as necessary for consolidation and placement operations to avoid standing in concrete.

3.7.4.1 Equipment and Template

In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping template and a longitudinal float for hand finishing. Provide a template at least 300 mm 1 foot longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, that is constructed of metal or other suitable material shod with metal. Provide a longitudinal float at least 3 m 10 feet long, of approved design, is rigid and substantially braced, and maintain a plane surface on the bottom. Grate tampers (jitterbugs) are not allowed.

3.7.4.2 Finishing and Floating

As soon as placed and vibrated, strike off the concrete and screeded to the crown and cross section and to such elevation above grade that when consolidated and finished, the surface of the pavement is at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, tamp the entire surface with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, float the pavement longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, place additional concrete, consolidated and screeded, and the float operated until a satisfactory surface has been produced. Do not advance the floating operation more than half the length of the float and then continued over the new and previously floated surfaces.

3.7.5 Texturing

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NOTE: Designer must select type of texturing desired, retain that subparagraph, and delete the others. A genuine effort must be made to determine the type of texturing, if any, desired by the using service. If no guidance is given, the usual default method must be burlap drag. If other than a burlap drag textured finish is required, edit the appropriate paragraph(s) as shown below.

For Air Force airfield paving projects, do not specify artificial turf, wire comb, or surface grooving textures. For Navy airfield paving projects, do not specify wire comb or surface grooving textures. Use Section 32 01 18.71 GROOVING OF AIRFIELD PAVING to specify saw-cut grooves.

Spring tine grooving is limited to use on roads and streets only.
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Before the surface sheen has disappeared and before the concrete hardens or curing compound is applied, texture the surface of the pavement as described herein. After curing is complete, thoroughly power broom all textured surfaces to remove all debris.

[3.7.5.1 Burlap Drag Surface

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

][3.7.5.2 Broom Texturing

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. Hand brooming is permitted only on isolated odd shaped slabs or slabs where hand finishing is permitted. For hand brooming, provide brooms with handles longer than half the width of slab to be finished. Transversely draw the hand brooms across the surface from the center line to each edge with slight overlapping strokes.

][3.7.5.3 Artificial Turf Drag Surface

Apply artificial turf texture by dragging the surface of the pavement in the direction of concrete placement with an approved full-width drag made with artificial turf.

]3.7.6 Edging

Before texturing has been completed, carefully finish the edge of the slabs along the forms, along the edges of slipformed lanes, 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.

3.7.7 Outlets in Pavement

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.

3.8 CURING

3.8.1 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. 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.

3.8.2 Wet Curing

Wet-cure concrete and continuously maintain wet for the entire curing period, commencing immediately after finishing. If forms are removed before the end of the curing period, carry out curing as on unformed surfaces, using suitable materials. Apply burlap to concrete surface and cover with polyethylene; lap sheets to ensure full coverage. When forms are removed, cover pavement sides with burlap and polyethylene and keep wet. Anchor burlap and polyethylene to prevent blowing or dislodging by wind or jet blast. Provide an approved work system to ensure that concrete surface is continuously wet 24 hours per day. Wet cure for 14 days. Adjacent lanes of High Temperature Concrete may be placed after 72 hours of wet curing and minimizing the disturbance of the burlap and polyethylene. Curing may be interrupted for no more than 12 hours (includes time for preparation, paving and initial hardening before wet curing). Reinstate wet curing until 14 days of wet curing are completed (add time for lack of curing while paving adjacent lanes).

3.9 JOINTS FOR NON-CONTINUOUSLY REINFORCED CONCRETE

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NOTE: Edit bracketed items in following subparagraphs to conform to design requirements. Even if not required, dowels must be permitted for construction joints. Remove joint types not required in the project.

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3.9.1 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][32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT].

3.9.2 Longitudinal Construction Joints

Install dowels in the longitudinal construction joints, or thicken the edges as indicated. Install dowels as specified above.[If any length of completed keyway of 1.5 m 5 feet or more fails to meet the previously

specified tolerances, install dowels in that part of the joint by drilling holes in the hardened concrete and grouting the dowels in place with epoxy resin.] After the end of the curing period, saw longitudinal construction joints to provide a groove at the top for sealant conforming to the details and dimensions indicated.

3.9.3 Transverse Construction Joints

Install transverse construction joints at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for 30 minutes or longer. Install the transverse construction joint at a planned transverse joint. Provide transverse construction joints by utilizing headers or by paving through the joint, then full-depth saw cutting the excess concrete. Construct pavement with the paver as close to the header as possible, with the paver run out completely past the header. Provide transverse construction joints at a planned transverse joint constructed as shown or, if not shown otherwise, dowelled in accordance with paragraph DOWELS INSTALLED IN HARDENED CONCRETE, or paragraph FIXED FORM PAVING above.

3.9.4 Expansion Joints

Provide expansion joints where indicated, and about any structures and features that project through or into the pavement, using joint filler of the type, thickness, and width indicated, and installed 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 and extend the full slab depth. After placement and curing of the adjacent slab, sawcut the sealant reservoir depth from the filler. 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.

3.9.5 Slip Joints

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. Construct 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.

3.9.6 Contraction Joints

Construct transverse and longitudinal contraction joints by sawing an initial groove in the concrete with a 3 mm 1/8 inch blade to the indicated depth. During sawing of joints, and again 24 hours later, the CQC team is required to inspect all exposed lane edges for development of cracks below the saw cut, and immediately report results. 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. The time of initial sawing varies depending on existing and anticipated weather conditions and be such as 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. The sawed faces of joints will be inspected for undercutting or washing of the concrete due to the early sawing, and sawing delayed 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 at the required spacing consecutively 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. Before sawing a joint, examine the concrete closely for cracks, and do not saw the joint if a crack has occurred near the planned joint location. Discontinue sawing when 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 vacuumed until all waste from sawing is removed from the joint and adjacent concrete surface. Respray the surface with curing compound as soon as free water disappears. Take necessary precautions to insure that the concrete is properly protected from damage and cured 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, and be maintained until removed immediately before sawing the joint sealant reservoir. Seal the exposed saw cuts on the 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.

3.9.7 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.

[3.10 SURFACE PREPARATION FOR SEALING

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NOTE: In order to prepare the surface of existing concrete or new concrete which has POL spillage, POL stains must be removed to ensure penetration of surface sealer solution. This paragraph is optional for new construction and may be deleted.

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Utilize one of the following agents and methodologies for removing POL stains prior to sodium silicate sealing:

a. Dishwashing detergent and hot water: Apply to stained concrete and scrub to develop a thick lather. Let set for five minutes then rinse with warm/hot water. Use of steam to pre-treat the area and rinse may aid removal.

b. Trisodium phosphate (TSP): Note that some states have banned this product because phosphate can cause problems with nearby waterways. DO NOT MIX TSP WITH ANY ACID! A violent reaction can occur and release noxious gas. You can use both products but they must be used separately, with a thorough rinsing with water between applications.

   Application method 1: Mix one measure of TSP with six measures of water. Apply over the stain with a paintbrush and allow it to dry completely before scraping off the dried paste. Rinse the concrete surface and scrub with a stiff brush and clean water.

Application method 2: Dissolve 1 pound, 6 ounces of TSP in a gallon of water. Add enough finely ground calcium carbonate (also called whiting or agricultural lime) to make a thick paste. (Agricultural lime is available at garden supply stores.) Spread the paste over the stain and allow it to dry for a day, if possible. Brush off the dry paste with a stiff brush and scrub the concrete with water. The paste has a high pH so personal protective equipment (PPE) must be used and the paste should be kept away from aircraft. If it is windy, protect the treated area until the area is cleaned and rinsed to keep the caustic material from blowing around the apron.

c. Sodium hydroxide: Make a solution of 5 percent sodium hydroxide (caustic soda: NaOH). Apply it over the stain with a paintbrush and allow it to dry for at least 24 hours. Rinse and scrub with clean water then repeat as required. This has a high pH so PPE must be used and the solution should be kept away from aircraft. If it is windy, protect the treated area until the area is cleaned and rinsed to keep the caustic material from blowing around the apron.

d. Sodium carbonate: Apply as directed. Rinse well with water. This is an organic salt. If it is windy, protect the treated area until the area is cleaned and rinsed to keep the salt from blowing around the apron.

e. Phosphoric acid cleaner: Apply as directed. Rinse well with water and sodium carbonate (washing soda or soda ash) to neutralize the pH then rinse with clear water. This product will etch the concrete so do not leave it on too long and ensure the area is rinsed well to ensure no acid is left on the concrete.

f. Bio-remediation: Apply as directed.

]3.11 SODIUM SILICATE SEALING

Seal the High Temperature Concrete surfaces with a sodium silicate solution, after paint marking application, using the following procedures:

a. After last continuously reinforced High Temperature Concrete pour is 90 days of age, and non-continuously reinforced High Temperature Concrete is 70 days of age (if used), dry broom and air blow concrete surfaces and apply sodium silicate sealant. Concrete surface must be dry for 24 hours prior to applying sealer. Air temperature must be 5 degrees C 40 degrees F or more and relative humidity must be 80 percent or less, both during application and the 48 hours after application.

b. Apply three coats of sodium silicate solution, using low pressure airless spraying equipment that ensures uniform application. Start applying the solution at the highest point in the pavement and continue downgrade. Each coat must cover not more than 5 square meters per liter 200 square feet per gallon. Excessive application is to be avoided to prevent efflorescence. Allow sodium silicate to penetrate for 2 hours then wash off any visible excess (ponded) solution. Allow the area to dry for 24 hours between each coat.

c. After allowing the last coat to dry for 24 hours, evaluate the surface for any excess silica or dusting. Wash off any excess silica or dusting as needed. Protect application from any pedestrian or

vehicular traffic until the last coat has dried.

3.11.1 Pavement Marking Installation

Apply pavement markings and glass beads before sodium silicate application. Apply sodium silicate over markings and glass beads.

3.12 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED CONCRETE FOR CONTINUOUSLY REINFORCED CONCRETE

3.12.1 High Temperature Concrete

Remove and replace new High Temperature Concrete determined to not meet acceptance requirements using materials, methods and equipment, and to the limits as directed by Contracting Officer at no additional cost to Government. Removal of partial slabs, or partial lanes of continuously reinforced lanes, is not permitted; remove and replace the entire continuously reinforced lane.

3.12.1.1 Removal and Replacement Of Continuously Reinforced High Temperature Concrete

Removal of partial slabs, or partial lanes of continuously reinforced lanes, is not permitted; remove and replace the entire continuously reinforced lane. Removal of a lane of continuously reinforced High Temperature Concrete pavement requires saw cutting the concrete full depth on all sides 380 mm 15 inches inside from each edge of the lane to be removed using a diamond saw. Remove the concrete within this initial sawcut . Remove the remaining 380 mm 15 inch concrete buffer only with hand held 14 kg 30 pound or less pneumatic hammers to remove the concrete above and below the remaining continuous reinforcement. Remove any loose longitudinal rebar exposed. Regrade and recompact surface of base course. Use manufacturer approved mechanical connector clamp, weld or use threaded connector to attach new transverse reinforcement to existing; lap splicing is not adequate. Replace continuous reinforcement in both directions per plans. Replace concrete following this specification. Submit complete removal and repair plan to Contracting Officer for review prior to work.

3.12.2 Removal and Replacement of Plane Jointed Concrete Pavement

Where it is necessary to remove concrete pavement, remove in accordance with paragraph EXISTING CONCRETE PAVEMENT REMOVAL AND REPAIR. Remove and replace full depth, by full width of the lane, and the limit of removal must be normal to the paving lane and extend to each original joint. Remove and replace any damaged reinforcing bars. Place concrete as specified for original construction. Prior to placement of new concrete, recompact and shape the underlying material as specified in the appropriate section of these specifications, and clean the surfaces of all four joint faces of all loose material and contaminants. Prepare the resulting joints around the new slab as specified for original construction.

3.13 REPAIR, REMOVAL AND REPLACEMENT OF NEWLY CONSTRUCTED SLABS FOR NON-CONTINUOUSLY REINFORCED CONCRETE

3.13.1 General Criteria

Repair or remove and replace 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.

3.13.2 Slabs with Cracks

No cores can be taken within continuously reinforced concrete. Before repairing cracks that have developed within continuously reinforced concrete consultation with [Corps of Engineers Transportation Systems Center (TSMCX)][Air Force Civil Engineer Center (AFCEC)][Naval Facilities Engineering Command (NAVFAC, Echelon III)] pavement Subject Matter Expert (SME).

The Government may require cores to be taken over cracks to determine depth of cracking. Such cores are to be drilled with a minimum diameter of 150 mm 6 inches, and be backfilled with an approved non-shrink concrete. 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 injected full depth with epoxy resin, Type IV, Grade 1. Remove and replace slabs containing cracks deeper than 50 mm 2 inches.

3.13.3 Removal and Replacement of Full Slabs

Remove and replace slabs containing more than 15.0 percent of any longitudinal or transverse joint edge spalled. Where it is necessary to remove full slabs, remove in accordance with paragraph REMOVAL OF EXISTING PAVEMENT SLAB below. Remove and replace full depth, by full width of the slab, and the limit of removal normal to the paving lane and extend to each original joint. Compact and shape the underlying material as specified in the appropriate section of these specifications, and clean the surfaces of all four joint faces of all loose material and contaminants and coated with a double application of membrane forming curing compound as 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 four edges of the new slab. Cut off original damaged dowels flush with the joint face. Lightly oil or grease protruding portions of new dowels. 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.

3.13.4 Repairing Spalls Along Joints

Conventional spall repairs are prohibited of all Vertical Landing Zones, Short Take-Off Lanes, and associated safety zones, blast zones, and rotation areas. In these areas, only full depth repairs are acceptable. In areas which have continuously reinforced steel, repair must not damage reinforcing steel in any way.

Repair spalls along joints to be sealed 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 scrubbed 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 the following table based on the cavity volume.

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. Saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean the reservoir and then sealed with the sealer specified for the joints.[In lieu of sawing, spalls not adjacent to joints and popouts, 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 or13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.]

3.13.5 Repair of Weak Surfaces

Weak surfaces are defined as mortar-rich, rain-damaged, uncured, or containing exposed voids or deleterious materials. 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 PART 1 GENERAL.

Remove and replace slabs containing weak surfaces greater than 6 mm 1/4 inch thick.

3.13.6 Repair of Pilot Lane Vertical Faces

Repair excessive edge slump and joint face deformation in accordance with paragraph EDGE SLUMP AND JOINT FACE DEFORMATION in PART 1. Repair inadequate consolidation (honeycombing or air voids) by saw cutting the face full depth along the entire lane length with a diamond blade. Obtain cores, as directed, to determine the depth of removal.

3.14 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--dowels, keys, tie bars, etc--and its condition. Normally, the joint between the new pavement and existing pavement should be made at an existing joint in the old pavement. Coordinate with Section 02 41 00 [DEMOLITION][AND][DECONSTRUCTION].

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Remove existing concrete pavement at locations indicated on the drawings. Prior to commencing pavement removal operations, inventory the pavement distresses (cracks, spalls, and corner breaks) along the pavement edge to remain. After pavement removal, survey the remaining edge again 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.

3.14.1 Removal of Existing Pavement Slab

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NOTE: The saw cut at a distance from the joint should be sawed with a wheel saw which produces a 38 mm 1-1/2 inches or wider kerf and better prevents stress from propagating across the saw cut. Specify wheel saw for Army and Air Force projects. Specify diamond saw for Navy projects.

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When existing concrete pavement is to be removed and adjacent concrete is to be left in place, 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. 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] [diamond saw] as specified in paragraph SAWING EQUIPMENT. Remove all pavement beyond this last saw cut in accordance with the approved demolition work plan. 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. In

lieu of this method, 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. In lieu of the above specified removal method, the slab may be sawcut full depth to divide it into several pieces and each piece lifted out and removed. Use suitable equipment to provide a truly vertical lift, and safe lifting devices used for attachment to the slab.

3.14.2 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 damage areas is considered a subsidiary part of concrete pavement construction. Saw off all exposed keys and keyways full depth.

3.14.2.1 Spall Repair

Conventional spall repairs are prohibited of all Vertical Landing Zones, Short Take-Off Lanes, and associated safety zones, blast zones, and rotation areas. In these areas, only full depth repairs are acceptable. In areas which have continuously reinforced steel, repair must not damage reinforcing steel in any way.

Not more than 15.0 percent of each slab's edge is allowed to be spalled. Provide a full depth saw cut on the exposed face to remove the spalled face of damaged slabs with spalls exceeding this quantity, regardless of spall size. Provide repair materials and procedures as previously specified in paragraph REPAIRING SPALLS ALONG JOINTS.

3.14.2.2 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 which is to remain in place from damage or disturbance during removal operations and until placement of new concrete, and be shaped as 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.

3.15 PAVEMENT PROTECTION

Protect the 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. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment is permitted on the new pavement after the pavement has been cured for 7 days and the joints have been sealed or otherwise protected, the concrete has attained a minimum field cured flexural strength of 3.8 MPa 550 psi and approved means are provided to prevent damage to the slab edge. Continuously maintain all new and existing pavement carrying

construction traffic or equipment completely clean, and spillage of concrete or other materials cleaned up immediately upon occurrence. Take special care in areas where traffic uses or crosses active airfield pavement. Power broom other existing pavements at least daily when traffic operates. For fill-in lanes, provide equipment that does not damage or spall the edges or joints of the previously constructed pavement.

3.16 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL

3.16.1 Testing and Inspection by Contractor

During construction, perform sampling and testing of aggregates, cementitious materials (cement, slag cement, and pozzolan), and concrete to determine compliance with the specifications. Provide facilities and labor as may be necessary for procurement of representative test samples. Furnish sampling platforms and belt templates to obtain representative samples of aggregates from charging belts at the concrete plant. Obtain samples of 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, either for pay adjustment purposes or for any other reason.

3.16.2 Testing and Inspection Requirements

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

TABLE 6 5 4
CONTRACTOR TESTING AND INSPECTION REQUIREMENTS

TABLE 6 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Fine Aggregate Gradation and Fineness Modulus			
2 per lot	ASTM C136/C136M sample at belt	9 of 10 tests must vary less than 0.15 from average	Retest, resolve, retest
		Outside limits on any sieve	Retest
		2nd gradation failure	Stop, resolve, retest
1 per 10 gradations	ASTM C117	Outside limits on any sieve	Retest
		2nd gradation failure	Stop, repair, retest
Coarse Aggregate Gradation (each aggregate size)			
2 per lot	ASTM C136/C136M sample at belt	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, correct
		2 consecutive averages of 5 tests outside limits	report to COR, stop ops, repair, retest

TABLE 6 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
1 per 10 gradations	ASTM C117	Outside limits on any sieve	Retest
		2nd gradation failure	report to COR, correct
		2 consecutive averages of 5 tests outside limits	report to COR, stop ops, repair, verify all operations
Workability Factor and Coarseness Factor Computation			
Same as C.A. and F.A.	see paragraph AGGREGATES	Use individual C.A. and F.A. gradations. Combine using batch ticket percentages. 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, re-calibrate scales
		2 consecutive averages of 5 tests outside limits	Stop production paving, report to COR, and revise materials and operations to be in compliance prior to restarting production paving
Aggregate Deleterious, Quality, and ASR Tests			
First test no later than time of uniformity testing and then every [30][60] days of concrete production	see paragraph AGGREGATES		Stop production, retest, replace aggregate. Increase testing interval to 90 days if previous 2 tests pass
Plant - Scales, Weighing Accuracy			
Monthly	NRMCA QC 3		Stop plant ops, repair, re-calibrate
Plant - Batching and Recording Accuracy			
Weekly	Record/Report	Record required/recorded/actual batch mass	Stop plant ops, repair, re-calibrate
Plant - Batch Plant Control			

TABLE 6 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Every lot	Record/Report		Record type and amount of each material per lot
Plant - Mixer Uniformity - Stationary Mixers			
Every 4 months during paving	COE CRD-C 55	After initial approval, use abbreviated method	Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
Plant - Mixer Uniformity - Truck Mixers			
Every 4 months during paving	ASTM C94/C94M	Random selection of truck.	Increase mixing time, change batching sequence, reduce batch size to bring into compliance. Retest
Concrete Mixture - Air Content			
When test specimens prepared plus 2 random	ASTM C231/C231M sample at point of discharge within the paving lane	Individual test control chart: Warning plus or minus 1.0	Adjust AEA, retest
		Individual test control chart: Action plus or minus 1.5	Halt operations, repair, retest
		Range between 2 consecutive tests: Warning plus 2.0	Re-calibrate AEA dispenser
		Range between 2 consecutive tests: Action plus 3.0	Halt operations, repair, retest
Concrete Mixture - Unit Weight and Yield			
Same as Air Content	ASTM C138/C138M sample at point of discharge within the paving lane	Individual test basis: Warning Yield minus 0 or plus 1 percent	Check batching tolerances
		Individual test basis: Action Yield minus 0 or plus 5 percent	Halt operations
Concrete Mixture - Slump			
When test specimens prepared plus 4 random	ASTM C143/C143M sample at point of discharge within the paving lane	Individual test control chart: Upper Warning minus 13 mm 1/2 inch below max	Adjust batch masses within max W/C ratio
		Individual test control chart: Upper Action at maximum allowable slump	Stop operations, adjust, retest
		Range between each consecutive test: 38 mm 1-1/2 inches	Stop operations, repair, retest
Concrete Mixture - Temperature			

TABLE 6 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
When test specimens prepared	ASTM C1064/C1064M sample at point of discharge within the paving lane	See paragraph WEATHER LIMITATIONS	
Concrete Mixture - Strength			
8 per lot	ASTM C31/C31M sample at point of discharge within the paving lane	See paragraph CONCRETE STRENGTH TESTING for CQC Perform fabrication of strength specimens and initial cure outside the paving lane and within 300 m 1,000 feet of the sampling point.	
Paving - Inspection Before Paving			
Prior to each paving operation	Report	Inspect underlying materials, construction joint faces, forms, reinforcing, dowels, and embedded items	
Paving - Inspection During Paving			
During paving operation		Monitor and control paving operation, including placement, consolidation, finishing, texturing, curing, and joint sawing.	
Paving - Vibrators			
Weekly during paving	COE CRD-C 521	Test frequency (in concrete), and amplitude (in air), average measurement at tip and head.	Repair or replace defective vibrators.
Moist Curing			
2 per lot, min 4 per day	Visual		Repair defects, extend curing by 1 day
Membrane Compound Curing			
Daily	Visual	Calculate coverage based on quantity/area	Respray areas where coverage defective. Re-calibrate equipment
Cold Weather Protection			

TABLE 6 TESTING AND INSPECTION REQUIREMENTS			
Frequency	Test Method	Control Limit	Corrective Action
Once per day	Visual		Repair defects, report conditions to COR

3.16.3 Concrete Strength Testing for CQC

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NOTE: If paragraph FLEXURAL STRENGTH AND THICKNESS is based on 28-day flexural strength for acceptance, modify this subparagraph to match it. The first option "Cylinders/Beams" includes items a through g; the second option "Beams" includes listing a through f.
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Perform Contractor Quality Control operations for concrete strength consisting of the following steps:

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

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

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

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

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

f. Fabricate and cure two beams for every 1500 cubic meters 2000 cubic yards of concrete placed. Fabricate and cure in accordance with ASTM C31/C31M; test at 14-days of age in accordance with ASTM C78/C78M. Use the flexural strength results to verify the cylinder-beam acceptance correlation ratio.

g. Maintain up-to-date control charts for strength, showing the 7-day CQC

compressive strength, the 14-day compressive strength (from acceptance tests) and the [28] [90]-day equivalent flexural strength of each of these for each lot.

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

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

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

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

e. If the equivalent average [28] [90]-day strength for the lot is below the Average Flexural Strength Required for Mixtures by 490 kPa 69 psi flexural strength or more, at any time, adjust the mixture to increase the strength, as approved.

f. Maintain up-to-date control charts for strength, showing the 7-day CQC flexural strength and the [28] [90]-day flexural strength (from acceptance tests) of each of these for each lot.

]3.16.4 Reports

Report all results of tests or inspections conducted informally as they are completed and in writing daily. Prepare a weekly report for the updating of control charts covering the entire period from the start of the construction season through the current week. During periods of cold-weather protection, make daily reports of pertinent temperatures. 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 --