

SECTION 03 01 33
REPAIR OF HORIZONTAL CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
2. ASTM International (ASTM):
 - a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
 - b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
 - g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm Cube Specimens]).
 - h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
 - j. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
 - k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
 - l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
 - m. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
 - n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
 - o. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.

- p. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
- q. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- r. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
- s. D638, Standard Test Method for Tensile Properties of Plastics.
- t. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
- u. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
- v. D4259, Standard Practice for Abrading Concrete.
- w. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

1.02 DEFINITIONS

- A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.
- B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.
- C. High-Pressure Water Blasting (sometimes referred to as hydro-demolition): Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.
- D. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

- A. Action Submittals: Product data sheets for each material supplied.
- B. Informational Submittals:
 - 1. Repair Mortar System: Manufacturer's preparation and installation instructions.
 - 2. Written description of equipment proposed for concrete removal and surface preparation.

3. Certificates:
 - a. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to weather, potable water, or receive traffic.
 - b. Mortar Manufacturer's Certificate of Proper Installation.
4. Statements of Qualification:
 - a. Repair mortar system applicator.
 - b. Independent Testing Laboratory.
5. Field and laboratory test results.

1.04 QUALITY ASSURANCE

- A. Qualifications:
 1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.
- B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.
- C. Pre-repair Conference:
 1. Required Meeting Attendees:
 - a. Contractor.
 - b. Repair Subcontractor.
 - c. Technical representative for repair material manufacturer.
 - d. Contracting Officer.
 2. Schedule and conduct prior to incorporation of respective products into Project. Notify Contracting Officer of location and time.
 3. Agenda shall include, but not limited to:
 - a. Review of field conditions. Conduct field observations of the Work to be performed.
 - b. Based on above observations, repair material manufacturer's technical representative shall confirm material selection and make Project specific repair method recommendations.
 - c. Technical representative for repair material manufacturer shall review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
 - d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.
- B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 1—MAGNESIUM PHOSPHATE REPAIR MORTAR

- A. Manufacturers and Products:
 - 1. BASF Construction Chemicals, LLC - Building System, Shakopee, MN; MasterEmaco T 545 or T 545HT.
 - 2. Or equal.
- B. Physical Characteristics: One-component or two-component, magnesium-ammonium-phosphate concrete mortar.
- C. Functional Characteristics: None.
- D. Performance Characteristics:
 - 1. Compressive Strength, ASTM C109/C109M modified:
 - a. 1 Hour: 2,000 psi minimum.
 - b. 3 Hours: 5,000 psi minimum.
 - c. 1 Day: 6,000 psi minimum.
 - d. 28 Days: 7,500 psi minimum.
 - 2. Flexural Strength, ASTM C78/C78M Modified (3-inch by 4-inch by 16-inch prism) at 1 Day: 550 psi minimum.
 - 3. Modulus of Elasticity, ASTM C469 at 7 Days: 4.18 by 10⁶ psi minimum.
 - 4. Freeze-thaw Resistance and Resistance to Deicing Chemicals, ASTM C666/C666M, Procedure A, at 300 Cycles: 80 percent RDM minimum.
 - 5. Sulfate Resistance, ASTM C1012/C1012M, Length Change after 52 Weeks: 0.09 percent maximum.
 - 6. Application Temperature Range: 20 degrees F to 85 degrees F for normal weather applications 85 degrees F to 100 degrees F for hot weather applications.

2.02 REPAIR MORTAR SYSTEM NO. 2—HIGH EARLY STRENGTH REPAIR MORTAR

A. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 415.
2. Or equal.

B. Physical Characteristics: One or two-component, fast-setting, high early strength repair mortar.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Compressive Strength, ASTM C109/C109M:
 - a. 2 Hours: 1,500 psi minimum.
 - b. 1 Day: 4,500 psi minimum.
 - c. 7 Days: 8,000 psi minimum.
 - d. 28 Days: 9,000 psi minimum.
2. Flexural Strength, ASTM C348:
 - a. 1 Day: 850 psi minimum.
 - b. 7 Days: 1,000 psi minimum.
 - c. 28 Days: 1,100 psi minimum.
3. Modulus of Elasticity, ASTM C469:
 - a. 1 Day: 3.8×10^6 psi minimum.
 - b. 28 Days: 4.5×10^6 psi minimum.
4. Slant Shear Bond Strength, ASTM C882/C882M (Modified):
 - a. 1 Day: 2,500 psi minimum.
 - b. 7 Days: 2,900 psi minimum.
 - c. 28 Days: 3,100 psi minimum.
5. Splitting Tensile Strength, ASTM C496/C496M:
 - a. 1 Day: 850 psi minimum.
 - b. 7 Days: 1,200 psi minimum.
 - c. 28 Days: 1,300 psi minimum.
6. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 98 percent RDM.
7. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 or AASHTO T277, 28 Days: 960 coulombs maximum.

2.03 REPAIR MORTAR SYSTEM NO. 3—SHRINKAGE COMPENSATED REPAIR MORTAR

A. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 466 CI.
2. Or equal.

B. Physical Characteristics: One-component or two-component cement-based, flowable, shrinkage compensated repair mortar system.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Compressive Strength, ASTM C109/C109M:
 - a. 1 Day: 2,500 psi minimum.
 - b. 7 Days: 6,000 psi minimum.
 - c. 28 Days: 8,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 770 psi minimum.
3. Modulus of Elasticity, ASTM C469 at 28 Days: 5.9×10^6 psi minimum.
4. Slant Shear Bond Strength, ASTM C882/C882M Modified:
 - a. 7 Days: 2,150 psi minimum.
 - b. 28 Days: 3,000 psi minimum.
5. Freeze-thaw Resistance, ASTM C666/C666M, Procedure A, at 300 Cycles: 97.0 percent RDM.
6. Chloride Ion Permeability Based on Charge Passed, ASTM C1202 at 28 Days: 650 coulombs maximum.
7. Sulfate Resistance, ASTM C1012/C1012M after 6 Months: 0.01 percent length change maximum.

2.04 REPAIR MORTAR SYSTEM NO. 4—METALLIC AGGREGATE REPAIR MORTAR

A. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; Master T 300.
2. Or equal.

B. Physical Characteristics: One-component or two-component cement-based, flowable, metallic-aggregate repair mortar system:

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Compressive Strength, ASTM C109/C109M:
 - a. 1 Day: 5,000 psi minimum.
 - b. 7 Days: 8,800 psi minimum.
 - c. 28 Days: 12,000 psi minimum.
2. Abrasion Resistance, ASTM C779/C779M, Procedure A: Eight times more wear resistance than plain concrete.
3. Density: 215-pound per cubic foot.

2.05 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

A. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco T 310 CI.
2. Or equal.

B. Physical Characteristics: One-component or two-component, fast-setting, polymer modified cementitious based repair mortar system.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Compressive Strength, ASTM C109/C109M:
 - a. 1 Day: 2,500 psi minimum.
 - b. 7 Days: 5,000 psi minimum.
 - c. 28 Days: 7,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,500 psi minimum.
3. Slant Shear Bond Strength, ASTM C882/C882M Modified at 28 Days: 2,000 psi minimum.
4. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
5. Abrasion Resistance Depth of Wear, ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033 inch maximum.
6. Drying Shrinkage, ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.
7. Rapid Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 28 Days: Under 850 coulombs maximum.

2.06 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.07 EVAPORATION RETARDANT

- A. As specified in Section 03 39 00, Concrete Curing.

2.08 CURING COMPOUND

- A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

- A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system.
- B. Existing Concrete Work: Repair concrete damaged during construction activities.

3.02 APPLICATION

- A. General:
 - 1. Repair Mortar System No. 1: Patches, joints, and overlays 1/2 inch to 3 inches thick. Return to service in 1 hour.
 - 2. Repair Mortar System No. 2: Patches, joints, or overlays 1/2 inch to 3 inches thick. Return to service in 3 hours to 7 days.
 - 3. Repair Mortar System No. 3: Patches, joints, or overlays 1 inch thick or greater. Return to service in 7 days or more.
 - 4. Repair Mortar System No. 4: Heavy-duty joints or overlays 2 inches thick or greater. Return to service in 7 days or more.
 - 5. Repair Mortar System No. 5:
 - a. Patches and Overlays: 1/4 inch to 3 inches thick.
 - b. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
 - c. Working Time: 30 minutes at 70 degrees F.
 - d. Application Temperature Range: 45 degrees F to 90 degrees F.

3.03 PREPARATION

- A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Contracting Officer. Review proposed extent of repair with Contracting Officer.
- B. Remove unsound, deteriorated, or otherwise defective areas of concrete from Work areas.
 - 1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine, as appropriate to suit Site conditions.

2. Remove concrete to abrade substrate concrete surface to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot-long straightedge, in accordance with ASTM D4259.
 3. Where final surface is required to be flush with existing adjacent surface, remove existing concrete depth as required for application of minimum thickness of repair mortar.
- C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.
- D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.
- E. Remove unsound concrete to satisfaction of Contracting Officer.
- F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.
- G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to entire circumference of exposed steel reinforcement if one or more of the following surface conditions exist:
1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
 2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
 3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Contracting Officer.
- H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.
- I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminants from prepared areas.

- J. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System Nos. 1, 2, 3, and 5: Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar, as required by and in accordance with repair mortar manufacturer's printed instructions.
- K. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System No. 4 Repair Mortar: Dry, in accordance with material manufacturer's printed instructions.
- L. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Contracting Officer.

3.04 PROTECTION

- A. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.05 PLACEMENT

- A. Repair Mortar System Nos. 1, 2, 3, and 5:
 - 1. Remove standing and free water from prepared area.
 - 2. Immediately place mixed repair mortar into prepared area from one side to the other side.
 - 3. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
 - 4. Level repair mortar and screed to elevation of existing concrete.
 - 5. Finish to same texture as existing concrete around patch.
 - 6. Repair Mortar System No. 5 screed or use self-leveling mixture to obtain a uniform and plane surface.
- B. Repair Mortar System No. 4:
 - 1. Remove free water from prepared area.
 - 2. Immediately place mixed repair mortar into prepared area from one side to the other side.
 - 3. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
 - 4. Level repair mortar and screed to elevation of existing concrete.
 - 5. Finish to same texture as existing concrete around patch.

3.06 FINISHING

- A. Spray full strength evaporation retardant on fresh concrete to prevent rapid drying during hot and windy weather.

3.07 CURING

A. Repair Mortar System No. 1:

1. No curing is required.
2. Protect from rain immediately after placing.
3. Liquid-membrane curing compounds or plastic sheeting may be used in accordance with repair mortar manufacturer's instructions to protect the surface from precipitation.
4. Never wet cure.

B. Repair Mortar System Nos. 2, 3, 4, or 5: Apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.08 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Chain drag or light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed materials from mixer during construction for compliance with Specifications.
3. Provide minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:

1. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
2. Record locations on in situ bond tests on each type of applied repair mortar.

D. Testing laboratory retained by Contractor will provide the following:

1. Compression Strength Test:
 - a. Testing will follow a “modified” ASTM C109/C109M.
 - b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
 - c. Record location where repair mortar is being applied at time production samples are obtained.
2. Direct Tension Bond Test:
 - a. Two core samples will be obtained and tested for each 2,000 square feet of repair work.
 - b. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
 - c. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.
 - d. Record locations of bond tests on each type of applied repair mortar tested.

E. Retest mortar repairs that do not meet test requirements.

F. Repair and fill holes using same repair mortar where core samples have been removed.

3.09 MORTAR REPAIR FAILED TEST

- A. Remove and replace unacceptable Work.
- B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge, remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.
- C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.
- D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.
- E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.10 MANUFACTURERS' SERVICES

- A. Provide mortar manufacturer's representative at Site to advice on product selection, review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.11 CLEANING

- A. Remove excess repair mortar materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of repair areas, finishing, and curing, and dispose offsite at approved disposal site.

END OF SECTION

