UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2018
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DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES

11/11

-- End of Section Table of Contents --

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USACE / NAVFAC / AFCEC / NASA	**UFGS-32 13 13.06 (November 2011) Change 2 - 08/17**

Preparing Activity: NAVFAC	**Superseding UFGS-32 13 13.06 (August 2008)**

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SECTION 32 13 13.06

PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES
11/11

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NOTE: This guide specification covers the requirements for small portland cement concrete paving jobs such as roads, streets, sidewalks, and parking lots.

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)**.**

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NOTE: The extent and location of the work to be accomplished should be indicated on the project drawings, or included in the project specifications. Precast structural concrete and portland cement pavements for airports are not included in this specifications.

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PART 1 GENERAL

1.1 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 CONCRETE INSTITUTE INTERNATIONAL (ACI)

ACI 211.1	(1991; R 2009) Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 301	(2016) Specifications for Structural Concrete
ACI 305.1	(2014) Specification for Hot Weather Concreting
ACI 306.1	(1990; R 2002) Standard Specification for Cold Weather Concreting
ACI 325.12R	(2002; R 2013) Guide for Design of Jointed Concrete Pavements for Streets and Local Roads
ACI 330R	(2008) Guide for the Design and Construction of Concrete Parking Lots

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C215	(2016) Extruded Polyolefin Coatings for Steel Water Pipe

ASTM INTERNATIONAL (ASTM)

ASTM A184/A184M	(2017) Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615/A615M	(2016) Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

ASTM A775/A775M	(2017) Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A966/A966M	(2015) Standard Test Method for Magnetic Particle Examination of Steel Forgings Using Alternating Current
ASTM C1077	(2017) Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157/C1157M	(2017) Standard Performance Specification for Hydraulic Cement
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C143/C143M	(2015) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C1549	(2016) Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
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	(2012) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C171	(2016) Standard Specification for Sheet Materials for Curing Concrete
ASTM C172/C172M	(2017) Standard Practice for Sampling Freshly Mixed Concrete
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 C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C31/C31M	(2017) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM C494/C494M	(2017) Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	(2017) Standard Specification for Blended Hydraulic Cements
ASTM C618	(2017) Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C78/C78M	(2016) Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C94/C94M	(2017a) Standard Specification for Ready-Mixed Concrete
ASTM C989/C989M	(2017) Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D6155	(2015) Nontraditional Coarse Aggregate for Bituminous Paving Mixtures

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-250-01	(2016) Pavement Design for Roads and Parking Areas

1.2 DESIGN

This materials and construction specification is intended to be used on projects where the design was completed using UFC 3-250-01 Pavement Design for Roads, Streets, Walks, and Open Storage Areas, ACI 330R, Guide for the Design and Construction of Concrete Parking Lots or ACI 325.12R, Guide for Design of Jointed Concrete Pavements for Streets and Local Roads, or equivalent.

1.3 RELATED SECTIONS

Portland cement concrete pavement must use Section 32 11 16.16 [BASE COURSE FOR RIGID] [AND SUBBASE COURSE FOR FLEXIBLE] [SUBBASE COURSE FOR PERVIOUS] PAVING, in addition to this section.

1.4 SUBMITTALS

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

The Guide Specification technical editors have designated those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control

System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

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

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance with Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Curing Materials; G[, [_____]]

Admixtures; G[, [_____]]

Dowel; G[, [_____]]

[Reinforcement; G[, [_____]]

] Submit a complete list of materials including type, brand and applicable reference specifications.

Cementitious Materials; G[, [_____]]

Aggregate; G[, [_____]]

[Albedo

Provide information identifying the reflectance of the pavement.

] SD-04 Samples

[Field-Constructed Mockup

] SD-05 Design Data

Concrete Mix Design; G[, [_____]]

Thirty days minimum prior to concrete placement, submit a mix design, with applicable tests, for each strength and type of concrete for approval. Submit a complete list of materials including type; brand; source and amount of cement, fly ash, slag, and admixtures; and applicable reference specifications. Provide mix proportion data using at least three different water-cement ratios for each type of mixture, which will produce a range of strength encompassing those required for each class and type of concrete required. Submittal must clearly indicate where each mix design will be used when more than one mix design is submitted. Obtain acknowledgement of approvals prior to concrete placement. Submit a new mix design for each material source change.

SD-06 Test Reports

Aggregate Tests; G[, [_____]]

Concrete Slump Tests; G[, [_____]]

Air Content Tests; G[, [_____]]

Flexural Strength Tests; G[, [_____]]

[Cementitious Materials; G[, [_____]]

] SD-07 Certificates

Ready-mixed Concrete Plant; G[, [_____]]

Batch Tickets; G[, [_____]]

Cementitious Materials; G[, [_____]]

1.5 DELIVERY, STORAGE, AND HANDLING

ASTM C94/C94M.

1.6 QUALITY ASSURANCE

1.6.1 Ready-mixed Concrete Plant Certification

Unless otherwise approved by the Contracting Officer, ready mixed concrete must be produced and provided by a National Ready-Mix Concrete Association (NRMCA) certified plant. If a volumetric mobile mixer is used to produce the concrete, rather than ready-mixed concrete, the mixer(s) must conform to the standards of the Volumetric Mixer Manufacturers Bureau (VMMB). Verification must be made by a current VMMB conformance plate affixed to the volumetric mixer equipment.

1.6.2 Contractor Qualifications

Unless waived by the Contracting Officer, the Contractor must meet one of the following criteria:

a. Contractor must have at least one National Ready Mixed Concrete Association (NRMCA) certified concrete craftsman and at least one American Concrete Institute (ACI) Flatwork Finisher Certified craftsman on site, overseeing each placement crew during all concrete placement.

b. Contractor must have no less than three NRMCA certified concrete installers and at least two American Concrete Institute (ACI) Flatwork Finisher Certified installers, who must be on site working as members of each placement crew during all concrete placement.

1.6.3 Required Information

Submit copies of laboratory test reports showing that the mix has been successfully tested to produce concrete with the properties specified and that mix will be suitable for the job conditions. The laboratory test reports must include mill test and all other test for cementitious materials, aggregates, and admixtures. Provide maximum nominal aggregate size, combined aggregate gradation analysis, percentage retained and passing sieve, and a graph of percentage retained verses sieve size. Submit test reports along with the concrete mix design. Sampling and testing of materials, concrete mix design, sampling and testing in the field must be performed by a commercial testing laboratory which conforms to ASTM C1077. The laboratory must be approved in writing by the Contracting Officer.

1.6.4 Batch Tickets

ASTM C94/C94M. Submit mandatory batch ticket information for each load of ready-mixed concrete.

[1.6.5 Field-Constructed Mockup

Install a minimum [37 square meters400 square feet] to demonstrate typical joints, surface finish, texture, color, thickness, and standard of workmanship. Test panels must be placed using the mixture proportions, materials, and equipment as proposed for the project. Test mock up panels in accordance with requirements in FIELD QUALITY CONTROL.

When a test panel does not meet one or more of the requirements, the test panel must be rejected, removed, and replaced at the Contractor's expense. If the test panels are acceptable, they may be incorporated into the project with the approval of the Contracting Officer.

]PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Cementitious Materials

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NOTE: ASTM C595 covers three kinds of blended hydraulic cements. The three types are as follows:

1. Portland Blast - Furnace Slag Cement (Type IS).

2. Portland - Pozzolan Cement (Types IP and P).

3. Ternary blended Cement (Type IT).

For sulfate resistance consider using types IS (MS) or IP (MS), II, and V.

Types IS-A, IP-A, PA, SA, and PM-A are air-entrained cements but should not be specified because of inability to control air content and lack of uniformity.

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NOTE: Cement is 10 to 15 percent of concrete, but is more energy intensive than the other constituents. Use the minimum amount of cement required for a project to produce quality concrete. Fly ash is commonly used as a replacement for portland cement but typically replaces less than 40 percent of the cement; it needs to be tested extensively for compatibility and performance if the fly ash is intended to replace 40 percent or more of the cement. Include the last sentence of the following paragraph if fly ash replaces 40 percent or more of the portland cement.

Coal fly ash, slag, cenospheres, and silica fumes are EPA designated recovered products to be ingredients in concrete and cement. Use materials with recycled content where appropriate for use. The following section allows a percentage range of non-portland cement materials to be used. The Contractor must incorporate these other non-cement materials based on local availability and mixes available at local plants. A resource that can be used for additional information on recovered materials used in cement and concrete is the "Comprehensive Procurement Guidelines (CPG)" page within the EPA's website at http://www.epa.gov**.**

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Cementitious materials in concrete mix must be 20 to 50 percent non-portland cement pozzolanic materials [or slag]by weight.[Provide test data demonstrating compatibility and performance of concrete satisfactory to Contracting Officer.]

2.1.1.1 Cement

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NOTE: A maximum alkali content of 0.40% is more desirable and should be used where available. However, the availability of low alkali cement is extremely limited and is not economically feasible in most cases. Therefore the use of low alkali cement is not required.

****

ASTM C150/C150M, Type I or II [III, for high early concrete] [or V] [low alkali]or ASTM C595/C595M, Type IS, IP, or P [MS] [MH] [mortar expansion] or ASTM C1157/C1157M [MS] [HS] [R].

2.1.1.2 Fly Ash and Pozzolan

****
NOTE: Fly ash, pozzolan, and slag cement may produce uneven discoloration of the concrete during the early stages of construction, depending upon the type of curing provided. Fly ash or pozzolan meeting the specified test results, which are more stringent than ASTM C618, should provide acceptable end results.
****

ASTM C618, Type F, or N. Fly ash certificates must include test results in accordance with ASTM C618.

****
NOTE: A maximum calcium oxide content of 2% is more desirable but not required.
****

2.1.1.3 Ultra Fine Fly Ash and Ultra Fine Pozzolan

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

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

b. The average particle size must not exceed 6 microns.

2.1.1.4 Slag

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NOTE: GGBFS Grade 120 is more desirable but Grade 100 is allowed.
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ASTM C989/C989M, Slag Cement (formerly Ground Granulated Blast Furnace Slag) Grade 100 or 120. Certificates must include test results in accordance with ASTM C989/C989M.

2.1.1.5 Supplementary Cementitious Materials (SCM) Content

The concrete mix must always contain one of the SCMs listed in Table 1 within the range specified therein, whether or not the aggregates are found to be reactive in accordance with the paragraph ALKALI REACTIVITY TEST".

TABLE 1 SUPPLEMENTARY CEMENTITIOUS MATERIALS CONTENT		
Supplementary Cementitious Material	Minimum Content (percent)	Maximum Content (percent)
Class N Pozzolan and Class F Fly Ash		
SiO2 + Al2O3 + Fe2O3 > 70 percent	25	35
SiO2 + A12O3 + Fe2O3 > 80 percent	20	35
SiO2 + A12O3 + Fe2O3 > 90 percent	15	35
UFFA and UFP	7	16
GGBF Slag	40	50

2.1.2 Water

Water must conform to ASTM C1602/C1602M. Hot water must not be used unless approved by the Contracting Officer.

2.1.3 Aggregate

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NOTE: Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

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Coarse aggregate must consist of crushed or uncrushed gravel, crushed stone, or a combination thereof.[Provide coarse aggregate with a minimum of [25][_____] percent recycled porcelain, concrete, stone, or other recycled material complying with ASTM D6155.] Aggregates, as delivered to the mixers, must consist of clean, hard, uncoated particles. Coarse aggregate must be washed. Washing must be sufficient to remove dust and other coatings. Fine aggregate must consist of natural sand, manufactured sand, or a combination of the two, and must be composed of clean, hard, durable particles. Both coarse and fine aggregates must meet the requirements of ASTM C33/C33M.

2.1.3.1 Alkali Reactivity Test

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NOTE: While not wholly conclusive, petrographic examination (ASTM C295/C295M) and the Chemical Test Method (ASTM C28/C28M) are valuable indicators. However, chemical test results may not be correct for aggregates containing carbonates of calcium, magnesium or ferrous iron, such as calcite, dolomite, magnesite or siderite; or silicates of magnesium such as serpentine. The Concrete Prism

Test (ASTM C1293) is also a valuable indicator. However, none of the methods above constitutes a substitute for the modified ASTM C1260.

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NOTE: The most important rocks and mineral known to be deleteriously reactive with the alkalies in Portland cement are listed in ASTM C33 (and ASTM C294). However, this list is not inclusive, and particles having a glassy or micro-crystalline structure should be considered suspect. Reactive aggregates are widespread in the United States, being especially common in the western half and southeastern portions. However, generalizations concerning area distribution of reactive aggregates should not be relied upon for important work. Contract documents for important concrete projects should include provisions for preventing such aggregate being used, if possible, or requiring their use exclusively with low-alkali cements, suitable blended cements, or pozzolanic admixtures as available and as required to avoid deleterious effects on the concrete.

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NOTE: It is recommended that the various types of aggregates also be evaluated separately, in accordance with the original ASTM C1260, to ascertain the specific reactivity of each aggregate.

****

Aggregates to be used in all concrete in projects over 4645 SM 50,000 SF in size must be evaluated and tested for alkali-aggregate reactivity in accordance with ASTM C1260. The types of aggregates must be evaluated in a combination which matches the proposed mix design (including Class F fly ash or GGBF slag), utilizing ASTM C1567. Test results of the combination must have a measured expansion of less than 0.08 percent at 28 days. Should the test data indicate an expansion of greater than 0.08%, the aggregate(s) must be rejected and new aggregate sources must be submitted for retesting or may submit additional test results incorporating Lithium Nitrate for consideration.

ASTM C1567 must be performed as follows to include one of the following options:

a. Utilize the low alkali Portland cement and Class F fly ash in combination for the test proportioning. The laboratory must use the Contractor's proposed percentage of cement and fly ash.

b. Utilize the low alkali Portland cement and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory must use the Contractor's proposed percentage of cement and GGBF.

c. Utilize the low alkali Portland cement and Class F fly ash and ground granulated blast furnace (GGBF) slag in combination for the test proportioning. The laboratory must use the Contractor's proposed

percentage of cement, fly ash and GGBF.

2.1.3.2 Fine Aggregates

ASTM C33/C33M.

2.1.3.3 Coarse Aggregates

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NOTE: Use the maximum nominal size aggregate. No. 67 20 mm to No. 4.75 mm sieve 3/4 inch to No. 4 sieve or No. 57 25.0 mm to 4.75 mm sieve one inch to No. 4 sieve are typical. Use the largest aggregate size which will accommodate rebar spacing and form spacing in accordance with ACI. Allow No. 467 37.5 mm to 4.75 mm 1 1/2 inch to No. 4 sieve when ACI clearance requirements are meet, especially for concrete slabs and pavements without rebar. Maximum aggregate size should not exceed:

1. 1/5 the dimension of nonreinforced members.

2. 3/4 the clear spacing between reinforcing bars or between reinforcing bars and forms.

3. 1/3 the depth of nonreinforced slabs on the ground.

****

ASTM C33/C33M.

2.1.4 Admixtures

ASTM C494/C494M: Type A, water reducing; Type B, retarding; Type C, accelerating; Type D, water-reducing and retarding; and Type E, water-reducing and accelerating admixture. Do not use calcium chloride admixtures. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

ASTM C260/C260M: Air-entraining.

2.1.5 Reinforcement

2.1.5.1 Dowel Bars

Bars must conform to ASTM A615/A615M, [Grade 300] [Grade 420] [Grade 40] [Grade 60] for plain billet-steel bars of the size and length indicated. Remove all burrs and projections from the bars.

2.1.5.2 Coated Dowel Bars

Bars must conform to ASTM A615/A615M, [Grade 300] [Grade 420] [Grade 40] [Grade 60] for plain billet-steel bars of the size and length indicated. Remove all burrs or projections from the dowel bars. Coating system must conform to AWWA C215, Type 2. Coat the bars with a double coat system or an epoxy coating system for resistance to penetration of oil and salt solutions. The systems must be in accordance with manufacturer's recommendation for coatings which are not bondable to concrete. Bond the coating to the dowel bar to resist laps or folds during movement of the

joint. Coating thickness must be 0.175 mm 7 mils minimum and 0.5 mm 20 mils maximum.

2.1.5.3 Tie Bars

Bars must be billet or axle steel deformed bars and conform to ASTM A615/A615M or ASTM A966/A966M [Grade 300] [Grade 420] [Grade 40] [Grade 60].[Epoxy coated in accordance with ASTM A775/A775M.]

[2.1.5.4 Reinforcement

Deformed steel bar mats must conform to ASTM A184/A184M. Bar reinforcement must conform to [ASTM A615/A615M] [ASTM A966/A966M], [Grade 300] [Grade 420] [Grade 40] [Grade 60].

]2.1.6 Curing Materials

2.1.6.1 White-Burlap-Polyethylene Sheet

ASTM C171, 0.10 mm 0.004 inch thick white opaque polyethylene bonded to 0.31 kg per meter 10 oz/linear yard (1.0 meter) (40 inch) wide burlap.

2.1.6.2 Liquid Membrane-Forming Compound

ASTM C309, white pigmented, Type 2, Class B, free of paraffin or petroleum.

[2.1.6.3 Liquid Chemical Sealer-Hardener Compound

Compound must be magnesium fluosilicate which when mixed with water seals and hardens the surface of the concrete. Do not use on exterior slabs exposed to freezing conditions. Compound must not reduce the adhesion of resilient flooring, tile, paint, roofing, waterproofing, or other material applied to concrete.

]2.1.7 Joint Fillers and Sealants

Provide as specified in Section [32 01 19 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS][32 13 73 COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS].[New joints must match existing alignment.]

[2.1.8 Biodegradable Form Release Agent

****

NOTE: Concrete release fluids are recognized as a biobased material. Use materials with biobased content where suitable for application and cost effective. Verify suitability, availability within the region, cost effectiveness, and adequate competition before specifying product biobased content requirements. A resource that can be used to identify products with bio-based content is the "Catalog" tab within the USDA's "Biopreferred" website at https://www.biopreferred.gov/BioPreferred/**. Other products with biobased content are also acceptable when meeting all requirements of this specification.**

****

Provide form release agent that is colorless and biodegradable. A minimum

of 87 percent of the total product must be biobased material. Provide product that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces. Provide form release agent that does not contain diesel fuel, petroleum-based lubricating oils, waxes, or kerosene.

]2.2 CONCRETE PAVEMENT

2.2.1 Joint Layout Drawings

If jointing requirements on the project drawings are not compatible with the proposed placement sequence, submit a joint layout plan shop drawing to the Contracting Officer for approval. No work must be allowed to start until the joint layout plan is approved. The joint layout plan must indicate and describe in the detail the proposed jointing plan for contraction joints, expansion joints, and construction joints, in accordance with the following:

a. Indicate locations of contraction joints, construction joints, and expansion joints. Spacing between contraction joints must not exceed 4.5 m 15 feet unless noted otherwise or approved by the Contracting Officer.

b. The larger dimension of a panel must not be greater than 125% of the smaller dimension.

c. The minimum angle between two intersecting joints must be 80 degrees, unless noted otherwise or approved by the Contracting Officer.

d. Joints must intersect pavement-free edges at a 90 degree angle the pavement edge and must extend straight for a minimum of 450 mm 1.5 feet from the pavement edge, where possible.

e. Align joints of adjacent panels.

f. Align joints in attached curbs with joints in pavement when possible.

g. Ensure joint depth, widths, and dimensions are specified.

h. Minimum contraction joint depth must be 1/4 of the pavement thickness. The minimum joint width must be 3 mm 1/8 inch.

i. Use expansion joints only where pavement abuts buildings, foundations, manholes, and other fixed objects.

[2.2.2 Albedo

****

NOTE: The urban heat island effect forms as vegetation is replaced by low reflectivity materials such as dark colored paving. These surfaces absorb, rather than reflect, the sun's heat, causing surface temperatures and urban ambient temperatures to be 1 to 6 degrees C (2 to 10 degrees F) hotter than surrounding rural areas.

Mitigation of heat island effect is not required by UFC 1-200-02 but may be desired for sustainability reasons. The albedo requirements below for roads

and parking lot paving are most beneficial in ASHRAE climate zones 1 through 5. Retain the following section when needed to meet project requirements.

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Provide a system with a minimum initial Solar Reflectance of at least 0.33 and a 3-year aged of 0.28 as tested in accordance with ASTM C1549.

]2.3 CONTRACTOR-FURNISHED MIX DESIGN

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NOTE: The 3.79 MPa 550 psi flexural strength specified in paragraph FLEXURAL STRENGTH TESTS is based on 4.48 MPa 650 psi flexural strength, 35 MPa 5,000 psi compressive strength, specified in paragraph CONTRACTOR-FURNISHED MIX DESIGN. If other flexural strength is specified in paragraph CONTRACTOR-FURNISHED MIX DESIGN, modify paragraph FLEXURAL STRENGTH TESTS. See Section 32 13 14.13 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENT for further information.

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NOTE: This specification is based on a flexural strength basis. For small jobs 75 cubic meters or less 100 cubic yards or less, compressive strength may be used. In that case modify these paragraphs to reflect a compressive strength basis.

NOTE: Allowable Air Content: Select 5 percent air content for maximum aggregate size of 37.5 or 50 mm 1 1/2 or 2 inches, and 6 percent air content for maximum aggregate size for 19 or 25 mm 3/4 or one inch.

NOTE: Minimum Cement Factor: The cement required to produce concrete strength of 4.48 MPa 650 psi at 28 days is generally sufficient to provide durable concrete and resistance to surface abrasion. In localities of substandard aggregates or when concrete is machine finished without vibration or finished with hand tools, a minimum cement factor should be specified. Specifying a minimum cement factor will not necessarily provide the specified flexural strength and additional cement may be required. The actual amount of cement required to obtain the required strength is decided by the Contractor based on mix designs for local aggregates and type of equipment and methods to be used in the field production of the concrete. Select a minimum cement factor to compensate for poor quality aggregates, seawater exposure, and for sites of difficult concrete placement conditions. Guidance for minimum cement contents for suitability, durability and workability of concrete is frequently given in the State Standard Specifications.

****

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NOTE: Coordinate with Contracting Officer for mix design requirement to satisfy project albedo and permeability needs.
****

Contractor-furnished concrete mix must be designed in accordance with ACI 211.1 except as modified herein, and the mix design must be as specified herein under paragraph SUBMITTALS. The concrete must have a minimum flexural strength of [4.48][_____]MPa [650][_____] pounds per square inch at 28 days. The concrete may be air entrained. If air entrainment is used the air content must be [5.0][6.0]. Maximum size aggregate for slip forming must be 38 mm 1.5 inches. The slump must be 25 mm to 75 mm one to 3 inches (or less when slip form is used). For slipformed pavement, at the start of the project, select a maximum allowable slump which will produce in-place pavement meeting the specified tolerances for control of edge slump. The selected slump must be applicable to both pilot and fill-in lanes.

If the cementitious material is not sufficient to produce concrete of the flexural strength required it must be increased as necessary, without additional compensation under the Contract. The cementitious factor must be calculated using cement, Class F fly ash, and or GGBF slag. The mix must use a SCM material by weight in accordance with Table 1 in "Supplementary Cementitious Materials (SCM) Content"

PART 3 EXECUTION

3.1 FORMS

3.1.1 Construction

Construct forms to be removable without damaging the concrete.

3.1.2 Coating

Before placing the concrete, coat the contact surfaces of forms [except existing pavement sections where bonding is required,] with a non-staining mineral oil, non-staining form coating compound, biodegradable form release agent, or two coats of nitro-cellulose lacquer.[When using existing pavement as a form, clean existing concrete and then coat with asphalt emulsion bondbreaker before concrete is placed.]

3.1.3 Grade and Alignment

Check and correct grade elevations and alignment of the forms immediately before placing the concrete.

3.2 REINFORCEMENT

3.2.1 Dowel Bars

****
NOTE: For projects which require dowel bars or coated dowel bars, show location, size, and tolerances on the drawings.
****

Install bars accurately aligned, vertically and horizontally, at indicated

locations and to the dimensions and tolerances indicated. Before installation thoroughly grease the sliding portion of each dowel. Dowels must remain in position during concrete placement and curing.

3.2.2 Coated Dowel Bars

Install bars, accurately aligned vertically and horizontally, at indicated locations and to the dimensions and tolerances indicated. Reject coatings which are perforated, cracked or otherwise damaged. While handling avoid scuffing or gouging of the coatings.

3.2.3 Tie Bars

****
NOTE: When tie bars are required in the contract, indicate location on drawings. Show bar size and spacing required and method of support.
****

Install bars, accurately aligned horizontally and vertically, at indicated locations.[For slipform construction, insert bent tie bars by hand or other approved means.]

3.2.4 Setting Slab Reinforcement

****
NOTE: For contracts which require reinforcing steel, specify the type, size and material of reinforcement. Edit paragraph to specify method of placement as appropriate for thickness of the concrete.
****

Reinforcement must be positioned on suitable chairs prior to concrete placement. At expansion, contraction and construction joints, place the reinforcement as indicated. Reinforcement, when placed in concrete, must be free of mud, oil, scale or other foreign materials. Place reinforcement accurately and wire securely. The laps at splices must be 300 mm 12 inches minimum and the distances from ends and sides of slabs and joints must be as indicated.

3.3 MEASURING, MIXING, CONVEYING, AND PLACING CONCRETE

3.3.1 Measuring

ASTM C94/C94M.

3.3.2 Mixing

ASTM C94/C94M, except as modified herein. Begin mixing within 30 minutes after cement has been added to aggregates. When the air temperature is greater than 29.4 degrees C 85 degrees F, place concrete within 60 minutes. With the approval of the Contracting Officer, a hydration stabilizer admixture meeting the requirements of ASTM C494/C494M Type D, may be used to extend the placement time to 90 minutes. Additional water may be added to bring slump within required limits as specified in Section 11.7 of ASTM C94/C94M, provided that the specified water-cement ratio is not exceeded.

3.3.3 Conveying

ASTM C94/C94M.

3.3.4 Placing

Follow guidance of ACI 301, except as modified herein. Do not exceed a free vertical drop of 1.5 m 5 feet from the point of discharge. Deposit concrete either directly from the transporting equipment or by conveyor on to the pre-wetted subgrade or subbase, unless otherwise specified. Do not place concrete on frozen subgrade or subbase. Deposit the concrete between the forms to an approximately uniform height. Place concrete continuously at a uniform rate, with minimum amount of segregation, without damage to the grade and without unscheduled stops except for equipment failure or other emergencies. If this occurs within 3 m 10 feet of a previously placed expansion joint, remove concrete back to joint, repair any damage to grade, install a construction joint and continue placing concrete only after cause of the stop has been corrected.

3.3.5 Vibration

Immediately after spreading concrete, consolidate concrete with internal type vibrating equipment along the boundaries of all slabs regardless of slab thickness, and interior of all concrete slabs 150 mm 6 inches or more in thickness. Limit duration of vibration to that necessary to produce consolidation of concrete. Excessive vibration will not be permitted. Vibrators must not be operated in concrete at one location for more than 15 seconds. Vibrating equipment of a type approved by the Contracting Officer may be used to consolidate concrete in unreinforced pavement slabs less than 150 mm 6 inches thick.

3.3.5.1 Vibrating Equipment

Operate equipment, except hand-manipulated equipment, ahead of the finishing machine. Select the number of vibrating units and power of each unit to properly consolidate the concrete. Mount units on a frame that is capable of vertical movement and, when necessary, radial movement, so vibrators may be operated at any desired depth within the slab or be completely withdrawn from the concrete. Clear distance between frame-mounted vibrating units that have spuds that extend into the slab at intervals across the paving lane must not exceed 750 mm 30 inches. Distance between end of vibrating tube and side form must not exceed 50 mm 2 inches. For pavements less than 250 mm 10 inches thick, operate vibrators at mid-depth parallel with or at a slight angle to the subbase. For thicker pavements, angle vibrators toward the vertical, with vibrator tip preferably about 50 mm 2 inches from subbase, and top of vibrator a few mm inches below pavement surface. Vibrators may be pneumatic, gas driven, or electric, and must be operated at frequencies within the concrete of not less than 8,000 vibrations per minute. Amplitude of vibration must be such that noticeable vibrations occur at 450 mm 1.5 foot radius when the vibrator is inserted in the concrete to the depth specified.

3.3.6 Cold Weather

****
NOTE: Calcium chloride accelerators should not be permitted for reinforced concrete and in concrete in contact with aluminum or other non-ferrous materials.
****

Except with authorization, do not place concrete when ambient temperature is below 5 degrees C 40 degrees F or when concrete is likely to be subjected to freezing temperatures within 24 hours. When authorized, when concrete is likely to be subjected to freezing within 24 hours after placing, heat concrete materials so that temperature of concrete when deposited is between 18 and 27 degrees C 65 and 80 degrees F. Methods of heating materials are subject to approval of the Contracting Officer. Do not heat mixing water above 74 degrees C 165 degrees F. Remove lumps of frozen material and ice from aggregates before placing aggregates in mixer. Follow practices found in ACI 306.1.

3.3.7 Hot Weather

Maintain required concrete temperature in accordance with Figure NRMCA NOMOGRAPH FOR ESTIMATING EVAPORATION RATE ON THE BASIS OF MENZEL FORMULA in ACI 305.1 to prevent evaporation rate from exceeding 0.98 kg of water per square meter 0.2 pound of water per square foot of exposed concrete per hour. Cool ingredients before mixing or use other suitable means to control concrete temperature and prevent rapid drying of newly placed concrete. After placement, use fog spray, apply monomolecular film, or use other suitable means to reduce the evaporation rate. Start curing when surface of fresh concrete is sufficiently hard to permit curing without damage. Cool underlying material by sprinkling lightly with water before placing concrete. Follow practices found in ACI 305.1.

3.4 PAVING

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

3.4.1 Consolidation

The paver vibrators must be inserted into the concrete not closer to the underlying material than 50 mm 2 inches. The vibrators or tamping units in front of the paver must be automatically controlled so that they stop immediately as forward motion ceases. Excessive vibration must not be permitted. Concrete in small, odd-shaped slabs or in locations inaccessible to the paver mounted vibration equipment must be vibrated with a hand-operated immersion vibrator. Vibrators must 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 must be made to prevent damage to the previously constructed pavement, including keeping the existing pavement surface free of debris, and placing rubber mats beneath the paver tracks. Transversely oscillating screeds and extrusion plates must 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 must be operated to produce a thoroughly consolidated slab throughout, true to line and grade within specified tolerances. The paver-finishing operation must produce a surface finish free of irregularities, tears, voids of any kind, and other discontinuities. It must produce only a minimum of paste at the surface. Multiple passes of

the paver-finisher must not be permitted. The equipment and its operation must 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), must 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 must 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 must 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 must have a base width not less than the vertical height of the form. Wood forms for curves and fillets must be adequate in strength and rigidly braced. Forms must 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 must 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 must be held securely in place with stakes or by other approved methods. Holes in existing pavements for form stakes must be carefully drilled without cracking or spalling the existing pavement. Prior to setting forms for paving operations, demonstrate the proposed form setting procedures at an approved location and do not proceed further until the proposed method is approved.] Forms must remain in place at least 12 hours after the concrete has been placed. Forms must 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 must shape the concrete to the specified and indicated cross section in one pass, and must finish the surface and edges so that only a very minimum amount of hand finishing is required. Dowels must 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 must be installed as the keyway is extruded.[The keyway liner must be protected and must 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 must be positioned on suitable chairs securely fastened to the subgrade prior to concrete placement.[If reinforcing for Continuously Reinforced Concrete Pavement (CRCP) is required, the entire operating procedure and equipment proposed must 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 must be installed with alignment not greater than one mm per 100 mm 1/8 inch per ft. Except as otherwise specified below, location of dowels must 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 must be painted with one coat of rust inhibiting primer paint, and then oiled just prior to placement. [Dowels] [and tie bars] in joints must 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 must be held securely in place by means of rigid metal basket assemblies. The [dowels] [and tie bars] must 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 must 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] must 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 must 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 must be drilled into the hardened concrete. Dowels must 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 is not permitted. The dowels must 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 must 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 must be installed at the paver, in front of the transverse screed or extrusion plate. If tie bars are required, a standard keyway must be constructed, and the bent tie bars must be inserted into the plastic concrete through a 0.45 to 0.55 mm 26 gauge thick metal keyway liner. Tie bars must not be installed in preformed holes. The keyway liner must be protected and must remain in place and become part of the joint. Before placement of the adjoining paving lane, the tie bars must 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 must be installed by the bonded-in-place method or by bonding into holes drilled in hardened concrete, using procedures specified above.

3.5 FINISHING CONCRETE

Start finishing operations immediately after placement of concrete. Use finishing machine, except hand finishing may be used in emergencies and for concrete slabs in inaccessible locations or of such shapes or sizes that machine finishing is impracticable. Finish pavement surface on both sides of a joint to the same grade. Finish formed joints from a securely supported transverse bridge. Provide hand finishing equipment for use at all times. Transverse and longitudinal surface tolerances must not exceed 6 mm in 3 m 1/4 inch in 10 feet.

3.5.1 Side Form Finishing

Strike off and screed concrete to the required [crown] [slope] and cross-section by a power-driven transverse finishing machine. Transverse rotating tube or pipe is not permitted unless approved by the Contracting Officer. Elevation of concrete must be such that, when consolidated and finished, pavement surface will be adequately consolidated and at the required grade. Equip finishing machine with two screeds which are readily and accurately adjustable for changes in pavement [crown] [slope] and compensation for wear and other causes. Make as many passes over each area of pavement and at such intervals as necessary to give proper compaction, retention of coarse aggregate near the finished surface, and a surface of uniform texture, true to grade and [crown] [slope]. Do not permit excessive operation over an area, which will result in an excess of mortar and water being brought to the surface.

3.5.1.1 Equipment Operation

Maintain the travel of machine on the forms without lifting, wobbling, or other variation of the machine which tend to affect the precision of concrete finish. Keep the tops of the forms clean by a device attached to the machine. During the first pass of the finishing machine, maintain a uniform ridge of concrete ahead of the front screed for its entire length.

3.5.1.2 Joint Finish

Before concrete is hardened, correct edge slump of pavement, exclusive of edge rounding, in excess of 6 mm 0.02 foot. Finish concrete surface on

each side of construction joints to the same plane, and correct deviations before newly placed concrete has hardened.

3.5.1.3 Hand Finishing

Strike-off and screed surface of concrete to elevations slightly above finish grade so that when concrete is consolidated and finished pavement surface is at the indicated elevation. Vibrate entire surface until required compaction and reduction of surface voids is secured with a strike-off template.

3.5.1.4 Longitudinal Floating

After initial finishing, further smooth and consolidate concrete by means of hand-operated longitudinal floats. Use floats that are not less than 3.65 m 12 feet long and 150 mm 6 inches wide and stiffened to prevent flexing and warping.

3.5.2 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.
****

****
NOTE: Select the type of texturing for roads. Climatic conditions must be considered for exposed concrete. When required, specify surfaces to receive brooming.

1. Specify wire brooming for non-skid concrete surface textures. Permit steel or new fiber brooms.

2. Specify broomed finish, if required in lieu of burlap drag finish. Broomed finish may cause excessive tire wear and is not recommended, except for special conditions in which light mechanical brooming may be desirable.

3. Additional information is published by American Concrete Paving Association (ACPA) in Technical Bulletins No. 6 (1969) and No. 19 (1975), Interim Recommendations for the Construction of Skid-Resistant Concrete Pavement and Guideline for Texturing of Portland Cement Concrete Highway Pavements, respectively.
****

Before the surface sheen has disappeared and before the concrete hardens, the surface of the pavement must 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 must inspect the texturing for compliance with design requirements. After curing is complete, all textured surfaces must be thoroughly power broomed to remove all debris.[Transverse texturing must

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 must be finished to provide a surface of the same texture as the surrounding area.

[3.5.2.1 Burlap Drag Finish

****
NOTE: Choose this paragraph or the paragraph above, or the paragraph below.
****

Before concrete becomes non-plastic, finish the surface of the slab by dragging on the surface a strip of clean, wet burlap measuring from 0.91 to 3 m 3 to 10 feet long and 600 mm 2 feet wider than the width of the pavement. Select dimension of burlap drag so that at least 0.91 m 3 feet of the material is in contact with the pavement. Drag the surface so as to produce a finished surface with a fine granular or sandy texture without leaving disfiguring marks.

][3.5.2.2 Brooming

****
NOTE: Choose this paragraph or one of the two paragraphs above.
****

Finish the surface of the slab by brooming the surface with a new wire broom at least 450 mm 18 inches wide. Gently pull the broom over the surface of the pavement from edge to edge just before the concrete becomes non-plastic. Slightly overlap adjacent strokes of the broom. Broom perpendicular to centerline of pavement so that corrugations produced will be uniform in character and width, and not more than 2 mm 1/16 inch in depth. Broomed surface must be free from porous spots, irregularities, depressions, and small pockets or rough spots such as may be caused by accidentally disturbing particles of coarse aggregate embedded near the surface.

][3.5.2.3 Wire-Comb Texturing

Surface texture transverse to the pavement center line must be applied using a mechanical wire comb drag. The comb must 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 must be overlapped the minimum necessary to obtain a continuous and uniformly textured surface. The scores must 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 mm 3/8 inch apart.

][3.5.2.4 Surface Grooving

The areas indicated on the drawings must 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 must be cut perpendicular to the centerline. Before grooving begins, the concrete must be allowed to stiffen sufficiently to prevent dislodging of aggregate. Grooves must not be cut within 150 mm 6 inches of a transverse joint or crack.

]3.5.3 Edging

At the time the concrete has attained a degree of hardness suitable for edging, carefully finish slab edges, including edges at formed joints, with an edge having a maximum radius of 3 mm 1/8 inch.[When brooming is specified for the final surface finish, edge transverse joints before starting brooming, then operate broom to obliterate as much as possible the mark left by the edging tool without disturbing the rounded corner left by the edger.] Clean by removing loose fragments and soupy mortar from corners or edges of slabs which have crumbled and areas which lack sufficient mortar for proper finishing. Refill voids solidly with a mixture of suitable proportions and consistency and refinish. Remove unnecessary tool marks and edges. Remaining edges must be smooth and true to line.

3.5.4 Repair of Surface Defects

Follow guidance of ACI 301.

3.6 CURING AND PROTECTION

Protect concrete adequately from injurious action by sun, rain, flowing water, [frost,] mechanical injury, tire marks and oil stains, and do not allow it to dry out from the time it is placed until the expiration of the minimum curing periods specified herein. Use White-Burlap-Polyethylene Sheet or liquid membrane-forming compound, except as specified otherwise herein. Do not use membrane-forming compound on surfaces where its appearance would be objectionable, on surfaces to be painted, where coverings are to be bonded to concrete, or on concrete to which other concrete is to be bonded. Maintain temperature of air next to concrete above 5 degrees C 40 degrees F for the full curing periods.

3.6.1 White-Burlap-Polyethylene Sheet

Wet entire exposed surface thoroughly with a fine spray of water, saturate burlap but do not have excessive water dripping off the burlap and then cover concrete with White-Burlap-Polyethylene Sheet, burlap side down. Lay sheets directly on concrete surface and overlap 300 mm 12 inches. Make sheeting not less than 450 mm 18 inches wider than concrete surface to be cured, and weight down on the edges and over the transverse laps to form closed joints. Repair or replace sheets when damaged during curing. Check daily to assure burlap has not lost all moisture. If moisture evaporates, resaturate burlap and re-place on pavement (re-saturation and re-placing must take no longer than 10 minutes per sheet). Leave sheeting on concrete surface to be cured for at least 7 days.

3.6.2 Liquid Membrane-Forming Compound Curing

Apply compound immediately after surface loses its water sheen and has a dull appearance and before joints are sawed. Agitate curing compound thoroughly by mechanical means during use and apply uniformly in a two-coat continuous operation by suitable power-spraying equipment. Total coverage for the two coats must be at least 4 liters one gallon of undiluted compound per 20 square meters 200 square feet. Compound must form a uniform, continuous, coherent film that will not check, crack, or peel and must be free from pinholes or other imperfections. Apply an additional coat of compound immediately to areas where film is defective. Respray concrete surfaces that are subject to heavy rainfall within 3 hours after curing compound has been applied in the same manner.

3.6.2.1 Protection of Treated Surfaces

Keep concrete surfaces to which liquid membrane-forming compounds have been applied free from vehicular traffic and other sources of abrasion for not less than 72 hours. Foot traffic is allowed after 24 hours for inspection purposes. Maintain continuity of coating for entire curing period and repair damage to coating immediately.

[3.6.3 Liquid Chemical Sealer-Hardener

Apply sealer-hardener to interior floors not receiving floor covering and floors located under access flooring. Apply the sealer-hardener in accordance with manufacturer's recommendations. Seal or cover joints and openings in which joint sealant is to be applied as required by the joint sealant manufacturer. The sealer-hardener must not be applied until the concrete has been moist cured and has aged for a minimum of 30 days. Apply a minimum of two coats of sealer-hardener.

]3.7 FIELD QUALITY CONTROL

3.7.1 Sampling

The Contractor's approved laboratory must collect samples of fresh concrete in accordance with ASTM C172/C172M during each working day as required to perform tests specified herein. Make test specimens in accordance with ASTM C31/C31M.

3.7.2 Consistency Tests

The Contractor's approved laboratory must perform concrete slump tests in accordance with ASTM C143/C143M. Take samples for slump determination from concrete during placement. Perform tests at the beginning of a concrete placement operation and for each batch (minimum) or every 16 cubic meters 20 cubic yards (maximum) of concrete to ensure that specification requirements are met. In addition, perform tests each time test beams and cylinders are made.

3.7.3 Flexural Strength Tests

****
NOTE: This specification is based on a flexural strength basis. For small jobs compressive strength may be used. In that case modify these paragraphs to reflect a compressive strength basis.
****

The Contractor's approved laboratory must test for flexural strength in accordance with ASTM C78/C78M. Make four test specimens for each set of tests. Test two specimens at [7][14] days, and the other two at [28] days. Concrete strength will be considered satisfactory when the minimum of the [28]-day test results equals or exceeds the specified [28]-day flexural strength, and no individual strength test is less than [3.79] [_____] MPa [550] [_____] pounds per square inch. If the ratio of the [7][28]-day strength test to the specified [28]-day strength is less than 65 percent, make necessary adjustments for conformance. Frequency of flexural tests on concrete beams must be not less than four test beams for each 38 cubic meters 50 cubic yards of concrete, or fraction thereof, placed. Concrete which is determined to be defective, based on the strength acceptance

criteria therein, must be removed and replaced with acceptable concrete.

3.7.4 Air Content Tests

Test air-entrained concrete for air content at the same frequency as specified for slump tests. Determine percentage of air in accordance with ASTM C231/C231M on samples taken during placement of concrete in forms.

3.7.5 Surface Testing

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

Surface testing for surface smoothness [, edge slump] and plan grade must be performed as indicated below by the Testing Laboratory. The measurements must be properly referenced in accordance with paving lane identification and stationing, and a report given to the Contracting Officer 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, must be provided to the Contracting Officer upon conclusion of surface testing.

3.7.5.1 Surface Smoothness Requirements

Surface smoothness must be measured every [_____] square meters square feet. The finished surfaces of the pavements must have no abrupt change of 3 mm 1/8 inch or more, and all pavements must be within the tolerances specified when checked with a 4 meter 12 foot straightedge: 5 mm 1/5 inch longitudinal and 6.5 mm 1/4 inch transverse directions for roads and streets and 6.5 mm 1/4 inch for both directions for other concrete surfaces, such as parking areas.

3.7.5.2 Surface Smoothness Testing Method

The surface of the pavement must be tested with the straightedge to identify all surface irregularities exceeding the tolerances specified above. The straightedge must be 3.6 meters 12 feet and be constructed of aluminum or other lightweight metal and must have blades of box or box-girder cross section with flat bottom reinforced to ensure rigidity and accuracy. Straightedges must have handles to facilitate movement on pavement. The entire area of the pavement must be tested in both a longitudinal and a transverse direction on parallel lines approximately 4.5 m 15 feet apart. The straightedge must 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 must 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.

3.7.6 Plan Grade Testing and Conformance

The surfaces must vary not more than 18 mm 0.06 foot above or below the plan grade line or elevation indicated. Each pavement category must be

checked for conformance with plan grade requirements by running lines of levels at intervals to determine the elevation at each joint intersection.

3.7.7 Test for Pavement Thickness

Full depth cores of 102 millimeter 4 inch diameter must be taken of concrete pavement every [_____] square meters square feet to measure thickness.

3.7.8 Reinforcement

Inspect reinforcement prior to installation to assure it is free of loose flaky rust, loose scale, oil, mud, or other objectionable material.

3.7.9 Dowels

Inspect dowel placement prior to placing concrete to assure that dowels are of the size indicated, and are spaced, aligned and painted and oiled as specified. Dowels must not deviate from vertical or horizontal alignment after concrete has been placed by more than 3 mm per 300 mm 1/8 inch per foot.

****

NOTE: Suggestions for improvement of this specification will be welcomed using the Navy "Change Request Forms" subdirectory located in SPECSINTACT in Jobs or Masters under "Forms/Documents" directory or DD Form 1426. Suggestions should be forwarded to:

Commander
Naval Facilities Engineering Command
Engineering Criteria Office, Code CI1
6506 Hampton Blvd.
Norfolk, VA 23508-1278

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-- End of Section --