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USACE / NAVFAC / AFCEC / NASA	**UFGS-32 01 29.61 (May 2017)** **Change 1 - 08/17**
Preparing Activity: USACE	**Superseding** **UFGS-32 01 28 (April 2008)** **UFGS-32 01 29.61 November 2008)**

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021

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SECTION 32 01 29.61

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SECTION 32 01 29.61

PARTIAL DEPTH PATCHING OF RIGID PAVING
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NOTE: This guide specification covers the requirements for partial depth patching of spalled concrete and popout areas of rigid paving. The work involves removal of spalled concrete, preparing the area to be repaired, and placing, finishing, and curing (as needed) the repair material. It is emphasized that this specification is for rehabilitation applications only and is not to be used with new construction.

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

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

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

****

PART 1 GENERAL

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NOTE: This specification is not intended for repair of heat resistant concrete pavements. See second note in paragraph entitled "Cement."

For details, drawings and illustrations related to partial depth patching, refer to UFC 3-270-03, "Concrete Crack and Partial-Depth Spall Repair" for

drawings, details and illustrations, at http://www.wbdg.org/ccb/DOD/UFC/ufc_3_270_3.pdf and UFC 3-270-01, "Asphalt and Concrete Pavement Maintenance and Repair". To download UFGS graphics related to this section, go to http://www.wbdg.org/ffc/dod/unified-facilities-guide-specifications-ufgs/for

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NOTE: For full-depth repairs of PCC pavements for roads and streets only, use Section 32 13 13.06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES. For full-depth patches or slab removal and replacement of airfield pavements, use Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS.

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NOTE: As a minimum, show the following information on the drawings:

1. Plans showing layout and identification of each affected joint and joint type. Include identification of joints with dowels and with tie-bars. Identify pavements or slabs that are reinforced and the reinforcement. Include location of each random crack where spall repairs are needed.

Spalling along a longitudinal joint in older concrete pavements may be a result of a broken keyway. Details for repairing broken keyways should be included in the project plans. Repair of broken keyways using the full-depth repair technique should be considered.

2. Show approximate location, length and width of each spall and location and size (usually average diameter) of popouts to be repaired. Dimensions of spalls and popouts need not be to scale. Identify by legend and symbol whether spall repair needed is approximately rectangular or circular or pentagonal (triangular spall). Specifically detail any special or unusual shapes or partial depth repairs.

3. If required spall repairs are extensive, provide a schedule showing scope of work and quantities for bid purposes in addition to the location plans. Identify feature areas where spalls or groups of spalls are located, area of spall repairs in square meter square feet, location and number or area of popouts, and other PCC pavement repairs which may be a part of the contract.

4. Provide details of spall and popout repairs. Refer to UFC 3-270-01 and UFC 3-270-03 for suggested details to be included on project drawings. Ensure

that these drawings include the required 50 mm 2 inch minimum horizontal beyond the unsound spalled areas in the length and width dimensions shown for each spall repair area.

5. In conducting field surveys to locate and size spalls needing repair, each suspect area must be sounded to determine extent of damage. Sounding may be done with a steel hammer, steel rod, or other suitable means for locating unsound areas that exhibit hollow sound, and indicator of potentially delaminated concrete that may develop into a spall. It is not unusual for delamination in a spall area to extend well beyond that visually obvious. Each existing partial depth patch should also be sounded to determine the performance of the patch. If soundings indicated that existing patches may be unsound, these patches should be included in the new patching program.

6. Indicate the maximum allowable time to return the repair area to aircraft/vehicle traffic. The pavement repair material that is required for the repairs may be dictated by the maximum allowable time to return the repair area to aircraft/vehicle traffic. Mixes based on the use of a standard Type I, II or V cement can be used when the time required to return the area to traffic is in excess of 3 days. Mixes based on the use of standard Type III cement can be used when the time required to return the area to traffic is in excess of 24 hours. Mixes which utilize blends of admixture in conjunction with standard cement types to further accelerate strength gains can be used when the time required to return the area to traffic is in excess of 4 hours; however, these blends are very sensitive to the mixing proportions and deviation as small as 5 percent can lead to a 6 to 8 hour increase in the cure times. When the time required to return the area to traffic is less than 4 hours use of proprietary or magnesium phosphate repair materials is required. In general, repairs using material designed for traffic after short curing periods have shorter life spans.

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1.1 UNIT PRICES

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NOTE: When lump sum payment is used, delete this paragraph . If patching is a separate pay item, revise the paragraph accordingly.

****

1.1.1 Measurement

The quantity of concrete and proprietary repair products to be paid for is the number of [cubic meters feet][kgs lbs] placed in the completed and accepted patched areas.

1.1.2 Payment

The quantity of concrete and proprietary repair products, measured as specified, is paid for at the contract unit price. The unit price includes full compensation for furnishing labor; materials; and for performing work involved in patching the pavements as specified.

1.2 REFERENCES

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

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

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

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO SDDP-1-OL	(2003) Shop Detail Drawing Presentation Guidelines

ASTM INTERNATIONAL (ASTM)

ASTM C31/C31M	(2019a) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C39/C39M	(2020) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94/C94M	(2020) Standard Specification for Ready-Mixed Concrete
ASTM C131/C131M	(2020) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the

	Los Angeles Machine
ASTM C136/C136M	(2019) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143/C143M	(2020) Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150/C150M	(2020) Standard Specification for Portland Cement
ASTM C192/C192M	(2019) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
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 C267	(2020) Standard Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes
ASTM C309	(2011) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C469/C469M	(2014) Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C494/C494M	(2019) Standard Specification for Chemical Admixtures for Concrete
ASTM C531	(2018) Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings, and Polymer Concretes
ASTM C579	(2018) Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C580	(2018) Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
ASTM C617/C617M	(2015) Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing

ASTM C685/C685M	(2017) Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881/C881M	(2020a) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C882/C882M	(2020) Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C884/C884M	(2016) Standard Test Method for Thermal Compatibility between Concrete and Epoxy-Resin Overlay
ASTM C1260	(2014) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1581/C1581M	(2018) Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage
ASTM C1602/C1602M	(2018) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM D75/D75M	(2019) Standard Practice for Sampling Aggregates
ASTM D1751	(2004; E 2013; R 2013) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	(2018) Standard Specification for Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D5023	(2015) Standard Test Method for Plastics: Dynamic Mechanical Properties: In Flexure (Three-Point Bending)

U.S. ARMY CORPS OF ENGINEERS (USACE)

COE CRD-C 300	(1990) Specifications for Membrane-Forming Compounds for Curing Concrete

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910	Occupational Safety and Health Standards

1.3 SUBMITTALS

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NOTE: Review submittal description (SD) definitions

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

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

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

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

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

SD-02 Shop Drawings

[Shop Drawings; G[, [_____]]]

SD-03 Product Data

Concrete Mix Design; G[, [_____]]
Rigid Proprietary Repair Products; G[, [_____]]
Polymeric Proprietary Repair Products; G[, [_____]]
Pigmented Liquid Membrane-Forming Compound; G[, [_____]]
Aggregate Service Record

SD-04 Samples

Absorbent Curing Material; G[, [_____]]
Joint Filler; G[, [_____]]
Joint Sealant; G[, [_____]]

SD-05 Design Data

Concrete Mix Design; G[, [_____]]

SD-06 Test Reports

Laboratory Test Results
Aggregate Gradation
Cement
Concrete Slump
Concrete Air Content
Concrete Compressive Strength (cylinder)
Mixer Calibration and Efficiency
Concrete Uniformity
Bond Strength
Polymeric Proprietary Repair Products; G[, [_____]]

SD-07 Certificates

Cement
Aggregate
Admixtures
Absorbent curing material
Pigmented Liquid Membrane-Forming Compound

Joint Filler
Joint Sealant

1.4 QUALITY ASSURANCE

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NOTE: Guidance for preparation of criteria to be used in inspection of laboratory facilities is contained in ASTM E329.
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1.4.1 Preconstruction Testing Of Materials

Submit proposed concrete mix design at least [30] [_____] days prior to placement. Provide mix design evaluation and certification by a Government approved engineering testing laboratory, and indicate the weight of each ingredient of the mixture, aggregate gradation, slump, air content, water-cement ratio, time of trafficking and 3-day and 28-day compressive strength test results. Include a complete list of materials including admixtures and applicable reference specifications. Place no concrete prior to Government approval of the proposed mix design. No deviation from the approved mix design is permitted without prior Contracting Officer approval.

Within 24 hours of physical completion of laboratory testing, submit copies of laboratory test results for Contracting Officer approval.

1.4.1.1 Cement

Test cement as prescribed in the referenced specification under which it is furnished. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specification.

1.4.1.2 Aggregate

Take aggregate gradation samples for laboratory testing in conformance with ASTM D75/D75M.

1.4.1.3 Proprietary Repair Products

At least 30 days before the repair material is used, submit certified copies of test results for the specific lots or batches to be used on the project, not more than 6 months old prior to use in the work.

Manufacturer's certifications may be submitted rather than laboratory test results for proprietary repair products. Include in the submittals details for substrate preparation, mixing, placing, finishing, curing and testing of the material, as applicable. Include a minimum of three case histories documenting the use of the product in a similar freeze-thaw environment and pavement condition. Certify compliance with the appropriate specification referenced herein. Place no materials without prior approval from the Contracting Officer.

1.4.2 Equipment; Approval, Maintenance, and Safety

Provide and use only dependable and well maintained equipment that is appropriate to accomplish the work specified. Allow sufficient time for assembly of equipment requiring such at the work site to permit thorough inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required prior to the start of work.

a. Submit volumetric mixer calibration and efficiency test results in accordance with the requirements of ASTM C685/C685M within 6 months of concrete placement. If applicable, submit concrete uniformity test data for the first load of the ready-mixed concrete to be used as the repair material.

b. Provide Safety Data Sheets (SDS) and Personal Protection Equipment (PPE) per 29 CFR 1910.

1.4.3 Shop Detail Drawings

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NOTE: Delete this paragraph if the project scope does not require detailed shop drawings and staging plans from the Contractor.

****

Submit detailed Shop Drawings conforming to AASHTO SDDP-1-OL.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Cement

Deliver cement in bulk or in suitable bags used for packaging cements and store in a manner to prevent absorption of moisture.

1.5.2 Aggregate

Deliver, handle, and store aggregates in a manner to avoid breakage, segregation, inter-mingling or contamination by foreign materials.

1.5.3 Other Materials

Deliver epoxy-resin, chemical admixtures and proprietary repair products to the site in such manner as to avoid damage or loss. Provide storage areas in a windowless and weatherproof, but ventilated, insulated noncombustible building, with provision nearby for conditioning the material to 20 to 30 degrees C 70 to 85 degrees F for a period of 48 hours prior to use. Keep the ambient temperature in the storage area no higher than 40 degrees C 100 degrees F.

1.6 Project/Site Conditions

Do not place concrete or other repair products when weather conditions detrimentally affect the quality of the finished product. Do not place concrete when the air temperature is below 5 degrees C 40 degrees F in the shade. When air temperature is likely to exceed 35 degrees C 90 degrees F, provide concrete having a temperature not exceeding 35 degrees C 90 degrees F when deposited. Keep the surface of placed concrete damp with a water fog until the approved curing medium is applied. Take similar precautions for placing other repair products, as directed by the product vendor's instructions. Do not place concrete or other repair products if the weather forecast indicates that the air temperature is expected to drop below 5 degrees C 40 degrees F over the next 7 days.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Coarse Aggregate

2.1.1.1 Composition

Provide coarse aggregate consisting of gravel, crushed gravel, crushed stone, or a combination thereof.

2.1.1.2 Quality

****

NOTE: Do not allow types of aggregate at locations where they have an unsatisfactory performance record. Specify aggregate to be washed in areas where deleterious substances are present and unsatisfactory performance has been observed.

If concrete is used for the repair, the concrete aggregates should be similar to aggregates in existing concrete pavement to ensure that there is thermal compatibility between the aggregate in the existing concrete pavement and the aggregate in the repair concrete.

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Provide aggregate , as delivered to the mixers, consisting of clean, hard, unweathered, and uncoated particles. Remove dust and other coatings from the coarse aggregate by adequate washing. Meet the requirements of ASTM C33/C33M, Class 5S. Provide aggregates with an abrasion loss, when tested in accordance with ASTM C131/C131M, not exceeding 40 percent; the maximum allowable percentage for clay lumps and friable particles is [1.5]

[_____] percent. Provide documentation of aggregate conforming to ASTM C136/C136M.

2.1.1.3 Particle Shape

Provide spherical or cubical shaped coarse aggregate particles. Remove all course aggregates with the largest dimension that is equal to or larger than three times the smallest dimension.

2.1.1.4 Gradation

****
NOTE: The spall repair depth should be a minimum of 50 mm 2 inches. The 13 mm 1/2 inch maximum nominal size for coarse aggregate specified below is suitable for 50 mm 2 inches deep spall repair areas.
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The maximum nominal size of the coarse aggregate is 13 mm 1/2 inch. Provide well graded coarse aggregate conforming to gradation size 7 in Table 3 of ASTM C33/C33M when tested in accordance with ASTM C136/C136M as delivered to the batching hoppers.

2.1.1.5 Alkali Silica Reactivity

****
NOTE: For small quantity patching projects, include the first paragraph and require the use of non-reactive aggregate.

For large quantity patching projects, include reference to Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDSand include the second paragraph cross-referencing ASR evaluation and mitigation testing.
****

[Evaluate and test coarse aggregate, to be used in all concrete, for alkali-silica reactivity in accordance with ASTM C1260. Provide aggregate with a measured expansion not exceeding 0.08 percent at 28 days when tested. Aggregates with test data indicating an expansion greater than 0.08 percent will be rejected.]

[Evaluate coarse aggregate in accordance with Section 32 13 14.13, paragraph: Alkali-Silica Reactivity, with mitigation of reactive aggregate in accordance with the referenced paragraph.]

For proprietary repair products, provide documentation from the supplier that the repair product combination with the aggregates selected will not exhibit alkali-silica reactivity.

2.1.2 Fine Aggregate

2.1.2.1 Composition

Provide fine aggregate consisting of either natural sand, manufactured sand, or a combination of natural and manufactured sand, and composed of

clean, hard, durable particles; conforming to Table 2 of ASTM C33/C33M.

2.1.2.2 Particle Shape

Ensure particles of the fine aggregate are generally spherical or cubical in shape.

2.1.2.3 Grading

Provide fine aggregate as delivered to the mixer conforming to the gradation in Table 1 of ASTM C33/C33M when tested in accordance with ASTM C136/C136M.

In addition, provide fine aggregate, as delivered to the mixer, with a fineness modulus of not less than 2.40 nor more than 2.90, when calculated in accordance with ASTM C136/C136M.

2.1.2.4 Alkali Silica Reactivity

Evaluate and test fine aggregate to be used in all concrete for alkali-silica reactivity in accordance with Paragraph ALKALI SILICA REACTIVITY.

2.1.3 Admixtures

2.1.3.1 Air-Entraining Admixtures

Provide air-entraining admixtures conforming to ASTM C260/C260M.

2.1.3.2 Chemical Admixtures

ASTM C494/C494M. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

2.1.4 Cement

****

NOTE: Specify type of portland cement to suit project requirement and location. Specify Type III cement only when pavements are expected to be returned to active service in excess of 24 hours and less than 3 calendar days. Specify type of cement, including low-alkali, to suit local aggregate conditions. Types of cements other than those bracketed may be specified provided the designer knows that they have a satisfactory service record in partial depth repairs.

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NOTE: In addition to portland cement, there are many types of cements, polymers, blends and modifications thereto, and other cementitious materials available for patching PCC. Some have performed very well in some cases but failed in others. Many are unusually sensitive to moisture, temperature conditions, mixing criteria, curing

techniques, quality of workmanship, or other critical processes. Some are suitable for use during cold weather. Many will develop a level of strength in excess of that needed for patching PCC pavements. Many are not as durable as PCC. Some have been introduced fairly recently and do not have a long term performance record. For patching PCC, most are less compatible, and more expensive than portland cement. Use of any of these materials will depend on the knowledge of the design engineer as well as project requirements and may necessitate significant modifications to this guide specification and attached details.

****

Provide portland cement conforming to ASTM C150/C150M, Type [_____]. Provide low alkali cement if the proposed fine or coarse aggregate are found to have greater than 0.08 percent expansion when tested in accordance with ASTM C1260, as per paragraph: Alkali Silica Reactivity.

2.1.4.1 Portland Cement ConcreteMix Design

****

NOTE: The required time for strength gain and compressive tests needs to be adjusted based on the maximum time available to return traffic to the repaired pavement. Pavement materials must reach the minimum required strength requirements within the time available to return traffic to the repaired pavement. Retain the bracketed time of testing, based on the length of time from finishing the placement, not to the initial set of the concrete, that best represents the time available before returning the area to traffic. The maximum interval for required compressive strength and testing is 3 days.

The minimum allowable compressive strength at the time of trafficking is 17.5 MPa 2,500 psi for roads, streets and parking areas and 20.7 MPa 3,000 psi for airfield pavements.

A list of materials that can meet the 2 hour cure time to return to traffic can be found on the approved material list on the Pavement Repair Material Certification Program web page at Blockedhttps://transportation.erdc.dren.mil/cacsites/TriService/pavement_rep

Delete the bracketed portion of the second paragraph for patching airfield pavements.

****

Design the concrete mixture to produce a minimum compressive strength of [17.5] [20.7] [____] MPa [2,500] [3,000] [____] psi at [2] [4] [24] [72] [___] hrs from the time the material is screeded and finished in the repair area and a minimum compressive strength of [31] [35] MPa [4,500] [5,000] psi at 28 days of age, determined in conformance with ASTM C39/C39M and ASTM C192/C192M, using standard 150 by 300 mm 6 by 12 inch cylinder specimens; and providing an air content by volume of [5] [6] [_____]

percent, plus or minus 1.5 percent, based on measurements made on concrete immediately after discharge from the mixer in conformance with ASTM C231/C231M.

The allowable range of slump is 13 to 50 mm 1/2 to 2 inches when tested in accordance with ASTM C143/C143M [except that maximum slump may be increased to 100 mm 4 inches when the Contractor has included an approved water-reducing, mid range, admixture conforming to ASTM C494/C494M in the mix design]. To minimize drying shrinkage, the maximum water-cement ratio by weight is limited to 0.45.

2.1.5 Curing Materials

****

NOTE: Use of curing material and curing type is dependent on the specific repair product used. Concrete and cementitious repair products must be cured using pigmented liquid membrane curing compound typically used for curing conventionally placed concrete pavement.

Polymer (epoxy) repair products will need to be cured as per the product vendor's instructions.

When time is critical and the curing time for concrete or cementitious repair material is not acceptable, specify use of rapid setting proprietary repair materials.

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2.1.5.1 Pigmented Liquid Membrane-Forming Compound

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NOTE: Delete reference to ASTM C309 when repairing airfield pavements. ASTM C309 may only be specified for repair of roads, streets, and parking areas only.

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Provide pigmented liquid membrane-forming compound conforming to COE CRD-C 300 [or ASTM C309].

2.1.6 Bonding-Agents

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NOTE: Bonding agents should be used only for proprietary repair materials that require their use. Use only bonding agents recommended by the manufacturer of the repair material. For concrete and cementitious repair materials, a saturated surface dry or damp contact area is sufficient and easier to manage under a range of ambient conditions. A grout scrub may be used on projects with slow setting materials placed in repair areas with irregular surfaces.

****

2.1.6.1 Epoxy-Resin

Provide two component epoxy-resin material formulated to meet the

requirements of ASTM C881/C881M, Type III, grade and class as approved, for use in bond coat applications and as a component of epoxy-resin concrete or mortar.

Mix epoxy-resin grout components in the proportions recommended by the manufacturer. Condition the components to 20 to 30 degrees C 70 to 85 degrees F for 48 hours prior to mixing. Mix the two epoxy components with a power-driven, explosion-proof stirring device in a metal or polyethylene container having a hemispherical bottom. Add the curing-agent component gradually to the epoxy-resin component with constant stirring until a uniform mixture is obtained. Stir such that the amount of entrained air is a minimum.

2.1.7 Joint Sealant

Provide joint sealant as [indicated on the drawings.] [as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVING.]

2.1.8 Joint Filler

Provide joint filler material conforming to ASTM D1751 or ASTM D1752, Type II[or 100 percent recycled material meeting ASTM D1752, subparagraphs 5.1 to 5.4].

2.1.9 Water

Test water that is not approved by Public Health authorities for domestic consumption in accordance with ASTM C1602/C1602M and only use water that meets the acceptance criteria of Table 1 or 2 of ASTM C1602/C1602M or provide documentation that the water does meet the acceptance criteria of Table 2 of ASTM C1602/C1602M.

2.1.10 RigidProprietary Repair Products

****

NOTE: The required time for strength gain and compressive tests needs to be adjusted based on the maximum time available to return traffic to the repaired pavement. Pavement materials must reach the minimum required strength requirements within the time available to return traffic to the repaired pavement. Retain the bracketed time of testing, based on the length of time from finishing, not the initial set of the concrete, that best represents the time available before returning the area to traffic. The maximum interval for required compressive and bond strength and testing is 3 days.

****

A rigid proprietary repair product is defined as a rigid material in its hardened state with an elastic modulus greater than 6,900 MPa 1,000,000 psi. For partial depth repairs do not extend the product with aggregates that are or can be retained on a 19 mm 3/4 inch sieve. Test the product in accordance with the following test series. Replicate each test on three specimens. Report all three results for each test and use the average value for comparison with the specification requirements. Report the curing conditions for each test type.

2.1.10.1 Compressive Strength

****
NOTE: The minimum allowable compressive strength at the time of trafficking is 17.5 MPa 2,500 psi for roads, streets and parking areas and 20.7 MPa 3,000 psi for airfield pavements.
****

Cast 75 by 150 mm 3 by 6 inch cylinder specimens in accordance with ASTM C192/C192M and test in accordance with ASTM C39/C39M, using bonded or unbonded caps, after [2] [4] [24] [72] [____] hours and 3 day curing period. Use only materials with a minimum compressive strength of [17.5] [20.7] MPa [2,500] [3,000] psi at the time traffic is returned to the repair.

2.1.10.2 Bond Strength

Cast 75 by 150 mm 3 by 6 inch cylinder specimens and test in accordance with ASTM C882/C882M. Cast the candidate material against a 30-degree wedge specimen consisting of the candidate material itself or an ordinary portland cement mixture. Test specimens, using bonded caps, after 1 day curing period. For a bond consisting of the candidate material bonded to OPC mortar, a minimum bond strength of 5,800 kPa 850 psi is required at 1 day of age. For a bond consisting of the candidate material bonded to itself, a minimum bond strength of 6,900 kPa 1,000 psi is required at 1 day of age.

2.1.10.3 Modulus of Elasticity

Cast 150 by 300 mm 6 by 12 inch cylinder specimens in accordance with ASTM C192/C192M and test in accordance with ASTM C469/C469M, using bonded caps, after 3 day curing period. A maximum chord modulus of elasticity of 27,600 MPa 4,000,000 psi is required at 3 days of age.

2.1.10.4 Coefficient of Thermal Expansion

Cast 25 by 25 by 250 mm 1 by 1 by 10-inches prismatic bar specimens and test in accordance with ASTM C531, after 3 days curing period. Use repair product with a coefficient not exceeding 11.6 by 10^{-6} mm per mm per degree C 7 by 10^{-6} inch per inch per degree F at 3 days of age. Also, determine the coefficient of thermal expansion of the existing pavement concrete by testing a core or by estimating based on material composition. Use a repair product with a coefficient of expansion within 20 percent of the coefficient of the existing pavement concrete.

2.1.10.5 Shrinkage Potential

Cast 330 mm I.D. by 406 mm O.D. by 150 mm 13 inch I.D. by 16 inch O.D. by 6 inch tall restrained toroidal specimens and test in accordance with ASTM C1581/C1581M. Start measuring strain after completion of casting. Use repair products with shrinkage not exceeding 40 microstrain is required at 14 days of age. No cracking is permitted at 28 days of age.

2.1.10.6 Freeze-Thaw Resistance

Use aggregate with a satisfactory service record in freezing and thawing environments of at least 5 years of sucessful service in three concrete paving projects. Provide aggregate service record certified by an

independent third party professional engineer, petrographer, or concrete materials engineer along with their resume. Otherwise, cast prismatic specimens in accordance with ASTM C192/C192M and test in accordance with ASTM C666/C666M, Procedure A. Begin freeze-thaw testing after specimens have been immersed in saturated lime-water for 3 days. Report the Durability Factor (DF) and the number of cycles to failure.

2.1.11 Polymeric Proprietary Repair Products

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NOTE: This specification does not address materials that require heating or melting for application. Polymeric materials may be selected for spall repair when rapid curing is necessary. Manufacturer-recommended cure times range from ten minutes to eight hours for most polymeric repair materials. Cure times are most often a function of environmental conditions, especially temperature, so cure times may vary from the laboratory to the field. Many materials require the application of a primer to the concrete surface before applying the repair material. Some repairs are designed to immediately follow the priming step, while some require that the primer coat be allowed to fully cure before repairing. Some polymeric repair materials comprise manufacturer supplied aggregates or fillers with the resin, others are designed to use local aggregates which must be acquired independently by the Contractor. Follow manufacturers' recommendations regarding aggregate selection and preparation.

****

Polymeric repair materials include epoxies, methacrylates, and urethanes with or without aggregate. Use only materials that have not reached the manufacturer's published shelf life for the material lot. Ship and store materials in areas with temperature, humidity, solar exposure and packaging integrity in accordance with manufacturer's recommendations. Use and apply primers, bond agents or bond adhesives, in accordance with manufacturer's recommendations. Procure, prepare and use aggregates and fillers in accordance with manufacturer's recommendations.

2.1.11.1 Chemical Reistance

Prepare two sets of three 51 mm 2-inch cubes cured at 23 Degrees C 73 Degrees F for seven days. Measure and weigh the specimens before submerging the test solvent, JP8 fuel at 66 Degrees C 150 Degrees F for 24 hours in accordance with ASTM C267 one set of three specimen. Test compressive strength of the other three specimens for comparison. Measure, test, record and report the weight change and loss of compressive strength. Use only materials that have less than or equal to a 20 percent reduction in the average compressive strength of the three immersed sample compared to the average compressive strength of the non-immersed samples. Use only materials that have a change in weight of 10 percent or less.

2.1.11.2 Compressive Strength

Determine, record and report the compressive strength of the material using procedures contained in ASTM C579. Prepare three sets of three

samples, one set per curing interval. Prepare the sample so that no sample dimension is less 51 mm 2 in or 5 times the maximum aggregate size. The maximum aggregate size is the smallest standard sieve size through which 100 percent or the aggregate will pass. Cure the samples at 23 Degrees C 73 Degrees F. Test the first set of specimens after a curing period of one hour and a second set after a curing period of four hours. Test the third set of samples at the manufacturer's published cure or trafficability time for the product at 23 Degrees C 73 Degrees F. Use only those materials which exceed 3,450 kPa 500 psi at the time of trafficking of the repair.

2.1.11.3 Flexural Strength and Modulus of Elasticity

Determine, record and report the Flexural strength and tangent modulus of elasticity of the material using procedures contained in ASTM C580 using three-point bending. Prepare three sets of three beam samples, one set per curing interval. Prepare the sample so that no sample dimension is less 51 mm 2 in or 5 times the maximum aggregate size. The maximum aggregate size is the smallest standard sieve size through which 100 percent of the aggregate will pass. Cure the samples at 23 Degrees C 73 Degrees F. Test the first set of specimens after a curing period of one hour and a second set after a curing period of four hours. Test the third set of samples at the manufacturer's published cure or trafficability time for the product at 23 Degrees C 73 Degrees F. Use only those materials with a flexural strength which exceeds 2,410 kPa 350 psi and a tangent modulus greater than 34.5 MPa 5,000 psi at the time of trafficking of the repair.

2.1.11.4 Bond Strength by Slant Shear

Test, determine, record and report the material bond strength using ASTM C882/C882M, with the following modification. In lieu of the specified testing using a layer of material sandwiched between two PCC dummies, prepare samples which contain one PCC dummy that represents half of the specimen with repair material use to produce the other half of the sample. Cast 75 by 150 mm 3 by 6 inch cylinder specimens by casting the polymeric repair material against a 30-degree wedge specimen consisting of an ordinary portland cement mixture. Prepare three sets of three cylinder samples, one set per curing interval. Cure the samples at 23 Degrees C 73 Degrees F. After curing, cap the cylinders according to ASTM C617/C617M. Test the composite cylinder in compression causing a shear failure at the bond line. Test one set of specimens after a curing period of four hours. Test another set after a curing period of 24 hours. Test the other set of samples at the manufacturer's published cure or trafficability time for the product at 23 Degrees C 73 Degrees F. Use only those materials with a calculated bond strength in excess of 3,450 kPa 500 psi at the time of traffic.

2.1.11.5 Thermal Compatibility

In accordance with ASTM C884/C884M, prepare two samples by first casting and curing for 28 days two PCC blocks, each measuring 305 mm x 305 mm x 76 mm 12 in x 12 in x 3 in. After 28 days of curing, apply an overlay of the repair material on each of these two PCC blocks measuring 13 mm 0.5 in thick. Cure each block for seven days at 23 Degrees C 73 Degrees F. Expose the composite specimens to five freeze–thaw cycles, each cycle consisting of exposure to -21 Degrees C -6 Degrees F for 24 hours then 23 Degrees C 73 Degrees F for 24 hours. Use only those materials that do not have any signs of delamination in either specimen.

2.1.11.6 Dynamic Mechanical Analysis (DMA)

Prepare three sample in accordance with ASTM D5023 using the largest samples that will fit in the test apparatus. Prepare the sample without aggregates if possible. Test, determine, record and report the change in Modulus of Elasticity as a function of temperature at intervals of 5 Degrees C 10 Degrees F . Report any melting of the repair material over the selected temperature range. Test the pavement repair material from -51 Degrees C to 204 Degrees C -60 Degrees F to 400 Degrees F. Use a sinusoidal three-point bending load on the specimen at a frequency of 0.1 second with a maximum strain of 0.01 percent. Increase the temperature linearly at a rate of 3 Degrees C per minute. Record the storage modulus (modulus of elasticity), loss modulus, and tangent delta as a function of temperature. Test the specimens after curing the specimens for seven days at 23 Degrees C 73 Degrees F. Report the temperature at which the storage modulus value decreases to 50 percent of the modulus value at 23 Degrees C 73 Degrees F. Report if the sample melts or combusts at temperatures less than or equal to 204 Degrees C 400 Degrees F. Use only materials which have 50 percent reduction in modulus at temperatures in excess of 66 Degrees C 150 Degrees F. Use only materials which do not melt or combust at temperatures less than or equal to 204 Degrees C 400 Degrees F.

2.1.12 Sand-Cement Mortar for Filling Small Popouts

Sand-cement mortars are not permitted for spall repair. For small popouts, an approved epoxy may the used as the repair material.

2.1.13 Reinforcement

Provide reinforcement as [indicated on the drawings][specified in Section 03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE].

PART 3 EXECUTION

3.1 PATCH MATERIAL SELECTION

Use Portland cement concrete (PCC) or approved proprietary product for repair areas more than 9,400 cubic centimeters 600 cubic inches in volume after unsound concrete is removed. Use Portland cement mortar for cavities between 850 and 9,400 cubic centimeters 50 and 600 cubic inches in size after unsound concrete is removed.

3.2 BATCHING, MIXING AND PROPORTIONING OF CONCRETE REPAIR MATERIAL

Provide facilities and equipment for the accurate measurement and control of each of the materials entering the concrete, mortar, and grout. Provide free access for the Contracting Officer to the batching and mixing plant at all times. Provide mixing equipment capable of combining the aggregate, cement, admixture, and water into a uniform mixture and discharging this mixture without segregation. The concrete mixing equipment is to meet the applicable requirements of ASTM C94/C94M.

The use of volumetric batching and continous mixing is acceptable, provided all operations are in accordance with ASTM C685/C685M.

3.2.1 Equipment

Assemble dependable and operable equipment, allowing time for thorough

inspection, calibration of weighing and measuring devices, adjustment of parts, and the making of any repairs that may be required prior to final approval and the commencement of work. Maintain the equipment in good working condition. Use only equipment that can ensure the water to cement ratio is within 2 percent of required.

3.2.2 Conveying

Convey concrete from mixer to repair area as rapidly as practible by methods which prevent segregation or loss of ingredients.

3.2.3 Facilities for Sampling

Provide facilities for readily obtaining representative samples of aggregate and concrete for test purposes. Furnish necessary platforms, tools, and equipment for obtaining samples.

3.2.4 Concrete Mix Proportions

Use proportions of concrete materials entering into the concrete mixture in accordance with the approved mix design. Revise the mix design whenever necessary to maintain the workability, strength, and standard of quality required, and to meet the varying conditions encountered during the construction; however, make no changes without prior approval. The water to cement ratio cannot exceed 0.45 at any time.

3.2.5 Measurement

Provide equipment necessary to measure and control the amount of each material in each batch of concrete. Weigh bulk cement. Cement in unopened bags as packed by the manufacturer may be used without weighing. One bag of portland cement is considered as weighing 42.64 kg 94 pounds.

Measure mixing water and air-entraining admixtures by volume or by weight. Consider one liter gallon of water as weighing 1 kg 8.33 pounds.

Use only equipment, sensors and measurement controls that ensure the water to cement ratio is accurately controlled within 2 percent of required.

3.2.6 Workability

Maintain the slump of the concrete at the lowest practicable value, not exceeding the value specified in Paragraph PORTLAND CEMENT CONCRETE MIX DESIGN or the manufacturer's recommendation when proprietary repair materials are used.

3.3 PREPARATION OF EXISTING PAVEMENT

****

NOTE: Airfield projects require full depth repairs in accordance with Section 32 13 14.13 CONCRETE PAVING FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS. For projects other than airfields, full depth repairs should be requied as specified in Section 32 13 13.06 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES.

****

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NOTE: Specify minimum depth of removal of existing PCC. A 50 mm 2 inch minimum depth is usually satisfactory and should be specified, except where local conditions indicate 50 mm 2 inch thick shallow patches have an unsatisfactory service record. When required depth of repair is known or reasonably expected to exceed one-half the pavement thickness, full depth repairs should be required.

****

3.3.1 Preparation of Existing Surfaces

In the area to be patched, [except popouts,] remove existing concrete to a minimum depth of [50] [_____] mm [2] [_____] inches below the pavement surface adjacent to spalls and to such additional depth where necessary to expose a surface of sound, unweathered, and non-delaminated concrete that is not contaminated by sealants, oils, greases, or deicing salts or solutions. Make a vertical perimeter saw cut at least 50 mm 2 inches deep and at least 50 mm 2 inches outside of the area needing repair. Accomplish concrete removal in spalled areas with light, hand-held, high-frequency chipping hammers weighing not more than 14 kg 30 pounds or other approved hand tools. Do not use jack hammers weighing more than 14 kg 30 pounds and do not use pavement breaker devices mounted on or pulled by mobile equipment. Use of milling devices such as a cold planer are allowed but require augmentation with concrete saws and jack hammers to generate the required vertical surfaces on edges of the repair which are milled at the curvature of the drum.

Clean the repair area surface by [sandblasting] [waterblasting], blowing with compressed air, sweeping, and vacuums. Use [sandblasting] [waterblasting] to remove all traces of sealer, oils, grease, rust, and other contaminants.

3.3.2 Reinforcement

****

NOTE: Dowel bars and tie bars are typically located at mid-depth of the slab. If unsound concrete extends to the depth of the dowel bars or tie bars, perform full-depth repairs at these locations.

****

Clean to bare metal by sandblasting any existing reinforcement exposed in the repair area. Remove any reinforcement that cannot be properly re-embedded in the new repair concrete. Cut and remove at the joint not less than 50 mm 2 inches of existing exposed reinforcement that is continuous through the repair area and is embedded in the adjacent slab.

3.3.3 Preparation of Joints Adjacent to Spalls

Remove existing joint sealing and joint filler materials. Saw as indicated and install insert board, cut to appropriate dimensions, to prevent contact between new patch material and existing concrete at the adjacent joint face. Use insert board with a thickness equal to or slightly larger than the joint width (groove) adjacent to the repair material, as indicated on the drawings. Install a bead of approved caulking material to preclude new patching material from getting around insert and into the joint from the sides and bottom of the insert. Clean up any caulking material accidentally deposited on the prepared spall

surface. Repair any sawcut overcuts with an approved epoxy repair material.

3.3.4 Disposal of Debris

****
NOTE: Specify location of disposal of debris.
****

Sweep pavement surface to remove excess joint material, dirt, water, sand, and other debris using vacuum sweepers or hand brooms. Remove the debris immediately [to a point off station.] [to an area designated by the Contracting Officer.] [in accordance with Section 02 41 00 [DEMOLITION] [AND] [DECONSTRUCTION].]

3.3.5 Bonding Agent, Adhesive or Coat

****
NOTE: Epoxy-resin bond coats should be limited to patches less than 600 mm 2 feet square. For proprietary patching products, prepare the substrate in accordance with the manufacturer's recommendations.
****

Prior to placing concrete, wash the previously prepared surfaces with a high pressure water jet followed by an air jet to remove free water on the repair surface.

3.3.5.1 Epoxy-Resin

Limit epoxy-resin bonding coat to use on patches with a surface area of less than 600 mm 2 feet square. Coat the clean and dry surface, including sawed faces, with a 0.02 to 0.04 mm 20 to 40 mil thick film of the epoxy-resin bonding coat Place the epoxy-resin bonding coat in one application, just prior to concrete placement, with the use of mechanical combination, mixing and spraying equipment, or two coat application with stiff brushes. Scrub the first brush coat into the concrete surface, followed by an additional brush coat to obtain the required thickness. Apply the final coat just prior to placement of the concrete.

3.3.5.2 Proprietary Repair Products

Apply in accordance with the manufacturer's written instructions.

3.3.6 Popout Repair

****
NOTE: Delete this paragraph if no popout repairs are included in the project. Note the first sentence for definition of popouts.

Delete the bracketed statements containing "sand-cement " and "chipping" for airfield projects, and specify overcoring surface defects in concrete. Overcoring refers to coring a hole around the popout that is at least 50 mm 2 inches in diameter wider

than the popout, centered on the popout and that is at least 25 mm 1 inch deeper than the popout or 50 mm 2 inches deep, whichever is deeper.

When the time to return to traffic is less than 12 hours normal concrete mixes will not likely meet mission requirements and the use of approved proprietary repair materials, including epoxy materials, should be considered. When repairs must be made in temperatures below 45 degrees F and above 90 degrees F the use of approved proprietary repair materials, including epoxy materials designed for use in the prevailing weather conditions at placement, should be considered. Epoxy materials should not be considered for repairs in excess of 4 square feet.

****

Popouts, as used herein, are pavement surface defects caused by deterioration of unsatisfactory coarse aggregate, decaying of organic material such as wood or roots, mechanical accidents, or other reasons. Most popouts are indicated on the drawings by average diameter but the actual surface configuration will vary from circular to polygonal. Repair popouts as indicated using [epoxy mortar] [approved proprietary repair material]. Clean popout cavities of all dirt and contaminants prior to filling. As indicated on drawings, prepare popout areas by [chipping] [overcoring surface defects in] the concrete to eliminate feather edging of the mortar or concrete repair material. Core out the distressed areas at least 50 mm 2 inches deep or 25 mm 1 inch below the depth of the popout.

3.4 PLACING

3.4.1 Portland Cement Concrete

****

NOTE: Specify placing time to suit concrete materials and environmental conditions. For most projects, 90 minutes from the time of initial mixing is adequate. However, during hot weather when daytime temperatures exceed 85 degrees F, specifiy 45 minutes.

****

Place concrete within [45] [90] minutes after the introduction of the mixing water to the cement and aggregate or the introduction of the cement to the aggregate and before the concrete has obtained its initial set. The temperature of the concrete, as deposited in the repair area, can not be not less than 10 degrees C 50 degrees F nor more than 32 degrees C 90 degrees F. Deposit concrete as to require a minimum of re-handling and in such a manner so as to least disturb the sand-cement grout. Place concrete as indicated to maintain existing joints [and working cracks]. Use an insert or other bond-breaking medium where the spalled area abuts a joint to prevent bond at the joint face and to allow movement of the slabs and to prevent stress concentrations. Do not allow new repair material to infiltrate or span existing joints [and cracks] indicated to remain. Place concrete continuously in each spall area. Do not allow workmen to walk on the damp repair surface or in the concrete during placing and finishing operations.

Consolidate the concrete by small spud vibrators not greater than 25 mm one inch in diameter, except that repair areas less than 100 mm 4 inches deep or 0.093 square meter one square foot in area may be consolidated by hand tamping or other approved means. To avoid pulling material away from patch edge and to maximize bond strength, work the finishing screed from the center of the patch out to the patch boundary. Fill all saw kerfs extending beyond the repair area with grout. Start finishing operations immediately after placement of the concrete. Match finished surface grade of patched areas to the existing surface grade of the adjacent undisturbed pavement. Keep screeding, floating, or troweling of patch material onto adjacent pavements to a minimum and remove loose or poorly bonded patch material from adjacent surfaces. Before the concrete becomes non-plastic, finish the surface with a [broom] [burlap drag] [_____] to approximately match the surface finish of existing adjacent concrete pavement. Remove repair materials for surfaces adjacent to but outside the repair surface.

[Popouts and spalls, both with a maximum dimension less than 150 mm 6 inches, and not within 100 mm 4 inches of a joint or working crack, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.]

3.4.2 Epoxy-Resin Concrete and Mortar

Limit epoxy-resin bonding coat to use on patches with a surface area of less than 600 mm 2 feet square. Place the epoxy resin materials in layers not over 50 mm 2 inches thick. Make the time interval between placement of additional layers such that the temperature of the epoxy resin material does not exceed 60 degrees C 140 degrees F at any time during hardening. Use mechanical vibrators and hand tampers to consolidate the concrete or mortar. Remove any repair material on the surrounding surfaces of the existing concrete before it hardens.

Place the repair material as indicated to maintain existing joints [and working cracks]. Use an insert or other bond-breaking medium where the spalled area abuts a joint to prevent bond at the joint face. Do not allow new repair material to infiltrate or span existing joints [and cracks] indicated to remain. Place the repair material continously in each spall area. Finish the repair material to match the grade of the adjacent concrete surface.

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. Repair the core hole as specified above for other spalls.

3.4.3 Proprietary Repair Products

Perform placing, consolidating, finishing, and curing operations in accordance with the manufacturer's written instructions.

Place the repair material as indicated to maintain existing joints [and working cracks]. Use an insert or other bond-breaking medium where the spalled area abuts a joint to prevent bond at the joint face. Do not allow new repair material to infiltrate or span existing joints [and cracks]. Place the repair material continuously in each spall area. Finish the repair material to match the grade of the adjacent concrete

surface.

3.5 CURING

****
NOTE: A minimum curing time of 3 days is required when Type I or Type II cements are used.
****

Cure the repair concrete by protection against loss of moisture and rapid temperature changes for a period of not less than [3] [_____] days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. Provide all equipment needed for adequate curing and protection of the concrete on hand and ready to install before actual concrete placement begins. Cure proprietary repair products in accordance with manufacturer's recommendations. Failure to comply with curing requirements will be cause for immediate suspension of concreting operations.

3.5.1 Membrane-Forming Curing Compound

Apply membrane -forming curing compound immediately to exposed concrete surfaces. Apply the curing compound with an overlapping coverage that will give a two-coat application at a coverage of not more than 20 square m/L 200 square feet per gallon for both coats. When application is made by hand-operated sprayers, apply the second coat in a direction approximately at right angles to the first coat.

Cure concrete properly at joints, but do not allow absorbent curing compound to enter joints that are to be sealed with a joint-sealing compounds. Provide a uniform, continuous, cohesive compound film that will not check, crack, or peel, and that will be free from pinholes and other imperfections. Respray concrete surfaces that are subjected to heavy rainfall within 3 hours after the curing compound has been applied at the coverage specified above and at no additional cost to the Government. Respray areas covered with absorbent curing material that are damaged by pedestrian and vehicular traffic or by subsequent construction operations within the specified curing period at no additional cost to the Government.

3.6 JOINT RE-ESTABLISHMENT

For joint spall repairs, after the repair material has cured, saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean and seal the reservoir with the sealer and backer rod specified for the joints. Construct new joints as detailed on the drawings and align with existing joints.

3.7 FINISH TOLERANCE

Provide finished surfaces of patched areas meeting the grade of the adjoining pavements without deviations more than 3 mm 1/8 inch from a true plan surface within the patched area or at the interface with the adjoining pavement.

3.8 REPAIR AREA PROTECTION

Protect the patched areas against damage prior to final acceptance of the work by the Government. Exclude traffic from the patched areas by

erecting and maintaining barricades and signs until the completion of the curing period of the concrete or the curing period of proprietary repair products as per the manufacturer's instructions.

3.9 FIELD QUALITY CONTROL

3.9.1 General Requirements

Test proprietary products in accordance with the manufacturer's written instructions.

3.9.2 Testing for Strength, Slump, and Air Content

Sample concrete in the field and test to determine the slump, air content, and strength of the concrete.

Make cylinders for each shift of placed concrete. Mold each group of test cylinders from the same batch of concrete, consisting of a sufficient number of specimens to provide two compressive-strength tests at each test age. Make one group of specimens during the first half of the shift, and the other during the last portion of the shift. However, at the start of paving operations and each time the aggregate source, aggregate characteristic, or mix design is changed, make one additional set of test cylinders. Mold and cure test cylinders at the site for the first 24 hours or until the testing is required if less than 24 hours of curing is required and later in the laboratory in conformance with ASTM C31/C31M. Test cylinders in accordance with ASTM C39/C39M.

Determine the air content and slump in accordance with ASTM C231/C231M and ASTM C143/C143M, respectively.

3.9.2.1 Test Results

Remove concrete not meeting strength, consistency, and air content requirements and provide concrete that meets the requirements of this specification. The removal and replacement method or methods are subject to approval of the Contracting Officer.

3.9.2.2 Acceptance

Within 30 days of spall repair or prior to final acceptance, any spall repair material that cracks, or delaminates, or loses bond partly or completely as indicated by soundings, or causes spalling of adjacent portland cement concrete, or is not separated properly from adjacent slabs at joints, or fails to cure uniformly and completely, or is otherwise defective will be rejected by the Government.

Remove all unacceptable repairs, including new damaged areas adjacent to new spall patches, and provide new repairs meeting the specifications.

-- End of Section --