

SECTION 930

MATERIALS FOR CONCRETE REPAIR

930-1 Description.

This Section covers materials used to repair voids in concrete including defects or purposely placed openings in concrete elements. Materials containing organic compounds, such as bitumens and epoxy resin as the principal binder are not included. The requirements for epoxy resin materials is covered in Section 926.

930-2 Product Acceptance on the Project.

930-2.1 Product Acceptance: Use only products listed on the Department's Qualified Products List (QPL). Manufacturers seeking evaluation of products must submit an application in accordance with Section 6 and include independently certified test reports that the material meets the requirements of this Section. The instruction for the maximum water to cementitious material ratio will be required when submitting the application for QPL approval.

Provide the Engineer certification conforming to the requirements of Section 6 from the manufacturer confirming that the material(s) used meets the requirements of this Section and is the appropriate product for the intended use.

When specified in the Contract Documents, furnish a report of test results from an independent laboratory on samples taken from material shipped. Ensure the test was performed within 45 days prior to the shipping date of the material.

930-2.2 Material Supply, Storage, and Marking: The material shall be pre-proportioned including aggregate. Deliver products in original, unopened containers with manufacturer's name, date of manufacture, expiration date, product identification label and batch numbers. Store the material in an elevated dry and weather protected enclosure in full compliance with the manufacturer's recommendations. Material must be used within manufacturer's recommended shelf life.

The material from which the containers are made shall have water vapor transmission not greater than 2,048 lb/ft² [10 Mg/m²] in 24 hours as determined in accordance with Procedure B of ASTM E 96.

All containers shall be marked with the following information:

- (a) LOT identification number and material expiration date
- (b) Directions for use shall include but are not limited to the following:
 - (1) The type and kind of adhesive recommended (if any) to bond fresh repair material to the concrete or mortar being repaired.
 - (2) The recommended amount of resin, other liquid component, or both, to be mixed with the package contents.
 - (3) The recommended length of mixing time or sequence of mixing and resting times in minutes.
- (c) Date the material was packaged.
- (d) The yield in cubic feet [cubic meters] or yield in ft²/in [m²/mm] thickness when mixed with the recommended amount of liquid.
- (e) The net weight in each container. (The contents of any container shall not vary by more than 2% from the weight stated in markings. The average weight of filled containers in a LOT shall be not less than the weight stated in the markings.)
- (f) Instructions for the maximum and minimum water (or solutions) to cementitious material ratio.
- (g) Define the approximate working time.

930-2.3 Sampling, Mixing, and Additional Testing: A LOT is the packaged repair material normally placed on a pallet. A unit sample is a single container or package of material randomly selected from the LOT. Mix and install the material(s) in accordance with the manufacture's recommendations.

Manufacturers will be required to provide field representation upon request by the Engineer. The Department reserves the right to conduct further field testing if desired.

930-2.4 Rejection: All broken containers will be rejected. Material that fails to meet any of the requirements of this Specification will be rejected. Report all materials failing to meet this specification and state the reason(s) for rejection in writing to the Engineer and the producer or supplier. Material in local storage in the hands of a vendor for more than six months after testing will be retested before use, except for the scaling resistance test and length change immersed in sulfate solution test for Magnesium Ammonium Phosphate Concrete. Retested material will be rejected if it fails to conform to any of the requirements of this Specification.

930-2.5 Chemical Requirements: The material shall not contain total chlorides or other corrosive ingredients in excess of 0.40 lb/yd³ [0.24 kg/m³] of the hardened concrete when used in reinforced and prestressed structures. Chloride determination shall be made in accordance with FM 5-516.

930-3 Cementitious Concrete or Mortar Materials for Rapid Repairs.

930-3.1 General: Packaged, dry concrete material shall contain aggregate of which more than 5% by weight of the total mixture is retained on a 3/8 inch [9.5 mm] sieve.

Packaged, dry mortar material may contain aggregate of which less than 5% by weight of the total mixture is retained on a 3/8 inch [9.5 mm] sieve. These materials may not be extended by the addition of aggregate in the field.

Aqueous solutions compounds and aqueous emulsions or dispersions compounds may be used to replace some or all of the required mixing water. These liquids must be furnished as components of the packaged materials.

930-3.2 Classification: The materials to be considered as alternates shall meet the following requirements:

930-3.2.1 Rapid Hardening: Moderate compressive strength for repairing concrete with an original compressive strength less than or equal to 4,000 psi [27.6 MPa].

930-3.2.2 Very Rapid Hardening: High compressive strength for repairing concrete with an original compressive strength greater than 4,000 psi [27.6 MPa].

930-3.3 Physical Properties: The repair material shall meet or exceed the specified physical properties stated in Table 1 as determined by the following standard test methods.

Table 1 Physical Properties			
Requirement	Rapid Hardening	Very Rapid Hardening	Test Method
Minimum Compressive Strength			
3 hours, psi [MPa]	500 [3.5]	2,000 [13.8]	ASTM C 39 or ASTM C 109 [ASTM C 109M]
24 hours, psi [MPa]	2,000 [13.8]	4,000 [27.6]	
7 day, psi [MPa]	4,000 [27.6]	6,000 [41.4]	
28 day, psi [MPa]	The strength at 28 days shall not be less than the strength at seven days.		
Maximum Length Change (at 28 days)			
Allowable increase in water cured, based on length at one day, %	+0.15	+0.15	ASTM C 157
Allowable decrease in air cured, based on length at one day, %	-0.15	-0.15	ASTM C 157
Allowable difference between increase in water and decrease in air determination, %	0.20	0.20	ASTM C 157
Minimum Consistency			
Slump (Concrete), inches [mm]	3 [76.2]	3 [76.2]	ASTM C 143
Flow (Mortar), %	100	80	ASTM C 1437
Time of Setting			
Initial Set, minutes	30 to 60	10 to 29	ASTM C 191 or ASTM C 266

930-3.4 Specimen Preparation:

930-3.4.1 Concrete: Mechanically mix the packaged, dry concrete material with water and/or mixing liquid. Prepare and test three test specimens for each age of test and each level of mixing temperature in accordance with ASTM C 31 [ASTM C 31M]. The average strength of the test specimens for each age of test and each preparation temperature shall be not less than that prescribed in Table 1.

(a) The sample of packaged dry material shall be any combination of whole packages yielding not less than $2/3 \text{ ft}^3$ [0.02 m^3] of hardened material.

(b) Base the quantity of water, other liquid component, or both added to the sample on the quantity per bag stated in the instructions for use.

(c) Place the sample in the mixing machine and add the required amount of liquid. Start mixing immediately and continue mixing for the length of time indicated in the directions for use.

(d) When performing the slump test, schedule work so the test will be completed in $5 \pm 1/2$ minute after the mixing liquid is added to the very rapid hardening materials or $15 \pm 1/2$ minute after mixing the liquid with the rapid hardening materials.

(e) Mold the required number of specimens using additional samples as may be necessary, mixing in accordance with (a) through (d). Do not use the mixtures for molding test specimens when the slump test is less than that specified in Table 1.

Where the nominal maximum particle size is not greater than 1 inch [25 mm] the use of 4 inch x 8 inch [100 mm x 200 mm] cylindrical molds is required.

930-3.4.2 Mortar: Mechanically mix packaged, dry mortar material with mixing liquid. Prepare and test three test specimens for each age of test and each level of mixing temperature in accordance with ASTM C 109 [ASTM C 109M]. The average strength of the test specimens for each age of test and each preparation temperature shall be not less than that prescribed in Table 1.

(a) The sample obtained from the packaged dry material shall weigh 6.6 ± 0.05 lb [3.0 ± 0.02 kg] and shall be representatively obtained from a whole package in accordance with FM 1-T 248.

(b) Base the quantity of water, or other liquid component, or both added during mixing on the quantity per unit of weight stated in the directions for use.

(c) When performing the flow test, schedule work so the test will be completed in $5 \pm 1/2$ minute after the start of mixing liquid with the very rapid hardened materials or $15 \pm 1/2$ minute after mixing the liquid with the rapid hardening materials.

(d) Mold the required number of specimens using additional samples as necessary mixing in accordance with (a) through (c). Do not use the mixtures for molding test specimens when the flow is less than that specified in Table 1.

930-3.4.3 Temperature: In those cases where the manufacturer has indicated in the package markings, or elsewhere, that the packaged repair material can be mixed and applied at temperatures that lie beyond the range of 55°F to 85°F [12°C to 28°C], the product must meet the requirements of Table 1. Specimens shall be mixed, molded and cured during the first three hours within $\pm 2^\circ\text{F}$ [$\pm 1^\circ\text{C}$] of the extreme temperature(s) stated by the manufacturer in the package markings.

930-3.4.4 Length Change: Make and cure the test specimens in accordance with ASTM C 157 [ASTM C 157M], except omit the curing period in Section 10.3; however both 11.1.1 and 11.1.2 shall apply for 28 day curing period. The average length change of the test specimens for each preparation temperature and for each storage condition after 28 days shall meet the requirements shown in Table 1.

930-3.4.5 Manifestly Faulty Specimens: Treat manifestly faulty specimens in accordance with ASTM C 494 Section 15.2.

930-4 Magnesium Ammonium Phosphate Concrete (MAPC).

930-4.1 General: MAPC is intended to be used to repair block-outs and holes in post-tensioned boxes and girders and other locations required by the Contract Documents. Follow the manufacturers recommendations for preparing the surfaces and for mixing, placing and curing the concrete.

930-4.2 Physical Properties: The MAPC material shall meet or exceed the specified physical properties stated in Table 2 as determined by the following standard test methods.

Table 2 Physical Properties		
Requirement	Test Value	Test Method
Minimum Compressive Strength at 28 days, psi [MPa]	8,500 psi [58.6]	ASTM C 109*
Minimum Flexural Strength at 28 days, psi [MPa]	600 psi [4.1]	ASTM C 348*
Minimum Slant Shear Bond at 14 days, psi [MPa]	2,500 psi [17.2]	ASTM C 882*
Time of Setting		
Initial Set, minutes, minimum time	15	ASTM C 266***
Scaling Resistance	No scaling	ASTM C 672
Maximum Length Change		
Wet Cure at 28 days, %	0.03	ASTM C 157
Dry Cure at 28 days, %	0.03	ASTM C 596
Sulfate Resistance after 52 week of immersion, %	0.1	ASTM C 1012
Maximum Chloride Absorption at 21 days, %	1.5	NCHRP T-244**
* Modified test methods for air curing instead of moist curing.		
** Use cube specimens meeting the requirements of ASTM C 109.		
*** Specimen shall be tested at a minimum of 95 °F [35 °C]		

930-5 Packaged, Thermosetting Polymer Material For Concrete Repair.

930-5.1 General: This Section covers packaged, thermosetting, polymer material for rapid repairs to hardened portland cement concrete pavement and structures. Only low odor materials such as styrene diluted polyester resin will be considered.

930-5.2 Classification: The materials to be considered as alternates shall meet the following requirements:

930-5.2.1 Type 1 Polymer: Moderate compressive strength for repairing concrete with an original compressive strength less than 4,500 psi [31 MPa].

930-5.2.2 Type 2 Polymer: Low modulus with a compressive strength less than 2,500 psi [17.2 MPa] for repairing low quality and or moving concrete (across working cracks).

930-5.3 Physical Properties: The repair material shall meet or exceed the specified physical properties stated in Table 3 as determined by the following standard test methods.

Table 3 Physical Properties			
Requirement	Type 1 Polymer	Type 2 Polymer	Test Method
Minimum Compressive Strength			
3 hours, psi [MPa]	1,500 [10.3]	800 [5.5]	ASTM C 579
24 hours, psi [MPa]	3,500 [24.1]	1,500 [10.3]	
7 day, psi [MPa]	4,500 [31.0]	2,000 [13.8]	
28 day, psi [MPa]	The strength at 28 days shall not be less than the strength at seven days.		
Working Time	12 to 20 minutes	12 to 20 minutes	
Minimum Strength (at 7 days)			
PCC Bond, psi [MPa]	3,500 [24.1]	2,000 [13.8]	ASTM C 882
Flexural, psi [MPa]	1,800 [12.4]	800 [5.5]	ASTM C 580
Tensile, psi [MPa]	900 [6.2]	400 [2.7]	ASTM C 307
Maximum Shrinkage, %	0.03	0.03	ASTM C 531
Maximum Expansion, per °F [°C]	0.000012 [0.0000216]	0.000012 [0.0000216]	ASTM C 531

The catalyst, resin and aggregate blend shall be provided by the manufacturer and approved by the Department.

If the area is being used for vehicular traffic, the repair material shall have a minimum compressive strength of 2,200 psi prior to opening to traffic or as noted in the plans.

930-5.4 Constructability: Furnish to the Engineer for approval shop drawing as may be required to complete repairs in compliance with the design shown in the plans and the manufacturer's recommended repair system.