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USACE / NAVFAC / AFCEC

UFGS-32 01 29.61 (May 2017)

Change 1 - 08/17

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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 April 2024

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### SECTION 32 01 29.61

#### PARTIAL DEPTH PATCHING OF RIGID PAVING 05/17, CHG 1: 08/17

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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 \(CCR\)](#).

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## 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](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**, 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 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.

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##### 1.1.1 Measurement

The quantity of concrete and proprietary repair products to be paid for is the number of cubic meters 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 (2025a) Standard Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C33/C33M (2024a) Standard Specification for Concrete Aggregates

ASTM C39/C39M (2024) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

ASTM C94/C94M (2025) 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	(2024) Standard Specification for Portland Cement
ASTM C192/C192M	(2024) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C231/C231M	(2024) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260/C260M	(2024) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C469/C469M	(2022) Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C494/C494M	(2024) Standard Specification for Chemical Admixtures for Concrete
ASTM C531	(2018; R 2023) Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing, and Polymer Concretes
ASTM C666/C666M	(2015) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685/C685M	(2024) 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	(2024) Standard Test Method for Bond Strength of Bonding Systems Used With Concrete by Slant Shear
ASTM C1260	(2023) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1581/C1581M	(2024) Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage

ASTM C1602/C1602M (2022) Standard Specification for Mixing  
Water Used in Production of Hydraulic  
Cement Concrete

ASTM D75/D75M (2019) Standard Practice for Sampling  
Aggregates

ASTM D1751 (2018) Standard Specification for  
Preformed Expansion Joint Filler for  
Concrete Paving and Structural  
Construction (Nonextruding and Resilient  
Bituminous Types)

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

KOREAN INDUSTRIAL STANDARDS (KS)

KS F 2402 (2022) Test Method for Concrete Slump

KS F 2403 (2019; R 2024) Standard Test Method for  
Making Concrete Specimens

KS F 2405 (2022) Test Method for Compressive  
Strength of Concrete

KS F 2421 (2016; R 2021) Method of Test for Air  
Content of Fresh Concrete by Pressure  
Method

KS F 2438 (2017; R 2022) Test method for static  
modulus of elasticity and Poission's ratio  
in compression of cylindrical concrete  
specimens

KS F 2456 (2013; R 2023) Standard test method for  
resistance of concrete to rapid freezing  
and thawing

KS F 2501 (2017; R 2022) Standard Test Method for  
Sampling Aggregates

KS F 2502 (2019; R 2024) Standard Test Method for  
Sieve Analysis of Aggregates

KS F 2508 (2007; R 2022) Standard test method for  
resistance to abrasion of coarse aggregate  
by use of the Los Angeles machine

KS F 2527 (2024) Aggregates for Concrete

KS F 2538 (2021) Standard Specifications for  
Preformed Expansion Joint Fillers for



Concrete Paving and Structural Construction

KS F 2546	(2024) Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
KS F 2560	(2019; R 2024) Chemical Admixtures for Concrete
KS F 4009	(2024) Ready-Mixed Concrete
KS L 5201	(2021) Portland Cement

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 and Air Force 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 and Air Force projects, or choose the second bracketed item for Army projects.

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Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for 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

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

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](#) or [KS F 2501](#).

##### 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.**  
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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** for a period of 48 hours prior to use. Keep the ambient temperature in the storage area no higher than **40 degrees C**.

#### 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** in the shade. When air temperature is likely to exceed **35 degrees C**, provide concrete having a temperature not exceeding **35 degrees C** 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** 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

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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 or KS F 2527. Provide aggregates with an abrasion loss, when tested in accordance with ASTM C131/C131M or KS F 2508, 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 or KS F 2502.

2.1.1.3 Particle Shape

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

2.1.1.4 Gradation

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NOTE: The spall repair depth should be a minimum of 50 mm. The 13 mm 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. Provide well graded coarse aggregate conforming to gradation size 7 in Table 3 of ASTM C33/C33M or KS F 2527 when tested in accordance with ASTM C136/C136M or KS F 2502 as delivered to the batching hoppers.

#### 2.1.1.5 Alkali Silica Reactivity

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**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 PAVEMENT FOR AIRFIELDS AND OTHER HEAVY-DUTY PAVEMENTS. Sand include the second paragraph cross-referencing ASR evaluation and mitigation testing.**

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[Evaluate and test coarse aggregate, to be used in all concrete, for alkali-silica reactivity in accordance with [ASTM C1260](#) or [KS F 2546](#). 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] [32 13 14.14], 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](#) or [KS F 2527](#).

##### 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](#) or [KS F 2527](#) when tested in accordance with [ASTM C136/C136M](#) or [KS F 2502](#).

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](#) or [KS F 2502](#).

##### 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 or KS F 2560.

#### 2.1.3.2 Chemical Admixtures

ASTM C494/C494M or KS F 2560. Where not shown or specified, the use of admixtures is subject to written approval of the Contracting Officer.

#### 2.1.4 Cement

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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.  
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Provide portland cement conforming to ASTM C150/C150M or KS L 5201, Type I or II. [Provide Type III cement only in the following locations with Contracting Officer's approval.] 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 or KS F 2546, as per paragraph: Alkali Silica Reactivity.

#### 2.1.4.1 Portland Cement Concrete Mix Design

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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 for roads, streets and parking areas and 20.7 MPa 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\\_repair](https://transportation.erdc.dren.mil/cacsites/TriService/pavement_repair)

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

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Design the concrete mixture to produce a minimum compressive strength of [17.5] [20.7] [\_\_\_\_] MPa at 72 hrs from the time the material is screeded and finished in the repair area and a minimum compressive strength of 35 MPa at 28 days of age, determined in conformance with ASTM C39/C39M or KS F 2405 and ASTM C192/C192M or KS F 2403, using standard 150 by 300 mm cylinder specimens; and providing an air content by volume of 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 or KS F 2421.

The allowable range of slump is 13 to 50 mm when tested in accordance with ASTM C143/C143M or KS F 2402 except that maximum slump may be increased to 100 mm when the Contractor has included an approved water-reducing, mid range, admixture conforming to ASTM C494/C494M or KS F 2560 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

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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.

\*\*\*\*\*

Provide pigmented liquid membrane-forming compound conforming to COE CRD-C 300.

#### 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 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.] [and] [as specified in Section 32 01 19.61 SEALING OF JOINTS IN RIGID PAVING.] [as specified in Section 32 13 73.19 COMPRESSION CONCRETE PAVING JOINT SEALANT.]

#### 2.1.1.8 Joint Filler

Provide joint filler material conforming to ASTM D1751 or KS F 2538.

#### 2.1.1.9 Water

Test water that is not approved by Public Health authorities for domestic consumption in accordance with ASTM C1602/C1602M or KS F 4009 and only use water that meets the acceptance criteria of Table 1 or 2 of ASTM C1602/C1602M or KS F 4009 or provide documentation that the water does meet the acceptance criteria of Table 2 of ASTM C1602/C1602M or KS F 4009.

#### 2.1.1.10 Rigid Proprietary 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. For partial depth repairs do not extend the product with aggregates that are or can be retained on a 19 mm 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

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

\*\*\*\*\*

Cast 75 by 150 mm cylinder specimens in accordance with ASTM C192/C192M or KS F 2403 and test in accordance with ASTM C39/C39M or KS F 2405, using bonded or unbonded caps, after 3 day curing period. Use only materials with a minimum compressive strength of [17.5] [20.7] MPa at the time traffic is returned to the repair.

##### 2.1.10.2 Bond Strength

Cast 75 by 150 mm 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 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 is required at 1 day of age.

#### 2.1.10.3 Modulus of Elasticity

Cast 150 by 300 mm cylinder specimens in accordance with ASTM C192/C192M or KS F 2403 and test in accordance with ASTM C469/C469M or KS F 2438, using bonded caps, after 3 day curing period. A maximum chord modulus of elasticity of 27,600 MPa is required at 3 days of age.

#### 2.1.10.4 Coefficient of Thermal Expansion

Cast 25 by 25 by 250 mm 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 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 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 successful 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 or KS F 2403 and test in accordance with ASTM C666/C666M, Procedure A or KS F 2456. 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 Sand-Cement Mortar for Filling Small Popouts

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

#### 2.1.12 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 in volume after unsound concrete is removed. Use Portland cement mortar for cavities between 850 and 9,400 cubic centimeters 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 or KS F 4009.

The use of volumetric batching and continuous 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 practicable 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.

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

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] [Section 32 13 14.14 CONCRETE PAVING FOR SMALL AIRFIELD PROJECTS]. For projects other than airfields, full depth repairs should be required 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 minimum depth is usually satisfactory and should be specified, except where local conditions indicate 50 mm 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, remove existing concrete to a minimum depth of 50 mm 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 deep and at least 50 mm 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 or other approved hand tools. Do not use jack hammers weighing more than 14 kg 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 waterblasting, blowing with compressed air, sweeping, and vacuums. Use 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 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**

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**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 in accordance with Section 02 41 00 DEMOLITION .

**3.3.5 Bonding Agent, Adhesive or Coat**

\*\*\*\*\*

**NOTE: Epoxy-resin bond coats should be limited to patches less than 600 mm 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 square. Coat the clean and dry surface, including sawed faces, with a 0.02 to 0.04 mm 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 in diameter wider than the popout, centered on the popout and that is at least 25 mm deeper than the popout or 50 mm 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 or approved proprietary repair material. Clean popout cavities of all dirt and contaminants prior to filling. As indicated on drawings, prepare popout areas by chipping or 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 deep or 25 mm below the depth of the popout.

## 3.4 PLACING

### 3.4.1 Portland Cement Concrete

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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, specify 45 minutes.

\*\*\*\*\*

Place concrete within 45 minutes during hot weather when daytime temperatures exceed 29 degrees C and 90 minutes during weather when daytime temperatures equal or less than 29 degrees C 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 nor more than 32 degrees C. 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 in diameter, except that repair areas less than 100 mm deep or 0.093 square meter 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 or 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, and not within 100 mm of a joint or working crack, may be prepared by drilling a core 50 mm in diameter greater than the size of the defect, centered over the defect, and 50 mm deep or 13 mm 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 square. Place the epoxy resin materials in layers not over 50 mm 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 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 continuously 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 in maximum dimension, may be prepared by drilling a core 50 mm in diameter greater than the size of the defect, centered over the defect, and 50 mm deep or 13 mm 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. [When type III cement is applied, the curing period must be adjusted with Contracting Officer's approval.] 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 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 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](#) or [KS F 2403](#). Test cylinders in accordance with [ASTM C39/C39M](#) or [KS F 2405](#).

Determine the air content and slump in accordance with [ASTM C231/C231M](#) or [KS F 2421](#) and [ASTM C143/C143M](#) or [KS F 2402](#), 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 --