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USACE / NAVFAC / AFCESA / NASA **UFGS-32 13 14 (April 2006)**

Preparing Activity: USACE **Replacing without change UFGS-02754 (August 2004)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2007

Latest change indicated by CHG tags
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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 13 14

CONCRETE PAVEMENTS FOR SMALL PROJECTS

04/06

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SECTION 32 13 14

CONCRETE PAVEMENTS FOR SMALL PROJECTS
04/06

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NOTE: This guide specification covers the requirements for construction of concrete pavement for airfields and heavy-duty roads and hardstands, and vehicular pavement with volumes less than or equal to 2000 cubic meters (2500 cu. yd.) of concrete. For larger concrete volumes, or if a more detailed specification is required, Section 32 13 11 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDS should be used.

Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable items(s) or insert appropriate information.

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

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).
****

PART 1 GENERAL

****
NOTE: In preparing contract specifications for concrete pavement, the Designer will use UFC 3-250-04FA STANDARD PRACTICE FOR CONCRETE PAVEMENTS for guidance. State highway specifications may only be used for nonorganizational parking, roads, streets, and driveways where the paving index is

less than 5. All organizational vehicle parking, roads and airfield concrete pavements shall use the Corps of Engineers guide specifications without exception.

****

1.1 REFERENCES

****

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

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

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

****

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

ACI INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2002) Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 301	(2005) Specifications for Structural Concrete
ACI 305R	(1999; Errata 2006) Hot Weather Concreting

ASTM INTERNATIONAL (ASTM)

ASTM A 184/A 184M	(2006) Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A 615/A 615M	(2006a) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C 1077	(2006) Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation

ASTM C 123	(2004) Standard Test Method for Lightweight Particles in Aggregate
ASTM C 143/C 143M	(2005a) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C 150	(2005) Standard Specification for Portland Cement
ASTM C 192/C 192M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	(2004) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 31/C 31M	(2006) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	(2003) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2005e1) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 494/C 494M	(2005a) Standard Specification for Chemical Admixtures for Concrete
ASTM C 595	(2006) Standard Specification for Blended Hydraulic Cements
ASTM C 618	(2005) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C 666/C 666M	(2003) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 94/C 94M	(2006) Standard Specification for Ready-Mixed Concrete
ASTM C 989	(2006) Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
ASTM D 1751	(2004) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)

ASTM D 1752	(2004a) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion

NATIONAL READY MIXED CONCRETE ASSOCIATION (NRMCA)

NRMCA CPMB 100	(2000) Concrete Plant Standards

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 130	(2001) Standard Recommended Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete
COE CRD-C 540	(2001) Standard Specification for Nonbituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type
COE CRD-C 572	(1974) Specifications for Polyvinylchloride Waterstops

1.2 SYSTEM DESCRIPTION

****
NOTE: Edit or delete as appropriate.
****

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

1.3 MEASUREMENT AND PAYMENT

****
NOTE: Any project small enough to use this guide specification may use Unit Price or Lump Sum payment. If lump sum payment is used, delete the following paragraphs on Measurement and Payment.
****

1.3.1 Measurement

The quantity of concrete to be paid for will be the volume of concrete in cubic meters yards including 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 edges or the space occupied by embedded items or voids.

1.3.2 Payment

Payment will be made at the contract price per cubic meter yard for the

scheduled item. Payment will constitute full compensation for furnishing all materials, equipment, plant and tools, and for all labor and other incidentals necessary to complete the concrete pavement. No separate payment will be made for any cementitious materials, admixtures, steel reinforcement, dowels or tie bars, or for any joint materials.

1.4 ACCEPTABILITY OF WORK

****
NOTE: Correlate this paragraph with paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES and all other specification requirements. The District Pavement Engineer or Geotechnical Branch should be consulted for guidance.
****

The pavement will be accepted on the basis of tests made by the Government and by the Contractor or its suppliers, as specified herein. The Government may, at its discretion, make check tests to validate the results of the Contractor's testing. Concrete samples shall be taken by the Contractor at the placement to determine the slump, air content, and strength of the concrete. Test cylinders shall be made for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed into service. All air content measurements shall be determined in accordance with ASTM C 231. All slump tests shall be made in accordance with ASTM C 143/C 143M. All test cylinders shall be 150 by 300 mm 6 by 12 inch cylinders and shall be fabricated in accordance with ASTM C 192/C 192M, using only steel molds, cured in accordance with ASTM C 31/C 31M, and tested in accordance with ASTM C 39/C 39M. A strength test shall be the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days. The Contractor shall furnish all materials, labor, and facilities required for molding, curing, testing, and protecting test specimens at the site and in the laboratory.

1.4.1 Evaluation Sampling

Sampling, testing, and mixture proportioning shall be performed by a commercial Testing Laboratory, conforming with ASTM C 1077. The individuals who sample and test concrete and concrete constituents shall be certified as American Concrete Institute (ACI) Concrete Field Testing Technicians, Grade I. The individuals who perform the inspection of concrete shall be certified as ACI Concrete Construction Inspector, Level II. All mix design, weekly quality control reports, smoothness reports, and project certification reports shall be signed by a Registered Engineer.

1.4.2 Surface Testing

****
NOTE: Drawings should clearly show all pavement joint intersection elevations, and specific required deviations from a plane surface for such special features as crowns, drainage inlets, etc.
****

Surface testing for surface smoothness [, edge slump] and plan grade shall be performed as indicated below by the Testing Laboratory. The measurements shall be properly referenced in accordance with paving lane identification and stationing, and a report given to the Government within

24 hours after measurement is made. A final report of surface testing, signed by a Registered Engineer, containing all surface measurements and a description of all actions taken to correct deficiencies, shall be provided to the Government upon conclusion of surface testing.

1.4.2.1 Surface Smoothness Requirements

****
NOTE: Designer should delete categories of smoothness requirements below that are inapplicable to project.
****

The finished surfaces of the pavements shall have no abrupt change of 3 mm 1/8 inch or more, and all pavements shall be within the tolerances specified in Table 1 when checked with the straightedge.

TABLE 1
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Tolerances mm
Runways and Taxiways	Longitudinal	3
	Transverse	6.5
Calibration Hardstands & Compass Swinging Bases	Longitudinal	3
	Transverse	3
All Other Airfield and Helicopter Paved Areas	Longitudinal	6.5
	Transverse	6.5
Roads and Streets	Longitudinal	5
	Transverse	6.5
Tank Hardstands, Parking Areas, Open Storage Areas	Longitudinal	6.5
	Transverse	6.5

TABLE 1
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Tolerances inches
Runways and Taxiways	Longitudinal	1/8
	Transverse	1/4
Calibration Hardstands & Compass Swinging Bases	Longitudinal	1/8
	Transverse	1/8
All Other Airfield and Helicopter Paved Areas	Longitudinal	1/4
	Transverse	1/4
Roads and Streets	Longitudinal	3/16
	Transverse	1/4
Tank Hardstands, Parking	Longitudinal	1/4

TABLE 1
STRAIGHTEDGE SURFACE SMOOTHNESS--PAVEMENTS

Pavement Category	Direction of Testing	Tolerances inches
Areas, Open Storage Areas	Transverse	1/4

1.4.2.2 Surface Smoothness Testing Method

The surface of the pavement shall be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The entire area of the pavement shall be tested in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m 15 feet apart. The straightedge shall be held in contact with the surface and moved ahead one-half the length of the straightedge for each successive measurement. The amount of surface irregularity shall be determined by placing the straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length and measuring the maximum gap between the straightedge and the pavement surface, in the area between these two high points.

1.4.3 Edge Slump Testing and Conformance

****
NOTE: Delete this paragraph if no pavements are 200 mm (8 inches) or more in thickness or if slipform paving is not allowed. Delete bracketed item if all pavements are over 200 mm (8 inches) thick.
****

When slip-form paving is used, not more than 15 percent of the total free edge [of any 255 mm 10 inch or thicker slab] of the slipformed portion of the pavement, shall have an edge slump exceeding 6 mm 1/4 inch and no slab shall have an edge slump exceeding 9 mm 3/8 inch. Edge slump shall be determined as above for surface smoothness, at each free edge of each slipformed paving lane constructed. Measurements shall be made at 1.5 to 4.5 m 5 to 15 foot spacings, and as directed. When edge slump exceeding the limits specified above is encountered on either side of the paving lane, additional straightedge measurements shall be made, if required, to define the linear limits of the excessive slump. The concrete for the entire width of the paving lane within these limits of excessive edge slump shall be removed and replaced. Adding concrete or paste to the edge or otherwise manipulating the plastic concrete after the sliding form has passed, or patching the hardened concrete, shall not be used as a method for correcting excessive edge slump.

1.4.4 Plan Grade Testing and Conformance

The finished surface of the pavements shall conform, within the tolerances shown in Table 1, to the lines, grades, and cross sections shown. The finished surface of new abutting pavements shall coincide at their juncture. The finished surface of airfield runway, taxiway, and apron pavements shall vary not more than 12 mm 0.04 foot above or below the plan grade line or elevation indicated. The surfaces of other pavements shall vary not more than 18 mm 0.06 foot above or below the plan grade line or elevation indicated. Each pavement category shall be checked by the Contractor for conformance with plan grade requirements by running lines of

levels at intervals to determine the elevation at each joint intersection.

1.5 PRECONSTRUCTION TESTING OF MATERIALS

The Contractor shall not be entitled to any additional payment or extension of time because of delays caused by sampling and testing additional sources, or samples, necessitated by failure of any samples. Aggregates shall be sampled and tested by the Test Laboratory and shall be representative of the materials to be used for the project. Test results, signed by a Registered Engineer, shall be submitted [120] [45] [_____] days before commencing paving. No aggregate shall be used unless test results show that it meets all requirements of these specifications, including compliance with ASTM C 33 and deleterious materials limitations.

1.6 SUBMITTALS

****

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

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

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

****

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

SD-03 Product Data

Equipment

Manufacturer's literature on the concrete plant; mixing equipment; hauling equipment; placing and finishing, and curing equipment; at least 7 days prior to start of paving.

Paving

Paving Schedules at least 7 days prior to start of paving.

Mixture Proportions[; G][; G, [_____]]

The report of the Contractor's mixture proportioning studies showing the proportions of all ingredients and supporting information on aggregate and other materials that will be used in the manufacture of concrete, at least 14 days prior to commencing concrete placing operations.

1.7 EQUIPMENT

1.7.1 Batching and Mixing

****

NOTE: Edit bracketed items according to whether use of truck mixers is to be permitted. Truck mixers should not be permitted for mixing concrete if slipform paving is permitted for pavement thicker than 200 mm (8 inches).

****

The batching plant shall conform to NRMCA CPMB 100, the equipment requirements in ASTM C 94/C 94M, and as specified. Water shall not be weighed or measured cumulatively with another ingredient. All concrete materials batching shall meet ASTM C 94/C 94M requirements. Mixers shall be [stationary mixers] [truck mixers]. [Truck mixers shall not be used for mixing paving concrete.] Batching, mixers, mixing time, permitted reduction of mixing time, and concrete uniformity shall meet the requirements of ASTM C 94/C 94M, and shall be documented in the initial weekly QC Report.

1.7.2 Transporting Equipment

Transporting equipment shall be in conformance with ASTM C 94/C 94M and as specified herein. Concrete shall be transported to the paving site in rear-dump trucks, in truck mixers designed with extra large blading and rear opening specifically for low slump concrete, or in agitators. Bottom-dump trucks shall not be used for delivery of concrete.

1.7.3 Delivery Equipment

When concrete transport equipment cannot operate on the paving lane, side-delivery transport equipment consisting of self-propelled moving conveyors shall be used to deliver concrete from the transport equipment and discharge it in front of the paver. Front-end loaders, dozers, or similar equipment shall not be used to distribute the concrete.

1.7.4 Paver-Finisher

****

NOTE: Retain bracketed phrase only for pavements thicker than 250 mm (10 inches). Lighter-duty pavers can be used with thinner pavements.

****

The paver-finisher shall be a heavy-duty, self-propelled machine designed specifically for paving and finishing high quality pavement. [The paver-finisher shall weigh at least 3280 kg/m 2200 lb/foot of lane width, and shall be powered by an engine having at least 15000 W/meter 6.0 horsepower/foot of lane width.] The paver-finisher shall spread, consolidate, and shape the plastic concrete to the desired cross section in one pass. The paver-finisher shall be equipped with a full width "knock-down" auger, capable of operating in both directions, which will evenly spread the fresh concrete in front of the screed or extrusion plate. Immersion vibrators shall be gang mounted 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. The vibrators shall be automatically controlled so that they will be immediately stopped as forward motion of the paver ceases. The spacing of the immersion vibrators across the paving lane shall be as necessary to properly consolidate the concrete, but the clear distance between vibrators shall not exceed 750 mm 30 inches, and the outside vibrators shall not exceed 300 mm 12 inches from the edge of the lane. The paver-finisher shall be equipped with a transversely oscillating screed or an extrusion plate to shape, compact, and smooth the surface.

1.7.4.1 Paver-Finisher with Fixed Forms

The paver-finisher shall be equipped with wheels designed to ride the forms, keep it aligned with the forms, and to spread the preventing deformation of the forms.

1.7.4.2 Slipform Paver-Finisher

The slipform paver-finisher shall be automatically controlled and crawler mounted with padded tracks. Horizontal alignment shall be electronically referenced to a taut wire guideline. Vertical alignment shall be electronically referenced on both sides of the paver to a taut wire guideline, to an approved laser control system, or to a ski operating on a completed lane. Control from a slope-adjustment control or control operating from the underlying material shall not be used.

1.7.4.3 Other Types of Finishing Equipment

****

NOTE: Edit bracketed item according to whether use of bridge deck finishers is desired, and based on thickness of pavement and surface smoothness tolerances required.

****

[Bridge deck finishers shall be used for pavements 250 mm 10 inches or less in thickness, where longitudinal and transverse surface smoothness tolerances are 6.5 mm 1/4 inch or greater.] Clary screeds or other rotating tube floats will not be allowed on the project.

1.7.5 Curing Equipment

Equipment for curing is specified in paragraph CURING.

1.7.6 Texturing Equipment

****
NOTE: Edit the following paragraphs and delete non-applicable texturing methods to correlate with the drawings and with paragraph Texturing in PART 3. Do not specify artificial turf drag for Air Force projects.
****

Texturing equipment shall be as specified below.

1.7.6.1 Fabric Drag

A fabric drag shall consist of a piece of fabric material as wide as the lane width securely attached to a separate wheel mounted frame spanning the paving lane or to one of the other similar pieces of equipment. The material shall be wide enough to provide 300 to 450 mm 12 to 18 inches dragging flat on the pavement surface. [The fabric material shall be clean, reasonably new burlap, kept clean and saturated during use] [The fabric material shall be an artificial turf fabricated of a plastic material].

1.7.6.2 Deep Texturing Equipment

Texturing equipment shall consist of [a stiff bristled broom] [a comb with spring wire tines] [spring strips which will produce true, even grooves] forming a drag at least 1.2 m 4 feet long. This drag shall be mounted in a wheeled frame spanning the paving lane and constructed to mechanically pull the drag in a straight line across the paving lane perpendicular to the centerline.

1.7.7 Sawing Equipment

Equipment for sawing joints and for other similar sawing of concrete shall be standard diamond-tip-bladed concrete saws mounted on a wheeled chassis.

1.7.8 Straightedge

The Contractor shall furnish and maintain at the job site one 4 m 12 foot straightedge for testing concrete surface smoothness. The straightedge shall be constructed of aluminum or magnesium alloy and shall have blades of box or box-girder cross section with flat bottom, adequately reinforced to insure rigidity and accuracy. Straightedges shall have handles for operation on the pavement.

PART 2 PRODUCTS

****
NOTE: Delete any reference to any products which are not to be used on the project.
****

2.1 CEMENTITIOUS MATERIALS

****
NOTE: Edit these paragraphs as appropriate for the particular project. EPA regulations require that

fly ash be permitted for optional use by the Contractor on all Federal projects. Low-alkali cement, fly ash and the optional limits on alkalies in fly ash should be specified for most projects, especially in any area where there is a chance that alkali-silica reactive aggregates might be furnished. When sulfate bearing soil or water is encountered, specify Type II cement for moderate sulfate concentration and Type V cement (if available in the area) for high concentration. If use of blended cement has shown good service in the area, and it is desired for this project, specify it to meet ASTM C 595, Type as considered appropriate but do not specify Type I(PM) or Type I(SM). Class F pozzolan (fly ash) should be the pozzolan normally specified. Type III cement should not be specified unless "fast-track" paving is involved.

****

Cementitious materials shall be [portland cement [and pozzolan]] [portland-pozzolan cement] [portland blast-furnace slag cement] [only portland cement in combination with [pozzolan] [ground granulated blast furnace slag]] and shall conform to appropriate specifications listed below.

2.1.1 Portland Cement

Portland cement shall conform to ASTM C 150 [Type II, low-alkali] [Type V, low-alkali].

2.1.2 High-Early-Strength Portland Cement

****

NOTE: Use this paragraph only where "fast-track" paving is required; delete it for all other projects. Fill in blank when applicable.

****

High-early-strength cement shall conform to ASTM C 150 Type III, with C3A limited to [5] [8] percent, [low-alkali].

2.1.3 Blended Cements

****

NOTE: Use this paragraph only in areas where each blended cement has a good service record; delete it for other areas. Edit as appropriate.

****

Blended cement shall conform to ASTM C 595 Type [IP] [IP (MS)] [IS] [IS (MS)].

2.1.4 Pozzolan (Fly Ash)

Fly ash shall conform to ASTM C 618 Class F, including all the supplementary optional physical requirements. Fly ash shall conform to EPA requirements in accordance with Section 01 62 35 RECYCLED / RECOVERED MATERIALS.

2.1.5 Ground Granulated Blast-Furnace Slag (GGBF Slag)

****
NOTE: Use this paragraph only in areas where each GGBF Slag has a good service record; delete it for other areas.
****

Ground granulated blast-furnace slag shall conform to ASTM C 989 Grade 120.

2.2 AGGREGATES

****
NOTE: Materials engineers in the local USACE District should be consulted prior to specifying aggregate for any project. Delete bracketed freeze-thaw requirements in areas not subjected to freeze-thaw. Special attention will be given to aggregates to be used for compass calibration hardstands. Usage of aggregates with magnetic properties, such as, but not limited to, magnetite in granites, high-iron minerals in traprock, pyrite in limestone, and free iron or iron oxide in slag aggregate must be prevented. When the paving of compass calibration hardstands is required, include, add to, and edit the bracketed item concerning compass pads as additional requirement for coarse aggregates. Do not, under any conditions, permit use of steel furnace slag for any aggregate since it is markedly different from iron blast furnace slag. In power check pads, the high temperatures from jet blast can cause distress in aggregates in the concrete. Include bracketed item if power check pads are to be constructed.

For Air Force Projects add the second set of brackets.
****

Aggregates shall consist of clean, hard, uncoated particles meeting the requirements of ASTM C 33, including deleterious materials, abrasion loss and soundness requirements of ASTM C 33, and other requirements specified herein. [Aggregate not having a satisfactory demonstrable service record shall have a durability factor of 50 or more when subjected to freezing and thawing in concrete in accordance with ASTM C 666/C 666M.]

[In addition to the grading requirements specified for coarse aggregate and for fine aggregate, the combined aggregate grading shall meet the following requirements.

a. If necessary, a blending aggregate shall be used to meet the required combined grading. This blending aggregate shall be batched separately. The combined grading of all aggregates used, in the proportions selected, shall be computed on the basis of cumulative percent retained on each sieve specified for fine and coarse aggregate.

b. The materials selected and the proportions used shall be such that

when the Coarseness Factor (CF) and the Workability Factor (W) are plotted on a diagram as described in d. below, the point thus determined shall fall within the parallelogram described therein.

c. The Coarseness Factor (CF) shall be determined from the 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)

The Workability Factor (W) is defined as the cumulative percent passing the 2.36 mm No. 8 sieve. However, W shall be adjusted, 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.

d. A diagram shall be plotted using a rectangular scale with W 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 shall be plotted with corners at the following coordinates (CF-75, W-28), (CF-75, W-40), (CF-45, W-32.5), and (CF-45, W-41). If the point determined by the intersection of the computed CF and W does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary.

e. In addition, the individual percent retained on each sieve shall be plotted for the combined aggragate grading, on either rectangular or semi-log graph paper. The graph shall show a relative smooth transition between coarse and fine aggregate and shall have no major valleys or peaks in the area smaller than the 23.6 mm No. 8 sieve. If this plot does not meet the above criteria, the grading of each size aggregate used and the proportions selected shall be changed as necessary.]

2.2.1 Coarse Aggregate

****

NOTE: Select the size aggregate available in the project area, and appropriate for the thickness of paving. The nominal maximum size aggregate used in a thin bonded overlay should not exceed one-third of the overlay thickness, not including additional thickness for leveling. The entrained air content should be increased nearer the upper limit as the maximum coarse aggregate size is decreased. More stringent deleterious materials requirements for coarse aggregate may be necessary for some airfield pavements, and are mandatory where a history of any deleterious material problems exist, such as popouts, weatherouts, D-line cracking, and the like. For these situations, the deleterious materials requirements for coarse aggregate from Section 32 13 11 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDS must be used, using service record information, with

guidance from the pavements/materials engineer.
****

Coarse aggregate shall consist of [crushed] [uncrushed] gravel, crushed stone, or a combination thereof. [Aggregate used for paving compass calibration hardstands shall be free of materials having magnetic properties.] [Coarse aggregate used for paving power check pads shall be limestone, dolomite, or basalt, or another aggregate if that aggregate has a proven service record demonstrating that it will not cause thermal distress from jet blast.] The nominal maximum size of the coarse aggregate shall be [19.0] [25.0] [27.5] mm [3/4] [1] [1-1/2] inches. When the nominal maximum size is greater than 25.0 mm 1 inch, the aggregates shall be furnished in two ASTM C 33 size groups, No. 67 and No. 4. The amount of deleterious material in each size of coarse aggregate shall not exceed the limits shown in ASTM C 33 Class 1N, 4M or 4S, depending on the weathering region, and the following limits:

a. Lightweight particles 1.0 max. percent by mass (ASTM C 123).

b. Other soft particles 2.0 max. percent by mass (COE CRD-C 130).

c. Total of all deleterious 5.0 max. percent by mass (substances listed in ASTM C 33 and above, exclusive of material finer than 0.075 mm No. 200 sieve).

d. The separation medium for lightweight particles shall have a density of 2.0 Mg/cubic meters Sp. Gr. of 2.0.

2.2.2 Fine Aggregate

Fine aggregate shall consist of natural sand, manufactured sand, or a combination of the two, and shall be composed of clean, hard, durable particles. [Aggregate used for paving compass calibration hardstands shall be free of materials having magnetic properties.] All fine aggregate shall be composed of clean, hard, durable particles meeting the requirements of ASTM C 33 and the requirements herein. The amount of deleterious material in the fine aggregate shall not exceed the limits in ASTM C 33and shall not exceed the following limits:

a. Lightweight particles (ASTM C 123) 1.0 percent max. by mass using a medium with a density of 2.0 Mg/cubic meter. Sp. Gr. of 2.0.

b. The total of all deleterious material types, listed in ASTM C 33 and above, shall not exceed 3.0 percent of the mass of the fine aggregate.

2.3 CHEMICAL ADMIXTURES

Air-entraining admixture shall conform to ASTM C 260. An accelerator shall be used only when specified in paragraph SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES and shall not be used to reduce the amount of cementitious material used. Accelerator shall conform to ASTM C 494/C 494M Type C. Calcium chloride and admixtures containing calcium chloride shall not be used. A water-reducing or retarding admixture shall meet the requirements of ASTM C 494/C 494M. Type G or H admixtures are not allowed.

2.4 CURING MATERIALS

Membrane forming curing compound shall be a white pigmented compound

conforming to COE CRD-C 300. Burlap shall be new or shall be clean material never used for anything other than curing concrete.

2.5 WATER

Water for mixing and curing shall be clean, potable, and free of injurious amounts of oil, acid, salt, or alkali.

2.6 JOINT MATERIALS

****
NOTE: Edit as appropriate for project requirements. Expansion joint filler material must be compatible with joint sealer specified. Do not use bituminous joint filler if joint sealer is non-bituminous.
****

2.6.1 Expansion Joint Material

Expansion joint filler shall be a preformed material conforming to [ASTM D 1751] [ASTM D 1752 Type [I] [II] [III]]. Expansion joint filler shall be 20 mm 3/4 inch thick.

2.6.2 Slip Joint Material

Slip joint material shall be 6 mm 1/4 inch thick expansion joint filler conforming to ASTM D 1751 or ASTM D 1752.

2.6.3 Contraction Joint Inserts

****
NOTE: Retain this paragraph only if contraction joint inserts are to be permitted; delete it when not permitted. Delete bracketed item about nonsawable inserts if they are not to be permitted.
****

Sawable contraction joint inserts shall conform to COE CRD-C 540. [Nonsawable contraction joint inserts shall have sufficient stiffness to permit placement in plastic concrete without deviation from a straight line and shall conform to the physical requirements of COE CRD-C 540, with the exception of resistance to sawing. Material for polyvinyl chloride inserts shall conform to COE CRD-C 572.] No metal inserts of any kind shall be used.

2.7 REINFORCING

****
NOTE: Edit these paragraphs to conform to project requirements. Add epoxy-coated bars (ASTM A 775) or low-alloy bars (ASTM A 706) if design requires them. Remove steel fiber paragraph when not applicable.
****

2.7.1 General

Reinforcing bars shall conform to ASTM A 615/A 615M Grade [_____]. Bar mats shall conform to ASTM A 184/A 184M. Reinforcement shall be free from loose, flaky rust, loose scale, oil, grease, mud, or other coatings that

might reduce the bond with concrete.

2.7.2 Steel Fiber Reinforcing

Minimum ultimate tensile strength of the fibers shall be 345 MPa 50000 psi. The maximum aspect ratio (length divided by diameter) shall not exceed 100. Fibers longer than 60 mm 2-1/2 inches shall not be used. The fibers shall be deformed and shall be furnished in small bundles adhered with water soluble glue.

2.8 DOWELS AND TIE BARS

****
NOTE: Retain paragraph on dowels if design requires dowels or if they are optional. Even if not required, design should normally allow dowels as an option. Edit tie bars as required by design.
****

2.8.1 Dowels

Dowels shall be single piece, plain (non-deformed) steel bars conforming to ASTM A 615/A 615M Grade 60 or higher. Dowels shall be free of loose, flaky rust and loose scale and shall be clean and straight.

2.8.2 Tie Bars

Tie bars shall be deformed steel bars conforming to ASTM A 615/A 615M Grade [_____]. Grade 60 or higher shall not be used for bars that are bent and straightened during construction.

2.9 EPOXY RESIN

All epoxy-resin materials shall be two-component materials conforming to ASTM C 881/C 881M, Class as appropriate for each application temperature to be encountered; except, that in addition, the materials shall meet the following requirements:

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

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

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

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

2.10 SPECIFIED CONCRETE STRENGTH AND OTHER PROPERTIES

****
NOTE: Fill in blanks as appropriate. Specified strength is compressive strength at 28 days. Pavement design is based on flexural strength. Compressive strength is the basis for this specification due to the small size of these

pavement projects. This requires the designer to develop a site specific correlation between flexural and compressive strength, in order to select an adequate compressive strength for the specification. This correlation should be developed using information from UFC 3-250-04FA Standard Practice for Concrete Pavements, the American Concrete Institute, and site specific data for the aggregates available in the project area whenever possible, since there is no single correlation for all concrete aggregates. Designer must also ensure that this strength is attainable with the available aggregates, without excessive cement content. The District Pavement Engineer or Geotechnical Branch should be consulted for guidance. Maximum water-cementitious material ratio should be 0.45 for severe or moderate climate and 0.50 for mild climate with little or no snow or frost. Air content should be specified as 6 percent where freezing and thawing is a concern and 4 percent where it is not a concern. Delete slip-formed requirements if slip-forming is not allowed.

****

Specified compressive strength, f'c, for concrete is [_____] MPa psi at 28 days. Maximum allowable water-cementitious material ratio is [0.45] [0.50]. The water-cementitious material ratio is based on absolute volume equivalency, where the ratio is determined using the weight of cement for a cement only mix, or using the total volume of cement plus pozzolan converted to an equivalent weight of cement by the absolute volume equivalency method described in ACI 211.1. The concrete shall be air-entrained with a total air content of [6] [4] plus or minus 1 percent. The maximum allowable slump of the concrete shall be 75 mm 3 inchesfor pavement constructed with fixed forms. [For slipformed pavement, the maximum allowable slump shall be 30 mm 1-1/4 inches.] The strength of the concrete will be considered satisfactory so long as the average of all sets of three consecutive test results equals or exceeds the specified compressive strength f'c and no individual test result falls below the specified strength f'c by more than 3.5 MPa 500 psi. Additional analysis or testing, including taking cores and/or load tests may be required at the Contractor's expense when the strength of the concrete in the structure is considered potentially deficient.

2.11 MIXTURE PROPORTIONS

****

NOTE: This paragraph places the responsibility for mixture proportioning on the Contractor. Edit bracketed items as appropriate. Normally, permit accelerator only with "fast-track" paving.

****

2.11.1 Composition Concrete

Composition concrete shall be composed of cementitious material, water, fine and coarse aggregates, and admixtures. Fly ash, if used, shall [be used only at a rate between 15 and 35 percent by mass of the total cementitious material] [conform to EPA requirements in accordance with Section 01 62 35 RECYCLED / RECOVERED MATERIALS]. Admixtures shall consist

of air entraining admixture and [shall] [may] also include [accelerator] [retarder] [water-reducing admixture]. High range water-reducing admixtures and admixtures to produce flowable concrete shall not be used. No substitutions shall be made in the materials used in the mixture proportions without additional tests to show that the quality of the concrete is satisfactory.

2.11.2 Concrete Mixture Proportioning Studies

Trial design batches, mixture proportioning studies, and testing shall be the responsibility of the Contractor, and shall be performed by the Test Laboratory and signed by a Registered Engineer. No concrete pavement shall be placed until the Contracting Officer has approved the Contractor's mixture proportions. All materials used in mixture proportioning studies shall be representative of those proposed for use on the project. If there is a change in materials, additional mixture design studies shall be made using the new materials. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in ACI 211.1. At least three different water-cementitious ratios, which will produce a range of strength encompassing that required on the project, shall be used. Laboratory trial mixtures shall be proportioned for maximum permitted slump and air content. Maximum sand content shall be 40 percent of the total aggregate SSD weight. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

2.11.3 Mixture Proportioning Procedure

The Contractor shall perform the following:

a. Fabricate, cure and test 6 test cylinders per age for each mixture at 7 and 28 days.

b. Using the average strength for each w/(c+p), plot the results from each of the three mixtures on separate graphs for w/(c+p) versus 28-day strength.

c. From the graphs select a w/(c+p) which will produce a mixture giving a 28-day strength equal to the required strength determined in accordance with the following paragraph.

2.11.4 Average Strength Required for Mixtures

In order to ensure meeting, during production, the strength requirements specified, the mixture proportions selected shall produce a required average strength, f'cr, exceeding the specified strength, f'c, in accordance with procedures in Chapter 3 of ACI 301, "Proportioning."

PART 3 EXECUTION

3.1 CONDITIONING OF UNDERLYING MATERIAL

****
NOTE: Edit bracketed items as appropriate.
Correlate with requirements specified in paragraph
Transporting and Transfer-Spreading Operations.
****

Underlying material, [subgrade] [base course] [subbase course], upon which concrete is to be placed shall be clean, damp, and free from debris, waste

concrete or cement, frost, ice, and standing or running water. After the underlying material has been prepared for concrete placement, no equipment shall be permitted thereon.

3.2 WEATHER LIMITATIONS

3.2.1 Hot Weather Paving

****
NOTE: ACI 305R contains additional information concerning hot weather concreting.
****

The temperature of concrete shall not exceed 32 degrees C 90 degrees F. Steel forms, dowels and reinforcing shall be cooled prior to concrete placement when steel temperatures are greater than 49 degrees C120 degrees F.

3.2.2 Cold Weather Paving

****
NOTE: Retain bracketed item allowing accelerator if desired. Otherwise delete.
****

The ambient temperature of the air at the placing site and the temperature of surfaces to receive concrete shall be not less 5 degrees C 40 degrees F. The temperature of the concrete when placed shall be not less than 10 degrees C 50 degrees F. Materials entering the mixer shall be free from ice, snow, or frozen lumps. Salt, chemicals or other materials shall not be incorporated in the concrete to prevent freezing. [Upon written approval, chemical admixture conforming to ASTM C 494/C 494M Type C or E may be used provided it contains no calcium chloride.] Calcium chloride shall not be used at any time. Covering and other means shall be provided 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. Pavement damaged by freezing shall be completely removed and replaced at the Contractor's expense as specified in paragraph, REPAIR, REMOVAL, AND REPLACEMENT OF SLABS.

3.3 CONCRETE PRODUCTION

****
NOTE: Designer must coordinate these paragraphs with the requirements in paragraph EQUIPMENT in PART 1. Delete item in brackets if truck mixers are not permitted.
****

3.3.1 General Requirements

Concrete shall be deposited 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 shall be reduced to 30 minutes. Every load of concrete delivered to the paving site shall be accompanied by a batch ticket from the operator of the batching plant. Tickets shall show at least the mass, or volume, of all ingredients in each batch delivered, [the water meter and revolution meter reading on truck mixers] and the time of day. Tickets shall be delivered to the

placing foreman who shall keep them on file and deliver them to the Government daily.

3.3.2 Transporting and Transfer-Spreading Operations

****
NOTE: Edit bracketed items as appropriate. Transporting equipment should be allowed to operate on the prepared underlying material in the paving lane only if previous experience has shown it to cause no problems; normally, it should not be allowed for airfield pavement, unless the base course has been stabilized with asphalt or portland cement. Retain the last sentence only if truck mixers have been permitted.
****

Non-agitating equipment shall be used only on smooth roads and for haul time less than 15 minutes. [No equipment shall be allowed to operate on the prepared and compacted underlying material in front of the paver-finisher.] [Equipment shall be allowed to operate on the underlying material only if no damage is done to the underlying material and its degree of compaction. Any disturbance to the underlying material that does occur shall be corrected before the paver-finisher reaches the location of the disturbance and the equipment shall be replaced or procedures changed to prevent any future damage.] [Additional water may be added to truck mixers to bring the slump within the specified range provided the mixture water-cement ratio is not exceeded.]

3.4 PAVING

****
NOTE: Designer must coordinate these paragraphs with the requirements in paragraph EQUIPMENT in PART 1. Edit bracketed item on slipform paving as required.
****

Pavement shall be constructed with paving and finishing equipment utilizing [fixed forms] [slipforms].

3.4.1 Consolidation

The paver vibrators shall be inserted into the concrete not closer to the underlying material than 50 mm 2 inches. The vibrators or any tamping units in front of the paver shall be automatically controlled so that they shall be stopped immediately as forward motion ceases. Excessive vibration shall not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment shall be vibrated with a hand-operated immersion vibrator. Vibrators shall not be used to transport or spread the concrete.

3.4.2 Operation

When the paver is operated between or adjacent to previously constructed pavement (fill-in lanes), provisions shall be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of any debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates shall

overlap the existing pavement the minimum possible, but in no case more than 200 mm 8 inches.

3.4.3 Required Results

The paver-finisher shall be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation shall produce a surface finish free of irregularities, tears, voids of any kind, and any other discontinuities. It shall produce only a very minimum of paste at the surface. Multiple passes of the paver-finisher shall not be permitted. The equipment and its operation shall produce a finished surface requiring no hand finishing, other than the use of cutting straightedges, except in very infrequent instances. No water, other than true fog sprays (mist), shall be applied to the concrete surface during paving and finishing.

3.4.4 Fixed Form Paving

****
NOTE: Delete bracketed sentences on overlay pavements if not applicable.
****

Forms shall be steel, except that wood forms may be used for curves having a radius of 45 m 150 feet or less, and for fillets. Forms may be built up with metal or wood, added only to the base, to provide an increase in depth of not more than 25 percent. The base width of the form shall be not less than eight-tenths of the vertical height of the form, except that forms 200 mm 8 inches or less in vertical height shall have a base width not less than the vertical height of the form. Wood forms for curves and fillets shall be adequate in strength and rigidly braced. Forms shall be set on firm material cut true to grade so that each form section when placed will be firmly in contact with the underlying layer for its entire base. Forms shall not be set on blocks or on built-up spots of underlying material. [Forms for overlay pavements and for other locations where forms must be set on existing pavements shall be held securely in place with stakes or by other approved methods. Holes in existing pavements for form stakes shall be carefully drilled without cracking or spalling the existing pavement. Prior to setting forms for paving operations, the Contractor shall demonstrate the proposed form setting procedures at an approved location and shall not proceed further until the proposed method is approved.] Forms shall remain in place at least 12 hours after the concrete has been placed. Forms shall be removed without injuring the concrete.

3.4.5 Slipform Paving

****
NOTE: Retain slipform paving as an option unless the designer has specific, valid reasons for deleting it. Be sure all other paragraphs correlate with choice made here.
****

The slipform paver shall shape the concrete to the specified and indicated cross section in one pass, and shall finish the surface and edges so that only a very minimum amount of hand finishing is required. Dowels shall not be installed by dowel inserters attached to the paver or by any other means of inserting the dowels into the plastic concrete. [If a keyway is required, a 0.45 to 0.55 mm 26 gauge thick metal keyway liner shall be

installed as the keyway is extruded. [The keyway liner shall be protected and shall remain in place and become part of the joint.]]

3.4.6 Placing Reinforcing Steel

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

Reinforcement shall be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement, or may be placed on an initial layer of consolidated concrete, with the subsequent layer placed within 30 minutes of the first layer placement. [If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, the entire operating procedure and equipment proposed shall be submitted for approval at least 30 days prior to proposed start of paving.]

3.4.7 Placing Dowels and Tie Bars

****
NOTE: Delete references to slipform paving installation of dowels and tie bars if slipform paving is not allowed. Delete references to installation in contraction joints if not required. Delete bracketed references to tie bars, if tie bars are not used.
****

Dowels shall be installed with alignment not greater than 1 mm per 100 mm 1/8 inch per ft. Except as otherwise specified below, location of dowels shall be within a horizontal tolerance of plus or minus 15 mm 5/8 inch and a vertical tolerance of plus or minus 5 mm 3/16 inch. The portion of each dowel intended to move within the concrete or expansion cap shall be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement. [Dowels] [and tie bars] in joints shall be omitted when the center of the [dowel] [tie bar] is located within a horizontal distance from an intersecting joint equal to or less than one-fourth of the slab thickness.

3.4.7.1 Contraction Joints

[Dowels] [and] [tie bars] in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal basket assemblies. The [dowels] [and tie bars] shall be welded to the assembly or held firmly by mechanical locking arrangements that will prevent them from becoming distorted during paving operations. The basket assemblies shall be held securely in the proper location by means of suitable anchors.

3.4.7.2 Construction Joints-Fixed Form Paving

Installation of [dowels] [and tie bars] shall be by the bonded-in-place method, supported by means of devices fastened to the forms. Installation by removing and replacing in preformed holes will not be permitted.

3.4.7.3 Dowels Installed in Hardened Concrete

Installation shall be by bonding the dowels into holes drilled into the

hardened concrete. Holes approximately 3 mm 1/8 inch greater in diameter than the dowels shall be drilled into the hardened concrete. Dowels shall be bonded in the drilled holes using epoxy resin injected 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 shall not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic collar fitted around the dowel. The vertical alignment of the dowels shall be checked by placing the straightedge on the surface of the pavement over the top of the dowel and measuring the vertical distance between the straightedge and the beginning and ending point of the exposed part of the dowel. [Where tie bars are required in longitudinal construction joints of slipform pavement, bent tie bars shall be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway shall be constructed, and the bent tie bars shall be inserted into the plastic concrete through a 0.45 to 0.55 mm 26 gauge thick metal keyway liner. Tie bars shall not be installed in preformed holes. The keyway liner shall be protected and shall remain in place and become part of the joint. Before placement of the adjoining paving lane, the tie bars shall be straightened, without spalling the concrete around the bar.]

3.4.7.4 Expansion Joints

****
NOTE: Delete this paragraph if not required.
****

Dowels in expansion joints shall be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

3.5 FINISHING

****
NOTE: Edit these paragraphs as appropriate. Retain slipform paving subparagraph except when it is prohibited elsewhere. Delete paragraph Other Types of Finishing Equipment in PART 1 and following paragraphs not wanted.
****

Clary screeds, "bridge deck" finishers, or other rotating pipe or tube type equipment shall not be permitted. The sequence of machine operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Hand finishing shall be used only infrequently and only on isolated areas of odd slab shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Equipment to be used for supplemental hand finishing shall primarily be 3 to 4 m 10 to 12 feet cutting straightedges; only very sparing use of bull floats shall be allowed. At no time shall water be added to the surface of the slab in any way, except for fog (mist) sprays to prevent plastic shrinkage cracking.

3.5.1 Machine Finishing With Fixed Forms

The machine shall be designed to ride the forms. Machines that cause displacement of the forms shall be replaced. The machine shall make only

one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

3.5.2 Machine Finishing With Slipform Pavers

If there is sufficient concrete slurry or fluid paste on the surface that it runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed. No slurry, concrete or concrete mortar shall be used 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.

3.5.3 Surface Correction

While the concrete is still plastic, irregularities and marks in the pavement surface shall be eliminated by means of cutting straightedges, 3 to 4 m 10 to 12 feet in length. Depressions shall be filled with freshly mixed concrete, struck off, consolidated, and refinished. Projections above the required elevation shall also be struck off and refinished. Long-handled, flat "bull floats" shall be used sparingly and only as necessary to correct minor, scattered surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Joints and edges shall not be overfinished.

3.5.4 Hand Finishing

Hand finishing operations shall be used only for those unusual slabs as specified previously. Grate tampers (jitterbugs) shall not be used. As soon as placed and vibrated, the concrete shall be struck off and screeded. The surface shall be tamped with a strike-off and tamping screed, or vibratory screed. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally. Long-handled, flat bull floats shall be used sparingly and only as necessary to correct surface defects. Finishing with hand floats and trowels shall be held to the absolute minimum necessary. Joints and edges shall not be overfinished. No water shall be added to the pavement during finishing operations.

3.5.5 Texturing

****

NOTE: Designer must select type of texturing required by the using service, retain that subparagraph, and delete the others. If no guidance is given, the usual default method should be burlap drag. Edit bracketed sentence as appropriate.

****

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement shall be given a texture as described herein. Following initial texturing on the first day of placement, the Placing Foreman, Contracting Officer representative, and a representative of the Using Agency shall inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces shall be thoroughly power broomed to remove all debris. [Any type of transverse texturing shall produce grooves in straight lines across each lane within a

tolerance of plus or minus 13 mm 1/2 inch of a true line.] The concrete in areas of recesses for tie-down anchors, lighting fixtures, and other outlets in the pavement shall be finished to provide a surface of the same texture as the surrounding area.

3.5.5.1 Fabric-Drag Surface Finish

Surface texture shall be applied by dragging the surface of the pavement, in the direction of the concrete placement, with a moist fabric drag. The dragging shall produce a uniform finished surface having a fine sandy texture without disfiguring marks.

3.5.5.2 Broom Texturing

Surface texture shall be applied using a mechanical stiff bristle broom drag of a type that will uniformly score the surface transverse to the pavement center line. The broom shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the broom shall be overlapped the minimum necessary to obtain a uniformly textured surface. The scores should be uniform in appearance and approximately 1.5 mm 1/16 inch in depth but not more than 3 mm 1/8 inch in depth. Hand brooming will be permitted only on isolated odd shaped slabs or slabs where hand finishing is permitted.

3.5.5.3 Wire-Comb Texturing

Surface texture transverse to the pavement center line shall be applied using a mechanical wire comb drag. The comb shall be capable of traversing the full width of the pavement in a single pass at a uniform speed and with a uniform pressure. Successive passes of the comb shall be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. The scores shall be 2 to 5 mm 1/16 to 3/16 inch deep, 1.5 to 3 mm 1/16 to 1/8 inch wide, and spaced 10 mm3/8 inch apart.

3.5.5.4 Surface Grooving

The areas indicated on the drawings shall be grooved with a spring tine drag producing individual grooves 6 mm 1/4 inch deep and 6 mm 1/4 inch wide at a spacing between groove centerlines of 50 mm 2 inches. These grooves shall be cut perpendicular to the centerline. Before grooving begins, the concrete shall be allowed to stiffen sufficiently to prevent dislodging of aggregate. Grooves shall not be cut within 150 mm 6 inches of a transverse joint or crack.

3.5.6 Edging

****
NOTE: Delete bracketed sentence if slipform paving is not allowed.
****

[The edges of slipformed lanes shall not be edged.] After texturing has been completed, the edge of the slabs along the forms shall be carefully finished with an edging tool to form a smooth rounded surface of 3 mm 1/8 inch radius. No water shall be added to the surface during edging.

3.6 CURING

Concrete shall be continuously protected against loss of moisture and rapid temperature changes for at least 7 days from the completion of finishing operations. Unhardened concrete shall be protected from rain and flowing water. During hot weather with low humidity and/or wind, the Contractor shall institute measures to prevent plastic shrinkage cracks from developing. ACI 305R contains means of predicting plastic shrinkage cracking and preventative measures. Plastic shrinkage cracks that occur shall be filled by injection of epoxy resin after the concrete hardens. Plastic shrinkage cracks shall never be troweled over or filled with slurry. Curing shall be accomplished by one of the following methods.

3.6.1 Membrane Curing

A uniform coating of white-pigmented membrane-forming curing compound shall be applied to the entire exposed surface of the concrete including pavement edges as soon as the free water has disappeared from the surface after finishing. If evaporation is high and no moisture is present on the surface even though bleeding has not stopped, fog sprays shall be used to keep the surface moist until setting of the cement occurs. Curing compound shall then be immediately applied. Curing compound shall be applied to the finished surfaces by means of a self-propelled automatic spraying machine, equipped with multiple spraying nozzles with wind shields, spaning the newly paved lane. The curing compound shall be applied at a maximum application rate of 5 square meters per L 200 square feet per gallon. The application of curing compound by hand-operated, mechanical powered pressure sprayers will be permitted only on odd widths or shapes of slabs where indicated and on concrete surfaces exposed by the removal of forms. The compound shall form a uniform, continuous, cohesive film that will not check, crack, or peel and that will be free from pinholes and other discontinuities. Areas where the curing compound develops the above defects or is damaged by heavy rainfall, sawing or other construction operations within the curing period, shall be immediately resprayed.

3.6.2 Moist Curing

Concrete to be moist-cured shall be maintained continuously wet for the entire curing period, commencing immediately after finishing. Surfaces shall be cured by ponding, by continuous sprinkling, by continuously saturated burlap or cotton mats, or by continuously saturated plastic coated burlap. Impervious sheet curing shall not be used.

3.7 JOINTS

****

NOTE: Edit bracketed items in following subparagraphs to conform to design requirements. Even if not required, dowels should normally always be permitted for construction joints. Before requiring or permitting use of tie bars, always thoroughly analyze effect on the pavement action.

****

No deviation from the jointing pattern shown on the drawings shall be made without written approval of the Design District Pavement or Geotechnical Engineer. All joints shall be straight, perpendicular to the finished grade of the pavement, 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.

3.7.1 Longitudinal Construction Joints

[Dowels] [Keys] [Tie bars] shall be installed in the longitudinal construction joints, or the edges shall be thickened as indicated. [The dimensions of the keyway shall not vary more than plus or minus 3 mm 1/8 inch from the dimensions indicated and shall not deviate more than plus or minus 6 mm 1/4 inch from the mid-depth of the pavement. If any length of completed keyway of 1.5 m 5 feet or more fails to meet the above tolerances, dowels shall be installed.]

3.7.2 Transverse Construction Joints

Transverse construction joints shall be installed at a planned transverse joint, at the end of each day's placing operations and when concrete placement is interrupted. Transverse construction joints shall be constructed either by utilizing headers and hand placement and finishing techniques, or by placing concrete beyond the transverse construction joint location and then saw cutting full depth and removing concrete back to the transverse construction joint location. For the latter case, dowels shall be installed using methods for dowels installed in hardened concrete described above. All transverse construction joints shall be dowelled.

3.7.3 Expansion Joints

****
NOTE: Delete expansion and slip joint paragraphs when not applicable.
****

Expansion joints shall be formed where indicated, and about any structures and features that project through or into the pavement, using preformed joint filler of the type, thickness, and width indicated, and shall extend the full slab depth. Edges of the concrete at the joint face shall be edged. The joint filler strips shall be installed to form a recess at the pavement surface to be filled with joint sealant. Expansion joints shall be constructed with [dowels] [thickened edges] for load transfer.

3.7.4 Slip Joints

Slip joints shall be installed the full depth of the slab using expansion joint preformed joint filler material attached to the face of the original concrete placement. A reservoir for joint sealant shall be constructed at the top of the joint. Edges of the joint face shall be edged.

3.7.5 Contraction Joints

****
NOTE: Edit bracketed items and subparagraph as appropriate. Normally, it is better to delete insert type joints and allow only sawed joints for both longitudinal and transverse contraction joints, especially for slipformed pavement.
****

Transverse and longitudinal contraction joints shall be of the weakened-plane or dummy type. Longitudinal contraction joints shall be constructed by sawing a groove in the hardened concrete with a power-driven

saw. Transverse contraction joints shall be constructed in conformance with requirements for [sawed joints] [insert-type contraction joints].

3.7.5.1 Sawed Joints

Sawed contraction joints shall be constructed by sawing a groove in the concrete with a 3 mm 1/8 inch blade to the indicated depth. The time of initial sawing shall vary depending on existing and anticipated weather conditions and shall be such as to prevent uncontrolled cracking of the pavement. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit cutting the concrete without chipping, spalling, or tearing. The joints shall be sawed at the required spacing consecutively in the sequence of the concrete placement. Sawing at a given joint location shall be discontinued when a crack develops ahead of the saw cut. Immediately after the joint is sawed, the saw cut and adjacent concrete surface shall be thoroughly flushed with water until all waste from sawing is removed from the joint. The surface shall be resprayed with curing compound as soon as free water disappears. The top of the joint opening and the joint groove at exposed edges shall be tightly sealed with cord or backer rod before the concrete in the region of the joint is resprayed with curing compound.

3.7.5.2 Insert-Type Joints

****
NOTE: Delete this paragraph when not applicable.
****

Insert-type joints shall not be used for slipformed pavements. Insert-type non-metallic contraction joints shall be constructed by installing a preformed insert in the plastic concrete to form a weakened plane to induce cracking. Inserts shall be installed using a machine equipped with a vibrating bar for cutting a groove in the plastic concrete for placement of the insert or for vibrating the insert into place at the prescribed joint location. The installed insert shall be perpendicular to the finished grade of the pavement, with the top of the insert not more than 3 mm 1/8 inch below the pavement surface.

3.7.6 Thickened Edge Joints

Underlying material in the transition area shall meet the requirements for smoothness and compaction specified for all other areas of the underlying material.

3.7.7 Special Joints

****
NOTE: Delete this paragraph when not applicable.
****

Special joints (undercut joints) shall be constructed adjacent to existing pavement as indicated. The concrete shall be worked under the edge of the existing pavement to completely fill the void and shall be thoroughly consolidated by the use of hand-held vibrators.

3.8 REPAIR, REMOVAL, AND REPLACEMENT OF SLABS

New pavement slabs that contain full-depth cracks shall be removed and replaced, as specified herein at no cost to the Government. Removal and

replacement shall be full depth, shall be full width of the paving lane, and the limit of removal shall be from each original transverse joint . The Contracting Officer will determine whether cracks extend full depth of the pavement and may require minimum 150 mm 6 inch diameter cores to be drilled on the crack to determine depth of cracking. Cores shall be drilled and the hole later filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin. Drilling of cores and refilling holes shall be at no expense to the Government. Cracks that do not extend full depth of slab shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1. The Contractor shall ensure that the crack is not widened during epoxy resin injection. Where a full depth crack intersects the original transverse joint, the slab(s) containing the crack shall be removed and replaced, with dowels installed, as required below. Spalls along joints shall be repaired as specified.

3.8.1 Removal and Replacement of Full Slabs

Unless there are keys or dowels present, all edges of the slab shall be sawcut full depth. If keys, dowels, or tie bars are present along any edges, these edges shall be sawed full depth 150 mm 6 inches from the edge if only keys are present, or just beyond the end of dowels or tie bars if they are present. These joints shall then be carefully sawed on the joint line to within 25 mm 1 inch of the depth of the dowel or key. The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. The narrow strips along keyed or doweled edges shall be carefully broken up and removed. Care shall be taken to prevent damage to the dowels, tie bars, or keys or to concrete to remain in place. Protruding portions of dowels shall be painted and lightly oiled. The joint face below keys or dowels shall be suitably trimmed so that there is no abrupt offset. If underbreak occurs at any point along any edge, the area shall be hand-filled with concrete, producing an even joint face from top to bottom, before replacing the removed slab. If underbreak over 100 mm 4 inches deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels, tie bars, or keys on an edge, or where they have been damaged, dowels of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete. Original damaged dowels or tie bars shall be cut off flush with the joint face. All four edges of the new slab shall thus contain dowels or original keys or original tie bars. Prior to placement of new concrete, the underlying material shall be graded and recompacted, and the surfaces of all four joint faces shall be cleaned of all loose material and contaminants, and coated with a double application of membrane forming curing compound as bond breaker. Placement of concrete shall be as specified for original construction. The resulting joints around the new slab shall be prepared and sealed as specified.

3.8.2 Repairing Spalls Along Joints

Spalls along joints and cracks shall be repaired by first making a vertical saw cut at least 25 mm 1 inch outside the spalled area and to a depth of at least 50 mm 2 inches. Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete. The cavity shall be thoroughly cleaned with high pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a

thin coating and scrubbed into the surface with a stiff-bristle brush. Prime coat for portland cement repairs shall be a neat cement grout and for epoxy resin repairs shall be epoxy resin, Type III, Grade 1. The cavity shall be filled with low slump portland cement concrete or mortar, or with epoxy resin concrete or mortar. Portland cement concrete shall be used for larger spalls, those more than 0.009 cubic meter 1/3 cu. ft in size after removal operations; portland cement mortar shall be used for spalls between 0.00085 and 0.009 cubic meter 0.03 and 1/3 cu. ft; and epoxy resin mortar or Type III, Grade 3 epoxy resin for those spalls less than 0.00085 cubic meter 0.03 cu. ft in size after removal operations. Portland cement concretes and mortars shall be very low slump mixtures, proportioned, mixed, placed, tamped, and cured. [If the materials and procedures are approved in writing, latex modified concrete mixtures may be used for repairing spalls less than 0.009 cubic meter 1/3 cu.ft in size.] Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions, mixing, placing, tamping and curing procedures as recommended by the manufacturer. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other 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 or 13 mm 1/2 inch into sound concrete, whichever is greater. The core hole shall be repaired as specified above for other spalls.]

3.8.3 Areas Defective in Plan Grade or Smoothness

In areas not meeting the specified limits for surface smoothness and plan grade, high areas shall be reduced to attain the required smoothness and grade, except as depth is limited below. High areas shall be reduced by grinding the hardened concrete with a surface grinding machine after the concrete is 14 days or more old. The depth of grinding shall not exceed 6 mm 1/4 inch. All pavement areas requiring plan grade or surface smoothness corrections in excess of the specified limits, shall be removed and replaced. In pavement areas given a wire comb or tined texture, areas exceeding 2 square meters 25 square feet that have been corrected by rubbing or grinding shall be retextured by grooving machine sawn grooves meeting the requirements for the wire comb or tined texture. All areas in which grinding has been performed will be subject to the thickness tolerances specified in paragraph Thickness. Any grinding performed on individual slabs with excessive deficiencies shall be performed at the Contractor's own decision without entitlement to additional compensation if eventual removal of the slab is required.

3.9 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) so that the designer knows exactly what the in-place existing pavement is 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.

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Existing concrete pavement shall be removed as indicated and as specified in Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION] modified, and expanded as specified herein. Removal, repair and replacement shall be made as indicated and as specified in paragraph REPAIR, REMOVAL, AND REPLACEMENT OR SLABS.

3.10 PAVEMENT PROTECTION

The Contractor shall protect the pavement against all damage prior to final acceptance of the work. Traffic shall be excluded from the new pavement. As a construction expedient in paving intermediate lanes between newly paved pilot lanes, operation of the hauling equipment will be permitted on the new pavement after the pavement has been cured for 7 days and the joints have been sealed or otherwise protected. All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean. Special cleaning and care shall be used where Contractor's traffic uses or crosses active airfield pavement.

3.11 TESTING AND INSPECTION FOR CONTRACTOR QUALITY CONTROL (CQC)

Paragraph ACCEPTABILITY OF WORK contains additional CQC requirements. The Contractor shall perform the inspection and tests described below and, based upon the results of these inspections and tests, shall take the action required and submit reports as specified. When, in the opinion of the Contracting Officer, the paving operation is out of control, concrete placement shall cease.

3.11.1 Batch Plant Control

A daily report shall be prepared indicating checks made for scale accuracy with test weights, checks of batching accuracy, and corrective action taken prior to and during placement for weighing or batching, type and source of cement used, type and source of pozzolan or slag used, amount and source of admixtures used, aggregate source, the required aggregate and water masses per cubic meter yd, amount of water as free moisture in each size of aggregate, and the batch aggregate and water masses per cubic meter yd for each class of concrete batched during each day's plant operation.

3.11.2 Concrete Mixture

a. Air Content Testing. Air content tests shall be made when test specimens are fabricated. In addition, at least two other tests for air content shall be made on randomly selected batches of each separate concrete mixture produced during each 8-hour period of paving. Whenever air content reaches specified limits, an immediate confirmatory test shall be made. If the second test also shows air content at or exceeding specified limits, an adjustment shall immediately be made in the amount of air-entraining admixture batched to bring air content within specified limits. If the next adjusted batch of concrete is not within specified limits, concrete placement shall be halted until concrete air content is within specified limits.

b. Slump Testing. Slump tests shall be made when test specimens are fabricated. Additional tests shall be made when excessive variation in workability is reported by the placing foreman or Government inspector. Whenever slump approaches the maximum limit, an adjustment shall immediately be made in the batch masses

of water and fine aggregate, without exceeding the maximum w/(c+p). When a slump result exceeds the specification limit, no further concrete shall be delivered to the paving site until adjustments have been made and slump is again within the limit.

c. Temperature. The temperature of the concrete shall be measured when strength specimens are fabricated.

d. Concrete Strength Testing. Four (4) cylinders from the same batch shall be fabricated, cured and tested for compressive strength, testing two cylinders at 7-day and two cylinders at 28-day age. A minimum of one set of four (4) cylinders shall be fabricated, cured and tested for each shift of concrete placement. Control charts for strength, showing the 7-day and 28-day CQC compressive strengths, and the 28-day required compressive strength, shall be maintained and submitted with weekly CQC Reports.

3.11.3 Inspection Before Placing

Underlying materials, joint locations and types, construction joint faces, forms, reinforcing, dowels, and embedded items shall be inspected by a Registered Engineer in sufficient time prior to each paving operation in order to certify to the Contracting Officer that they are ready to receive concrete. The results of each inspection shall be reported in writing, and the certification signed by the Registered Engineer, prior to each days' paving.

3.11.4 Paving Operations

The placing foreman shall supervise all placing and paving operations, shall determine that the correct quality of concrete is placed in each location as shown, shall insure that the concrete is consolidated full depth and that finishing is performed as specified. The placing foreman shall be responsible for measuring and recording concrete temperatures and ambient temperature hourly during placing operations, weather conditions, time of placement, volume of concrete placed, and method of paving and any problems encountered.

3.11.5 Curing Inspection

a. Moist Curing Inspections. Each day on both work and non-work days, an inspection shall be made of all areas subject to moist curing. The surface moisture condition shall be noted and recorded. When any inspection finds an area of inadequate curing, immediate corrective action shall be taken, and the required curing period for the area shall be extended by 1 day.

b. Membrane Curing Inspection. At the end of each day's placement, the CQC Representative shall determine the quantity of compound used by measurement of the container; shall determine the area of concrete surface covered; shall then compute the rate of coverage in square meters per L square feet per gallon and shall also note whether or not coverage is uniform. When the coverage rate of the curing compound is less than that specified or when the coverage is not uniform, the entire surface shall be sprayed again.

3.11.6 Cold-Weather Protection

At least once per day, an inspection shall be made of all areas subject to

cold-weather protection. Any deficiencies shall be noted, corrected, and reported.

3.11.7 Reports

All results of tests or inspections conducted shall be reported informally as they are completed and in writing daily. A weekly report, signed by a registered engineer, shall be prepared for the updating of control charts and test data, and all CQC inspections and actions covering the entire period from the start of the construction through the current week. Reports of failures and the action taken shall be confirmed in writing in the routine reports. The Contracting Officer has the right to examine all CQC records. A copy of weekly reports shall be faxed to the Design District Pavement or Geotechnical Engineer. At the completion of concrete placement, a certification report shall be prepared containing mix designs, all updated control charts and concrete test data, quality control reports, smoothness reports, and other pertinent data on the concrete, with a certification by a registered engineer that the concrete placed meets all specification requirements. A copy of the certification report shall be mailed to the Design District pavement or Geotechnical Engineer.

-- End of Section --