
USACE / NAVFAC / AFCEA / NASA UFGS-32 01 29.61 (November 2008)

Preparing Activity: USACE Superseding
UFGS-32 01 28 (April 2008)
UFGS-32 01 29.61 (January 2008)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated October 2010

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SECTION 32 01 29.61

PARTIAL DEPTH PATCHING OF RIGID PAVING 11/08

NOTE: This guide specification covers the requirements for partial depth patching of rigid paving.

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

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

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

NOTE: TO DOWNLOAD UFGS GRAPHICS

Go to <http://www.wbdg.org/ccb/NAVGRAPH/graphtoc.pdf>.

PART 1 GENERAL

NOTE: This specification is not intended for repair of heat resistant concrete pavements, or for rapid repair of PCC that must be returned to service in a short time. See second note in paragraph entitled "Cement." 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.

NOTE: For full-depth patches or slab removal and

replacement of airfield pavements, use Section
32 13 11 - CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER
HEAVY DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDS or
Section 32 13 11 CONCRETE PAVEMENT FOR AIRFIELDS AND
OTHER HEAVY-DUTY PAVEMENTS.

To review UFC 3-270-03 (15 March 2001), "Concrete
Crack and Partial-Depth Spall Repair" for drawings,
details and illustrations, go to
http://www.wbdg.org/ccb/DOD/UFC/ufc_3_270_03.pdf.

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

1. Plans showing layout and identification of each 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 repairs are needed.
2. Show approximate location, length and width of each spall and location and size (usually average diameter) of each popout. Dimensions of spalls and popouts need not be to scale. Identify by legend and symbol whether spall repair needed is approximately rectangular 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 3-270-03 and AASHTO SDDP-1 for suggested details to be included on project drawings. Note that these sketches include the required 50 mm 2 inch minimum horizontal clearance of unsound concrete in the length and width dimensions shown.
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 hollows. It is not unusual for delamination in a spall area to extend well beyond that visually obvious. Each previous partial depth patch should also be sounded for present condition.

[1.1 UNIT PRICES

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

1.1.1.1 Concrete

The quantity of concrete to be paid for is the number of square **meters feet** placed in the completed and accepted patched areas.

1.1.1.2 Proprietary Cementitious Products

The quantity of proprietary cementitious product to be paid for is the number of square **meters feet** placed in the completed and accepted patched areas.

1.1.2 Payment

1.1.2.1 Concrete

The quantity of concrete, 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.

1.1.2.2 Proprietary Cementitious Products

The quantity of proprietary cementitious product, 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

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

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

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

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

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
(AASHTO)

AASHTO M 182 (2009) Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

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

ASTM INTERNATIONAL (ASTM)

ASTM C 1059/C 1059M (1999; R 2008) Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete

ASTM C 1260 (2007) Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

ASTM C 131 (2006) Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine

ASTM C 136 (2006) Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM C 143/C 143M (2010) Standard Test Method for Slump of Hydraulic-Cement Concrete

ASTM C 150/C 150M (2009) Standard Specification for Portland Cement

ASTM C 1581/C 1581M (2009a) Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage

ASTM C 1602/C 1602M (2006) Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete

ASTM C 171 (2007) Standard Specification for Sheet Materials for Curing Concrete

ASTM C 173/C 173M (2010a) Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method

ASTM C 192/C 192M (2007) Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

ASTM C 231	(2009b) Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	(2006) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 309	(2007) Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C 31/C 31M	(2009) Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33/C 33M	(2008) Standard Specification for Concrete Aggregates
ASTM C 39/C 39M	(2009a) Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 469	(2002e1) Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression
ASTM C 494/C 494M	(2010) Standard Specification for Chemical Admixtures for Concrete
ASTM C 531	(2000; R 2005) Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing, and Polymer Concretes
ASTM C 666/C 666M	(2003; R 2008) Resistance of Concrete to Rapid Freezing and Thawing
ASTM C 685/C 685M	(2010) Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C 881/C 881M	(2002) Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C 882/C 882M	(2005e1) Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear
ASTM C 94/C 94M	(2009a) Standard Specification for Ready-Mixed Concrete
ASTM D 1751	(2004; R 2008) Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 1752	(2004a; R 2008) Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion

ASTM D 75/D 75M

(2009) Standard Practice for Sampling
Aggregates

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

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

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

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

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

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

SD-02 Shop Drawings

[Shop Drawings[; G][; G, [____]]]

SD-03 Product Data

Mix Design[; G][; G, [_____]]

Proprietary Cementitious Products[; G][; G, [_____]]

pigmented liquid membrane-forming compound[; G][; G, [_____]]

SD-04 Samples

Absorbent curing material[; G][; G, [_____]]

Joint filler[; G][; G, [_____]]

[Joint sealant[; G][; G, [_____]]]

SD-05 Design Data

Concrete Mix Design[; G][; G, [_____]]

SD-06 Test Reports

Laboratory Test Results[; G][; G, [_____]]

Aggregates gradation[; G][; G, [_____]]

Cement[; G][; G, [_____]]

Concrete slump[; G][; G, [_____]]

Concrete air content[; G][; G, [_____]]

Concrete strength (cylinder)[; G][; G, [_____]]

mixer calibration and efficiency[; G][; G, [_____]]

SD-07 Certificates

Cement[; G][; G, [_____]]

Aggregate[; G][; G, [_____]]

Admixtures[; G][; G, [_____]]

Absorbent curing material[; G][; G, [_____]]

pigmented liquid membrane-forming compound[; G][; G, [_____]]

Waterproof Sheet[; G][; G, [_____]]

Joint filler[; G][; G, [_____]]

[Joint sealant[; G][; G, [_____]]]

1.4 QUALITY ASSURANCE

NOTE: Guidance for preparation of criteria to be

used in inspection of laboratory facilities is
contained in ASTM E 329.

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 an approved engineering testing laboratory, and indicate the weight of each ingredient of the mixture, aggregate gradation, slump, air content, water-cement ratio, and 7-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 approval of the proposed mix design. No deviation from the approved mix design is permitted without prior approval.

Within 24 hours of physical completion of laboratory testing, submit copies of [test results](#) for 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 D 75/D 75M](#).

1.4.1.3 Proprietary Cementitious Products and Epoxy

At least 30 days before the material is used, submit certified copies of test results for the specific lots or batches to be used on the project, 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 cementitious products. Include in the instructions details for substrate preparation, mixing, placing, finishing, curing and testing of the material. Include a minimum of three case histories documenting the use of the product in a similar freeze-thaw environment and airfield 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.

Submit volumetric [mixer calibration and efficiency](#) test results. Results must be current within 6 months of concrete placement.

Provide Material Safety Data Sheets (MSDS) and Personal Protection Equipment (PPE) per [29 CFR 1910](#).

1.4.3 Shop Detail Drawings

**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 aggregate in a manner to avoid breakage, segregation, or contamination by foreign materials.

1.5.3 Other Materials

Deliver epoxy-resin, chemical admixtures and proprietary cementitious 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 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.

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 or organic impurities are a problem.

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 C 33/C 33M](#), Class 4S for deleterious substances. Abrasion loss, when tested in accordance with [ASTM C 131](#), must not exceed 40 percent; the maximum allowable percentage for clay lumps and friable particles is [1.5] [_____] percent. Provide documentation of aggregate conforming to ASTM C 136.

2.1.1.3 Particle Shape

Provide spherical or cubical shaped coarse aggregate particles.

2.1.1.4 Gradation

NOTE: The 19 mm 3/4 inch nominal maximum dimension for coarse aggregate specified below may be excessive for shallow spalls. If the project contains numerous shallow depth 50 mm 2 inch spalls, the designer should specify a suitable gradation based on locally available aggregate.

The maximum nominal size of the coarse aggregate is 13 mm 1/2 inch. Provide well graded coarse aggregate, within the limits specified, and tested in accordance with [ASTM C 136](#), and conforming to the following grading requirements as delivered to the batching hoppers:

Sieve designation U.S. Standard square mesh	Percentage by weight passing individual sieves 4.75 mm to 12.5 mm
19.0 mm	100
12.5 mm	90-100
9.5 mm	40-70
4.75 mm	0-15
2.36 mm	0-5
Sieve designation U.S. Standard square mesh	Percentage by weight passing individual sieves No. 4 to 1/2 inch
3/4 inch	100
1/2 inch	90-100
3/8 inch	40-70
No. 4	0-15
No. 8	0-5

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 Section 32 13 11 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER HEAVY DUTY PAVEMENTS MORE THAN 10,000 CUBIC YARDS and 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 C 1260. Measured expansion must not exceed 0.08 percent at 28 days when tested. Test data indicating an expansion greater than 0.08 percent will be rejected.]

[Evaluate coarse aggregate in accordance with Section 32 13 11, paragraph: Alkali-Silica Reactivity, with mitigation of reactive aggregate in accordance with the referenced paragraph.]

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 ASTM C 33/C 33M, Table 1 for deleterious substances..

2.1.2.2 Particle Shape and Quality

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

2.1.2.3 Grading

Conform grading of the fine aggregate as delivered to the mixer to the following requirements when tested in accordance with ASTM C 136.

Sieve designation U.S. Standard square mesh	Percentage by weight, passing
9.5 mm	100
4.75 mm	95-100
2.36 mm	80-90
1.18 mm	60-80
0.60 mm	30-60
0.30 mm	12-30
0.15 mm	2-10
Sieve designation U.S. Standard square mesh	Percentage by weight, passing
3/8 inch	100

Sieve designation U.S. Standard square mesh	Percentage by weight, passing
No. 4	95-100
No. 8	80-90
No. 16	60-80
No. 30	30-60
No. 50	12-30
No. 100	2-10

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 C 136](#).

2.1.2.4 Alkali Silica Reactivity

Evaluate and test fine aggregate to be used in all concrete for alkali-silica reactivity using the procedures described for coarse aggregate.

2.1.3 [Admixtures](#)

2.1.3.1 Air-Entraining Admixtures

Provide air-entraining admixtures conforming to [ASTM C 260](#).

2.1.3.2 Chemical Admixtures

[ASTM C 494/C 494M](#). 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 less than 7 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.

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 tolerances, 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 superfluous 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 C 150/C 150M**, Type [____]. Provide low alkali cement if the proposed fine or coarse aggregate are found to have greater than 0.04 percent expansion when tested in accordance with paragraphs: Alkali Silica Reactivity.

2.1.4.1 Portland Cement Mix Design

NOTE: Delete the bracketed portion of the second paragraph for patching airfields.

Design the concrete mixture to produce a minimum compressive strength of [31] [35] [____] MPa [4500] [5,000] [____] psi at 28 days of age, determined in conformance with **ASTM C 39/C 39M** and **ASTM C 192/C 192M**, 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 C 231**.

The allowable range of **slump** is 13 to 50 mm 1/2 to 2 inches when tested in accordance with **ASTM C 143/C 143M** [except that maximum slump may be increased to 100 mm 4 inches when the Contractor has included an approved water-reducing, high range, admixture conforming to **ASTM C 494/C 494M** in the mix design]. To minimize drying shrinkage, the maximum water-cement ratio by weight is 0.45.

2.1.5 Curing Materials

2.1.5.1 Burlap

Provide burlap conforming to **AASHTO M 182**.

2.1.5.2 Pigmented Liquid Membrane-Forming Compound

NOTE: Retain the tailored option for COE CRD-C 300 for Air Force and Army projects, and delete the ASTM reference.

Provide **pigmented liquid membrane-forming compound** conforming to **COE CRD-C 300****ASTM C 309**.

2.1.5.3 Waterproof Sheet Materials

Provide **waterproof sheet** materials conforming to **ASTM C 171**, Type optional, color white.

2.1.6 Bonding-Agents

2.1.6.1 Epoxy-Resin

Provide two component epoxy-resin material formulated to meet the requirements of **ASTM C 881/C 881M**, 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 rate of entrained air is a minimum.

2.1.6.2 Latex

Provide latex bonding agent meeting the requirements of **ASTM C 1059/C 1059M**, Type II.

2.1.7 Joint Sealant

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

2.1.8 Joint Filler

Provide joint filler material conforming to **ASTM D 1751** or **ASTM D 1752**, Type II [or 100% recycled material meeting **ASTM D 1752**, subparagraphs 5.1 to 5.4].

2.1.9 Water

Use only clean, fresh water, free from injurious amounts of oil, acid, salt, alkali, organic matter, or other deleterious substances. Water approved by Public Health authorities for domestic consumption may be accepted for use without being tested. Test water that is of questionable quality, in the opinion of the Contracting Officer, in accordance with **ASTM C 1602/C 1602M** and acceptance criteria of Table 1 of **ASTM C 94/C 94M**.

2.1.10 Proprietary Cementitious Products

NOTE: The testing protocol for Proprietary
Cementitious Products is provided in the USAF draft
ETL, "Testing Protocol for Rigid Spall Repair
Materials."

A proprietary cementitious product is defined as a rigid material in its hardened state with an elastic modulus greater than **6900 MPa 1,000,000 psi**.

Maximum size of aggregate used to extend the product is 19 mm 3/4 inch. 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

Cast 75 by 150 mm 3 by 6 inch cylinder specimens in accordance with ASTM C 192/C 192M and test in accordance with ASTM C 39/C 39M, using bonded or unbonded caps, after 3 hours and 1 day curing period. A minimum compressive strength of 20.7 MPa 3500 psi is required at 3 hours and 1 day of age.

2.1.10.2 Bond Strength

Cast 75 by 150 mm 3 by 6 inch cylinder specimens and test in accordance with ASTM C 882/C 882M. 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 3400 kPa 500 psi is required at 1 day of age. For a bond consisting of the candidate material bonded to itself, a minimum bond strength of 6900 kPa 1000 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 C 192/C 192M and test in accordance with ASTM C 469, 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 C 531, after 3 days curing period. A maximum coefficient of $11.6 \text{ by } 10^{-6} \text{ mm per mm per degree C}$ $7 \text{ by } 10^{-6} \text{ inch per inch per degree F}$ is required at 3 days of age.

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 C 1581/C 1581M. Start measuring strain after completion of casting. A maximum of 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

Cast prismatic specimens in accordance with ASTM C 192/C 192M and test in accordance with ASTM C 666/C 666M, 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.

2.2 Neat Cement Grout

2.2.1 Sand-Cement Grout Bonding Course

Provide grout bonding course consisting of equal parts of Type [I or II], [III] portland cement and sand by dry weight, thoroughly mixed with water to yield a thick, creamy mixture; with a water-cement ratio no greater than 0.62 by weight. Sand must meet the requirements of the fine aggregate specified herein, except 100 percent must pass through a 2.36 mm No. 8 sieve.

[2.2.2 Sand-Cement Mortar for Filling Small Popouts

NOTE: Delete this paragraph for airfield projects
due to insufficient durability of sand-cement mortar.

Provide mortar consisting of one part Type [I or II], [III] portland cement and two parts sand by dry weight, thoroughly mixed with water to yield a thick, suitable mix; with a water-cement ratio no greater than 0.45 by weight. The sand must meet the requirements of the fine aggregate specified herein.

]2.2.3 Dowels, Tie Bars, and Reinforcement

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

PART 3 EXECUTION

3.1 PREPARATION OF EXISTING PAVEMENT

NOTE: Airfield projects require full depth repairs
in accordance with Section 32 13 11 - CONCRETE
PAVEMENT FOR AIRFIELDS AND OTHER HEAVY DUTY
PAVEMENTS MORE THAN 10,000 CUBIC YARDS or Section
32 13 11 CONCRETE PAVEMENT FOR AIRFIELDS AND OTHER
HEAVY-DUTY PAVEMENTS.

NOTE: For projects other than airfield repairs,
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 inchthick 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 as specified
in Section 32 13 13.06 [PERVIOUS] PORTLAND CEMENT
CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES.

3.1.1 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 concrete that is uncontaminated by sealants, oils, greases, or deicing salts or solutions. Make a vertical saw cut at least 50 mm 2 inches deep and 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.

Clean the cavity 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.

[3.1.1.1 Joint Widening (Except Expansion Joints)

NOTE: Edit this paragraph as required. New joint groove dimensions shall be shown on the plans.

The following information shall be shown on the project drawings:

1. Spacing, width, and type of joints in concrete pavements to be sealed.
2. Typical details of existing joints.
3. Depth of existing sealant to be removed for each type of joint, if not specified.
4. Detail of type of joint to be refaced or widened with a concrete saw. Show extent of new width and depth of sawing to provide the proper shape factor of the void space in the joint. For materials, other than silicone, the ratio of the depth to width (d/w) of the sealant reservoir should generally be not less than 1 nor greater than 1.5. For silicone sealant a depth to width ratio of approximately 0.5 is preferred. Depending upon the width of the refaced joint, the thickness of the sealant bead should be between 6 and 13 mm 1/4 and 1/2 inch. Following are the recommended details for silicone sealants:

<u>Refaced Joint Width</u>	<u>10 mm</u>	<u>13 mm</u>	<u>19 mm</u>	<u>25 mm</u>
Recess Below Surface	6 mm	6 mm	6 mm	13 mm
Thickness of Sealant	6 mm	6 mm	10 mm	13 mm
Backer Rod Diameter	13 mm	16 mm	22 mm	31 mm
Total Depth of Joint	25 mm	28 mm	38 mm	56 mm
<u>Refaced Joint Width</u>	<u>3/8"</u>	<u>1/2"</u>	<u>3/4"</u>	<u>1"</u>
Recess Below Surface	1/4"	1/4"	1/4"	1/2"
Thickness of Sealant	1/4"	1/4"	3/8"	1/2"
Backer Rod Diameter	1/2"	5/8"	7/8"	1 1/4"

<u>Refaced Joint Width</u>	<u>3/8"</u>	<u>1/2"</u>	<u>3/4"</u>	<u>1"</u>
Total Depth of Joint	1"	1 1/8"	1 1/2"	2 1/4"

5. Location and type of bond breaker or back-up.

6. Identify type of sealant based on proposed use of pavements. (See note in paragraph entitled "Joint Sealant.")

7. For joint details see MIL-HDBK-1021/4.

Saw joints having grooves less than 10 mm 3/8 inch wide and less than 25 mm one inch deep to a minimum width of [10] [13] [] mm [3/8] [1/2] [] inch and to the minimum depth, [of] [25 mm] [38 mm] [one inch] [1 1/2 inches] [as indicated].

]3.1.2 Dowels, Tie Bars, and Reinforcement

NOTE: For airfield projects, delete the bracketed references to torching. Torching is not permitted on airfield projects for reinforcing steel or dowels.

Cut and remove to minimum dimensions indicated existing dowels and tie bars exposed in joints adjacent to the spall cavity. Perform cutting by saws[, torch,] or other approved means; do not allow[torch or] other cutting methods to damage concrete to remain. Clean to bare metal by sandblasting any existing reinforcement or dowels remaining 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 13 mm 1/2 inch of existing exposed reinforcement that is continuous through the repair area and is embedded in the adjacent slab.

3.1.3 Preparation of Joints Adjacent to Spalls

Remove existing joint sealing and joint filler materials. Saw as indicated and install insert, cut to appropriate dimensions, to prevent contact between new patch material and existing concrete at existing joints. At the option of the Contractor, a bead of approved caulking material may be installed to preclude new patching material from getting around insert. Clean up any caulking material accidentally deposited on the prepared spall surface.

3.1.4 Disposal of Debris

NOTE: Specify location of disposal of debris.

Sweep from pavement surface to remove excess joint material, dirt, water, sand, and other debris by 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.]

3.1.5 Bonding Coat

NOTE: In general a neat cement bonding coat is appropriate for all patch sizes. Epoxy-resin bond coats should be limited to patches less than 2 feet (600 mm) square. For proprietary cementitious 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.

3.1.5.1 Neat Cement Grout

Coat the clean and dry surface, including sawed faces, with an approximate 2 mm 1/16 inch thick coat of neat cement grout. Place the grout just prior to concrete placement and scrub with stiff bristle brushes to fill all voids and crevices in the spall cavity surface. Apply additional brush coats as needed to obtain the required thickness. The concrete patch material must be placed before the grout dries or sets. Remove dried or hardened grout by sandblasting and re-coat the cavity with fresh grout before placing concrete patch material.

3.1.5.2 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 grout. Place the epoxy-resin grout 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. When the brush method is used, the initial coat may be allowed to dry; however, apply the final coat just prior to placement of the concrete.

3.1.5.3 Proprietary Cementitious Products

Apply in accordance with the manufacturer's written instructions.

Test 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, provided the cement is the product of a mill with a record for the production of high-quality cement for the past 3 years.

3.1.6 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 bracketd statements containing "sand-cement " and "chipping" for airfield projects, and specify overcoring surface defects in concrete.

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 [sand-cement mortar for small popouts (less than 50 mm 2 inches in width or depth) and]portland cement concrete for large popouts. 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.[After preparing large popout cavities, coat with sand-cement grout bonding course immediately prior to filling with concrete.]

3.1.7 Patch Material Selection

Fill the prepared cavity with: Portland cement concrete or latex modified concrete for cavities more than 9400 cc 600 cubic inches in volume after removal operations; portland cement mortar for cavities between 850 and 9400 cc 50 and 600 cubic inches; and epoxy resin mortar or latex modified mortar for those cavities less than 850 cc 50 cubic inches in size. Proprietary cementitious patching materials may be used, subject to approval by the Contracting Officer.

3.2 BATCHING, MIXING AND PROPORTIONING

Provide facilities for the accurate measurement and control of each of the materials entering the concrete, mortar, or 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 use of volumetric batching and continuous mixing is acceptable, provided all operations are in accordance with ASTM C 685/C 685M.

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.

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 Mix Proportions

Use proportions of 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, no changes shall be made without prior approval.

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 one gallon of water as weighing 1 kg 8.33 pounds.

3.2.6 Workability

Maintain the slump of the concrete at the lowest practicable value, not exceeding the specified value.

3.3 PLACING

3.3.1 Portland Cement Concrete

NOTE: Specify placing time to suit concrete
materials and environmental conditions. For most
projects, 90 minutes is adequate.

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, and before the sand-cement grout bonding course has dried or obtained its initial set. The temperature of the concrete, as deposited in the repair area, must 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]; 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 bonding course 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 toweling of patch material onto adjacent pavements to a minimum; 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.

3.3.2 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. Use an insert or other bond-breaking medium where the spalled area abuts a joint, to prevent bond at the joint face. Saw a reservoir for the joint sealant to the dimensions required for other joints. Thoroughly clean and seal the reservoir with the sealer specified for the joints. [In lieu of sawing, spalls not adjacent to joints and popouts, both less than 150 mm 6 inches in maximum dimension, may be prepared by drilling a core 50 mm 2 inches in diameter greater than the size of the defect, centered over the defect, and 50 mm 2 inches deep or 13 mm 1/2 inch into sound concrete, whichever is greater. Repair the core hole as specified above for other spalls.]

3.3.3 Proprietary Cementitious Products

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

3.3.4 Joints

Construct new joints as detailed on the drawings and align with existing joints. After curing of the concrete, seal new joints as indicated [and specified].

3.4 FIELD QUALITY CONTROL

3.4.1 General Requirements

Furnish concrete samples, taken in the field and tested to determine the slump, air content, and strength of the concrete. Make test cylinders for determining conformance with the strength requirements of these specifications and, when required, for determining the time at which pavements may be placed in service. Determine air content in conformance with ASTM C 231. Mold and cure test cylinders in conformance with ASTM C 31/C 31M and as specified below. Furnish all materials, labor, and facilities required for molding, curing, and protecting test cylinders at the site and under the supervision of the Contracting Officer. Include furnishing and operating water tanks in curing facilities for test beams, equipped with temperature-control devices that will automatically maintain the temperature of the water at 23 degrees C 73 degrees F plus or minus 3 degrees C 5 degrees F. Also furnish and maintain at the site, boxes or other facilities suitable for storing the specimens while in the mold at a temperature of 23 degrees C 73 degrees F plus or minus 6 degrees C 10 degrees F. Tests of the fresh concrete and of the hardened concrete cylinders are to be made by and at the expense of the Contractor. Test Proprietary Cementitious Products in accordance with the manufacturer's written instructions.

3.4.2 Specimens for Strength Tests

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 each 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 characteristics, or mix design is changed, make one additional set of test cylinders.

Determine the air content and slump in conformance with **ASTM C 173/C 173M** and **ASTM C 143/C 143M**, respectively. Mold and cure test cylinders in conformance with **ASTM C 31/C 31M**. Furnish and maintain at the site, boxes or other facilities suitable for storing the specimens while in the mold at a temperature of **23 degrees C 73 degrees F** plus or minus **5.5 degrees C 10 degrees F**. Test cylinders in accordance with **ASTM C 39/C 39M**.

3.4.2.1 Test Results

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

3.4.2.2 Acceptance

Reject any spall repair material that cracks, or delaminates, or loses bond partly or completely, 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. Remove all unacceptable repairs, including new damaged areas adjacent to new spall patches, and provide new repairs meeting the specifications.

3.5 FINISHING

Start finishing operations immediately after placement of the concrete. Finished surfaces of patched areas are to approximate surface texture of the adjacent undisturbed pavements.

3.6 CURING

NOTE: A minimum curing time of 7 days is required
when Type I or Type II cements are used. Specify a
minimum curing period of 3 days for Type III cement.

Cure the concrete by protection against loss of moisture and rapid temperature changes for a period of not less than [_____] 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 cementitious products in accordance with manufacturer's recommendations. Failure to comply with curing requirements will be cause for immediate suspension of concreting operations.

3.6.1 Moist Curing

Moist-cure all portland cement concrete patches for the first 24-hours after finishing. Immediately after the finishing operations are complete

and the concrete is set sufficiently to prevent marring the surface, cover the entire surface of the newly laid concrete with approved wetted burlap, and keep wet for a period of not less than 24 hours. Keep the surface of the newly laid concrete moist until the burlap coverings are in place. Ensure that moist curing is continuous 24 hours per day and that the entire surface is wet, by having an approved work system. Continue curing the concrete for the duration of the required curing period by this method or one of the methods specified below.

3.6.2 Waterproof-Paper Blankets or Impermeable Sheets

Immediately after removing the covering used for initial curing, moisten the exposed concrete surfaces with a fine spray of water and cover with waterproof-paper blankets, polyethylene-coated-burlap blankets, or impermeable sheets. Saturate polyethylene-coated burlap with water before placing. Place sheets with the light-colored side up. Overlap sheets not less than 300 mm 12 inches with edges taped or secured to form a completely closed joint. Weight down coverings to prevent displacement or billowing from winds. Immediately repair tears or holes appearing during the curing by patching.

3.6.3 Membrane-Forming Curing Compound

Apply membrane -forming curing compound immediately to exposed concrete surfaces after removing burlap coverings. 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 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.

3.7 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.

3.8 PAVEMENT 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.

3.9 JOINTS

Provide joints conforming in detail and in alignment with the existing joints. After curing of the concrete, prepare and seal the joints in accordance with Section 32 01 19.61 RESEALING OF JOINTS IN RIGID PAVEMENTS.

-- End of Section --