
USACE / NAVFAC / AFCEA UFGS-03930N (September 1999)

Preparing Activity: NAVFAC Replacing without revision
NFGS of same number and date

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 23 June 2005

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SECTION 03930

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09/99

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SECTION 03930

CONCRETE REHABILITATION 09/99

NOTE: This guide specification covers the requirements for repair of portland cement concrete using epoxy resin grouts, mortars and concretes.

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

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

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

NOTE: Select appropriate title for type of repair work in contract. For repairs involving bonding new Portland cement concrete to old Portland cement concrete using epoxy resin binder use Section 02752 PORTLAND CEMENT CONCRETE PAVEMENT FOR ROADS AND SITE FACILITIES or Section 03300N CAST-IN-PLACE CONCRETE depending on project requirements.

NOTE: The following information should be shown on the project drawings:

1. Location and extent of spalled, cracked or damaged concrete to be repaired with epoxy;
2. Location and extent of cracked concrete or saw kerfs to be filled with epoxy mortar;
3. Location of dowels to be installed and cracks to

be repaired with non-pressure grout; and

4. Location and sizes of cracks to be filled by
pressure grouting.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in
project specifications need not be more current than
provided by the latest guide specification. Use of
SpecsIntact automated reference checking is
recommended for projects based on older guide
specifications.

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.

ASTM INTERNATIONAL (ASTM)

| | |
|-----------------|--|
| ASTM C 117 | (2004) Materials Finer Than 75 micrometer (No. 200) Sieve in Mineral Aggregates by Washing |
| ASTM C 136 | (2004) Sieve Analysis of Fine and Coarse Aggregates |
| ASTM C 144 | (2003) Aggregate for Masonry Mortar |
| ASTM C 31/C 31M | (2003a) Making and Curing Concrete Test Specimens in the Field |
| ASTM C 33 | (2003) Concrete Aggregates |
| ASTM C 39 | (1993a) Compressive Strength of Cylindrical Concrete Specimens |
| ASTM C 881 | (1999) Epoxy-Resin-Base Bonding Systems for Concrete |

1.2 DEFINITIONS

1.2.1 Epoxy Resin Binder

A two-component epoxy bonding system in low and medium viscosities used by
itself as a primer or for producing epoxy concrete or mortars when mixed
with aggregate.

1.2.2 Epoxy Concrete

A combination of epoxy resin binder and fine and coarse aggregate used in
the repair of spalling along joints or cracks, small surface spalls or
"popouts."

1.2.3 Epoxy Mortar

A combination of epoxy resin binder and fine aggregate used in the surface repair of non-structural cracks and filling of saw kerfs.

1.2.4 Non-Pressure Epoxy Grout

A combination of epoxy resin binder, a mineral filler and a thixotropic agent used in cementing dowels in place and the repair of non-structural cracks.

1.2.5 Pressure Grouting Epoxy

A low viscosity epoxy resin system pumped under pressure into structural cracks in walls or pavements.

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

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 projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-05 Design Data

NOTE: Use this submittal on airfield projects and
on other projects where the total surface area to be
repaired exceeds 2 square meters 20 square feet.

Job mix formula

SD-06 Test Reports

NOTE: Use this submittal on airfield projects,
projects involving pressure grouting of cracks, and
other projects where the total surface area to be
repaired exceeds 2 square meters 20 square feet.

Sieve analysis test for aggregate

Epoxy resin binder tests

Epoxy grout tests

SD-07 Certificates

NOTE: Use this submittal on small repair projects,
not requiring pressure grouting of cracks, whose
total surface area to be repaired does not exceed 2
square meters 20 square feet.

Epoxy resin binder

Epoxy grout

SD-08 Manufacturer's Instructions

Epoxy repair material

Submit for mixing and applying.

1.4 QUALITY ASSURANCE

1.4.1 Design Data

1.4.1.1 Job Mix Formula

Submit, at least 15 days before work commences, a job-mix formula for each use of [epoxy concrete] [epoxy mortar]. Test reports shall accompany the mix design. Identify the proposed source of the materials and state the proportions of aggregates and epoxy resin. When determining job mix, use samples of materials to be used on the job.

- a. Trial batches: Perform a minimum of three trial batchings in a certified testing laboratory. Try different aggregate-resin

proportions to obtain satisfactory placing and finishing characteristics but keep the proportion by weight of aggregate to epoxy resin binder at least five to one. When mixing, add the fine aggregates first, and then the coarse aggregates. The final trial batch should be sufficiently wet so that some fines will "bleed" to the surface during finishing operations.

- b. Supporting criteria: Include in the submittal the following data for each trial batch:

- (1) Proportions by weight
- (2) Unit weights and specific gravities of constituents
- (3) Batch weights
- (4) Compressive strengths of 76 by 152 mm 3 by 6 inch cylinders, made in accordance with ASTM C 31/C 31M, air cured for 7 days and tested in accordance with ASTM C 39. Compressive strength shall be a minimum of [_____] psi.
- (5) Curing time

1.4.2 Test Reports

1.4.2.1 Epoxy Resin Binder

Include the following:

- a. Viscosity
- b. Consistency
- c. Gel time
- d. Absorption
- e. Shrinkage
- f. Thermal compatibility

1.4.2.2 Epoxy Resin Grout

Include the following:

- a. Epoxy number
- b. Consistency
- c. Compressive single shear strength
- d. Pot life

1.5 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to site for damage, unload and store with a minimum of handling. Deliver epoxy resin components and aggregate materials in original sealed containers and store in dry covered areas at temperatures below 30 degrees C 90 degrees F. Remove from job site unused mixed materials which have reached end of working or pot life.

1.6 WEATHER LIMITATIONS

Halt work when weather conditions detrimentally affect the quality of patching or bonding concrete. Apply epoxy resin materials only when the contact surfaces are completely dry and if the atmospheric and surface temperature ranges are suitable for the specified epoxy material. Follow manufacturer's instructions for weather conditions and temperature ranges.

1.7 TRAFFIC CONTROL

Do not permit vehicular or heavy equipment traffic on the pavement in the work area during the curing period. At the end of the curing period, light local traffic may be permitted on the pavement if approved by the Contracting Officer.

1.8 EQUIPMENT

Use a container recommended by the epoxy manufacturer as the mixing vessel. Use a power drive (air or spark-proof) propeller type blade for mixing except that hand mixing may be used for small batches. Use equipment specified by epoxy manufacturer for field mixing of aggregates and epoxy resin.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Epoxy

2.1.1.1 Epoxy Resin Binder for Concrete and Mortar

NOTE: The grades for ASTM C 881 and classes for both standards are as follows:

1. Grade 1: Low viscosity
2. Grade 2: Medium viscosity
3. Grade 3: Non-sagging consistency
4. Class B: For use between 5 and 15 degrees C 40 and 60 degrees F.
5. Class C: For use above 15 degrees C 60 degrees F.

Use the bracketed sentence on surfaces where a non-sagging epoxy resin is needed.

ASTM C 881, Type III, Grade [1] [2], Class [B] [C] without mineral filler. [For [walls] [and] [ceilings] use ASTM C 881, Type III, Grade 3, Class [B] [C] with filler.]

2.1.1.2 Non-Pressure Epoxy Grout

NOTE: The grades for ASTM C 881 and classes for

both standards are as follows:

1. Grade 1: Low viscosity
2. Grade 2: Medium viscosity
3. Grade 3: Non-sagging consistency
4. Class B: For use between 5 and 15 degrees C 40 and 60 degrees F.
5. Class C: For use above 15 degrees C 60 degrees F.

Use the bracketed sentence on surfaces where a non-sagging epoxy resin is needed.

ASTM C 881 Type IV, Grade [2] [3], Class [B] [C] with or without mineral filler.

2.1.1.3 Crack Sealer for Pressure Grouting

ASTM C 881, Type IV, Grade 1, Class [B] [C] without filler.

2.1.1.4 Crack Surface Sealer for Pressure Grouting

ASTM C 881, Type IV, Grade 3, Class [B] [C] with mineral filler.

2.1.2 Aggregate

For material passing No. 200 sieve provide a non-plastic material composed of a minimum of 75 percent limestone dust, talc or silica inert filler. Provide dry aggregate.

- a. For epoxy concrete: ASTM C 33, [maximum size [_____] [13 mm] [1/2 inch].] [Conform to the following requirements:

| <u>Sieve Designation</u> | <u>Percent Passing by Weight</u> |
|--------------------------|----------------------------------|
| 13 mm | |
| 10 mm | 100 |
| No. 4 | 93-100 |
| No. 8 | 70-80 |
| No. 16 | 50-65 |
| No. 30 | 37-53 |
| No. 50 | 20-37 |
| No. 100 | 10-20 |
| No. 200 | 5-10 |
| | 3-5 |

| <u>Sieve Designation</u> | <u>Percent Passing by Weight</u> |
|--------------------------|----------------------------------|
| 1/2 in. | |
| 3/8 in. | 100 |
| No. 4 | 93-100 |
| No. 8 | 70-80 |
| No. 16 | 50-65 |
| No. 30 | 37-53 |
| No. 50 | 20-37 |

| <u>Sieve Designation</u> | <u>Percent Passing by Weight</u> |
|--------------------------|----------------------------------|
| No. 100 | 10-20 |
| No. 200 | 5-10 |
| | 3-5] |

- b. For epoxy mortar: ASTM C 144, [maximum size [____ mm] [____ inch
].] [No. 8 sieve] [No. 40 sieve] [[____] sieve].

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Epoxy Concrete

3.1.1.1 Patch Areas

Remove loose concrete from the spalled areas indicated. Inspect the cavity for remaining defective concrete by tapping with a hammer or steel rod and listening for dull or hollow sounds. In areas where tapping does not produce a solid tone, remove additional concrete until testing produces a solid tone. Make the entire cavity at least 25 mm one inch deep. Sawcut edges of cavity to avoid feather edging. Prepare surface of cavity by sandblasting, grinding, or water blasting. Remove dust, dirt, and loosely bonded material resulting from cleaning. Ensure cavity surfaces are dry.

3.1.1.2 Spalls at Joints and Cracks

NOTE: Use this paragraph when repairing pavements.

For spalls to be repaired that are adjacent to joints and working cracks insert preformed joint filler to the working faces of the spall. Trim filler to fit shape of the working faces of joint or crack so epoxy material is prevented from bypassing filler. Where practicable, extend filler horizontally and vertically into joint or crack opening. Secure filler strip in place prior to and during placement of epoxy concrete. [Apply a bond breaker to working faces at keyed joints. Keep bond breaker off of concrete surface to be bonded.] After the epoxy concrete has completely cured, saw out the top 25 mm inch of the preformed joint filler and install liquid joint sealer in accordance with Section [02760 FIELD MOLDED SEALANTS FOR SEALING JOINTS IN RIGID PAVEMENTS] [02762 COMPRESSION JOINT SEALS FOR CONCRETE PAVEMENTS].

3.1.1.3 Joints and Cracks

NOTE: Use this paragraph when repairing pavements.
Fill in either Section 02762, "Joints, Reinforcement, and Mooring Eyes in Concrete Pavements" or Section 02982, "Resealing of Joints in Rigid Pavement."

NOTE: Insert the appropriate Section number and title in the blank below using format per UFC 1-300-02.

Clean and seal joints and cracks as specified in [____].

3.1.2 Epoxy Mortar for Cracks and Saw Kerfs

Apply epoxy mortar to newly exposed loose and unsound materials. Prepare surfaces by sandblasting, scarifying or waterblasting. Remove dust, dirt, and loosely bonded material resulting from cleaning. Ensure surfaces are dry before application of epoxy mortar.

3.1.3 Epoxy Grout for Cracks

Apply grout to newly exposed concrete free of loose and unsound materials. Prepare surfaces by sandblasting, scarifying or waterblasting. Remove dust, dirt, and loosely bonded material resulting from cleaning. Ensure surfaces are dry before application of epoxy grout.

3.2 MIXING MATERIALS

Make batches small enough to ensure placement before binder sets. Mix materials in accordance with manufacturer's recommendations.

3.3 PLACEMENT

3.3.1 Epoxy Concrete

NOTE: Do not place epoxy concrete in layers greater than 25 mm one inch in thickness. This is to avoid heat buildup and subsequent thermal contraction.

Prime dry cavity surfaces with epoxy resin using a stiff bristle brush. Make coating approximately 0.5 mm 20 mils thick. Place epoxy concrete while primer is still tacky and in layers not exceeding one inch thick. Use vibratory floats, plates, or hand tampers to consolidate the concrete. Level each layer and screed the final surface to match the adjoining surfaces. Remove excess epoxy concrete on adjacent surfaces before the concrete hardens. Do not feather epoxy concrete out onto adjacent surfaces.

3.3.2 Epoxy Mortar

Prime surfaces with epoxy resin binder. Scrub prime coat into surface with a stiff bristle brush. Make coating approximately 0.5 mm 20 mils thick. Place epoxy mortar while primer is still tacky. Apply at a thickness recommended by the manufacturer. Work mortar into place and consolidate thoroughly so that contact surfaces are wetted by the mortar. Finish surface of mortar to the required texture. Do not feather edge epoxy mortar onto adjacent surfaces.

3.3.3 Non-Pressure Epoxy Grout

3.3.3.1 Cementing Dowels

Immediately prior to placing the dowel, clean hole of dust and other deleterious material with a high pressure air hose. Fill hole halfway with grout. Insert dowel in hole by rotating it at least one complete turn while tapping it down. If necessary add more grout to fill hole.

3.3.3.2 Epoxy Grout for Cracks

Apply epoxy grout at a thickness recommended by the manufacturer. Work grout into place and consolidate thoroughly so that contact surfaces are wetted by the grout. Finish surface of grout to the required texture. Do not feather edge epoxy grout onto adjacent surfaces.

3.3.4 Pressure Grouting of Cracks

**NOTE: The interval between valves should be greater
than the thickness of the member being repaired.**

Clean each crack of dust, dirt, loose concrete and unsound material. Insert a valve at both ends of each crack, at the junction of two cracks, and along the length of each crack at 400 to 500 mm [16 to 20] [_____] inch intervals. Fill crack between valves with crack surface sealer. After crack surface sealer has hardened and cured, pump crack sealer into valve at one end of crack. For vertical surfaces start at lowest valve and work upwards. As crack sealer appears at next valve, pinch closed pumping valve and move to next valve and commence pumping. Continue procedure until other end of crack is reached. Avoid delays in pumping operation. After crack sealer has hardened and cured grind valves off flush with concrete surface. Coat areas of valves with crack surface sealer and allow to harden and cure.

3.4 CURING

Cure epoxy materials in accordance with manufacturer's recommendations.

3.5 FIELD QUALITY CONTROL

3.5.1 Sampling

As soon as epoxy resin and aggregate materials are available for sampling, obtain by random selection a sample of each batch. Clearly identify samples by designated name, specification number, batch number, project contract number, intended use and quantity involved.

3.5.2 Testing

**NOTE: For runway repair projects and other projects
requiring large amounts of epoxy repairs use the
bracketed sentences.**

At the discretion of the Contracting Officer, samples provided may be tested by the Government for verification. [Test samples by an approved laboratory. If a sample fails to meet specification requirements after two tests, replace the batch represented by the samples tested and retest. Test aggregates in accordance with ASTM C 117 and ASTM C 136.]

3.5.3 Inspection

**NOTE: Use this paragraph for airfield repair
projects and other projects having large patched**

surface areas.

Check each repaired area for cracks, spalls, popouts and loss of bond between repaired area and surrounding concrete. Check each repaired area for voids by tapping with a hammer or steel rod and listening for dull or hollow sounds. Immediately repair defects.

-- End of Section --