ITEM 429
CONCRETE STRUCTURE REPAIR

429.1. Description. Remove unsound concrete, repair spalled or delaminated concrete, and replace concrete with repair materials.

429.2. Materials. Provide materials in accordance with the requirements of the following Items:
- Item 420, “Concrete Structures”
- Item 421, “Hydraulic Cement Concrete”
- Item 431, “Pneumatically Placed Concrete”
- Item 440, “Reinforcing Steel”
- DMS-6100, “Epoxies and Adhesives”
- DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair.”

For all repairs, provide repair materials suitable for the appropriate horizontal, vertical, or overhead application. Obtain approval for any proposed repair material unless a repair material type is indicated in the plans.

A. Repairs Less Than 1 in. Thick. Use cement mortar; epoxy mortar using a Type VIII epoxy per DMS-6100, “Epoxies and Adhesives”; or a prepackaged repair material meeting the requirements of DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair.”

B. Repairs Between 1 and 6 in. Thick. Use concrete or a prepackaged repair material meeting the requirements of DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair,” containing a coarse aggregate whose maximum size is less than 1/3 the thickness of the thinnest portion of the repair.

C. Repairs Thicker Than 6 in. Use concrete of the same class as the original construction unless otherwise approved.

For concrete, submit a mix design for approval in accordance with Item 421, “Hydraulic Cement Concrete,” with a water-cement ratio less than 0.45. Include all pertinent information on admixtures. Prepackaged repair materials not meeting the requirements of DMS-4655, “Rapid-Hardening Cementing Materials for Concrete Repair,” may be used only for with approval. Unless noted otherwise, provide repair materials capable of achieving a 7-day compressive strength of 4,000 psi for repair of reinforced concrete and 5,000 psi for prestressed or post-tensioned concrete members. Pneumatically applied concrete or mortar placed in accordance with Item 431, “Pneumatically Placed Concrete,” may also be used with approval. Prepare trial batches of any proposed repair material or application method as directed.

Provide steel pins, studs, or expansion bolts with a minimum diameter of 1/8 in. and a minimum length of 2 in. to attach reinforcement at the described location as shown on the plans or as directed. Provide reinforcing steel, either welded wire fabric or reinforcing bars, as required by this Item or as shown on the plans.

429.3. Equipment. Provide equipment as outlined below.
A. **Concrete Removal Equipment.** Provide sawing equipment capable of sawing the concrete to the specified depth. Provide power-driven chipping tools not heavier than the nominal 30-lb. class or hydrodemolition equipment for the bulk removal of concrete. Provide chipping hammers not heavier than the nominal 15-lb. class or hydrodemolition equipment for the removal of concrete beneath reinforcing steel or along the edges of the repair area.

B. **Surface Preparation Equipment.** Provide abrasive blasting or hydrodemolition equipment capable of preparing the concrete surface and exposed reinforcing steel for the repair material. Provide air compressors with air lines equipped with filters designed to remove all oil from the air for air-blast cleaning. Provide high-pressure water blasting equipment as necessary to prepare surfaces for repair.

C. **Proportioning and Mixing Equipment.** Provide mixing equipment for concrete in accordance with Item 421, “Hydraulic Cement Concrete.” Provide small motor-driven mixers for small quantities of repair material using the volumetric method of measuring ingredients. Provide mixing equipment as recommended by the manufacturer for prepackaged repair materials.

D. **Placing and Finishing Equipment.** Provide sufficient and appropriate hand tools for placing and finishing stiff plastic concrete or prepackaged repair materials, and for working them to the correct level for strike-off. Provide small, immersion-type vibrators for all repairs deeper than 6 in. Provide external form vibrators where immersion-type vibrators cannot be used.

429.4. **Construction.** Obtain approval for all materials and methods of application at least 2 weeks before beginning any repair work. Repair locations will be indicated on the plans or by the Engineer. Saw-cut the entire perimeter of all repair areas to a minimum depth of 1/2 in. Avoid re-entrant corners for areas to be repaired. Adjust the depth of the saw-cut as necessary to avoid cutting reinforcing steel near the surface of the concrete.

A. **Removal of Concrete.** Use power-driven chipping tools or hydrodemolition equipment to remove all loose or defective concrete. Avoid damage to sound concrete to remain in place. Avoid hitting reinforcing steel with the chipping tools. Once the initial concrete is removed, use small power-driven chipping or hydrodemolition equipment to undercut all exposed reinforcing steel. Expose the entire perimeter of the steel bars for the full area of the repair. Provide a minimum clearance of 1/2 in. between the exposed steel and the surrounding concrete or 2 times the maximum aggregate size, whichever is greater. Remove additional concrete as necessary to keep the repair area to a reasonably uniform depth. Damage to sound concrete or to the bond of reinforcing steel outside the repair area will be repaired at the Contractor’s expense. Obtain approval of the completed concrete removal before proceeding to surface preparation.

B. **Surface Cleaning.** Clean the area to be repaired by abrasive blasting, high-pressure water blasting, or other approved methods. Remove all loose particles, dirt, deteriorated concrete, or other substances that would impair the bond of the repair material. Clean exposed reinforcing steel of concrete, rust, oil, and other contaminants. Follow this with a high-pressure air blast for final cleaning.
C. Anchors. When reinforcing steel is required, support it using anchor studs, expansion hook bolts, grouted rebar, or steel pins capable of resisting a pullout force of 2,500 lb. Space anchors no more than 12 in. center-to-center on overhead surfaces, 18 in. center-to-center on vertical surfaces, and 36 in. center-to-center on top horizontal surfaces. Use at least 3 anchors in each individual patch area. Secure steel pins or studs into the concrete with epoxy or other approved methods. Do not use explosive force to shoot pins, studs, or other anchors into the concrete. Check the resistance to pullout of the reinforcing anchors as directed. Notify the Engineer before installation of the anchors. Locate anchors to prevent damage to prestressing tendons or conduits embedded in the concrete. Maintain a minimum clear cover of 3/4 in. between the reinforcing steel and anchors and the finished surface of the repair area.

D. Reinforcing Steel. Replace or supplement any reinforcing steel that has more than 25% section loss due to corrosion. Place supplemental reinforcing steel as indicated on the plans or as directed. Provide additional reinforcement for all areas where the thickness of the repair material will exceed 4 in. Use a single layer of 2 × 2 – W1.2 × W1.2 or 3 × 3 – W1.5 × W1.5 welded wire fabric or No. 3 bars spaced at 6 in., unless noted otherwise on the plans. Place the reinforcing steel parallel to the finished surface, and support it so that it will be roughly in the middle of the repair area and a minimum of 3/4 in. out from the surface to be covered. Lap adjacent sheets or bars at least 6 in. and tie them together securely at a spacing of at most 18 in. Pre-bend reinforcing steel fabric to fit around corners and into re-entrant angles before installing it. Place and secure reinforcement to prevent displacement due to repair material application.

E. Formwork. Where forms are necessary or desired, erect them in accordance with Item 420, “Concrete Structures.” Ensure forms are securely attached and mortar-tight if pressure-type application methods are used.

F. Substrate Preparation. Use a bonding agent if cement mortar or concrete is used for the repair material unless directed otherwise. Use either a cement scrub coat or a Type V or Type VII epoxy conforming to DMS-6100, “Epoxies and Adhesives,” as the bonding agent. Follow the manufacturer’s recommendations for bonding agents if prepackaged repair materials are used. Do not use an epoxy bonding agent with rapid setting repair materials. Apply a cement scrub coat bonding agent to the saturated surface-dry substrate by scrubbing, brushing, or other approved methods immediately before placing the repair material. Apply an epoxy bonding agent in accordance with the manufacturer’s recommendations. Ensure that any bonding agent used does not set or cure prematurely, creating a bond breaker.

Where saturated surface-dry (SSD) conditions are needed, prewet the substrate by ponding water on the surface for 24 hr. before placing the repair materials. If ponding is not possible, achieve SSD conditions by high-pressure water blasting 15 to 30 min. before placing the repair material. A saturated surface-dry condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

G. Repair Material Application. Place the repair material in an approved manner ensuring that the repair material is in intimate contact with the substrate and free of voids. Follow the manufacturer’s recommendations for prepackaged repair materials. Place repair materials so that the original lines and surfaces of the structure are
restored. Follow the requirements of Item 420, “Concrete Structures,” for temperature limitations at time of placement.

**H. Curing.** Cure all cement mortar and concrete repairs for 4 days in accordance with Item 420, “Concrete Structures.” Cure prepackaged repair materials in conformance with the manufacturer’s recommendations. Cure pneumatically placed concrete in accordance with Item 431, “Pneumatically Placed Concrete.” Remove forms when approved or at the end of the curing period.

**I. Epoxy Injection.** Perform epoxy injection as indicated in the plans or as directed, in accordance with Item 780, “Epoxy Injection.”

**J. Repair of Defective Work.** As directed, after completion of curing, repair or replace defective areas and patched areas that have debonded, at the Contractor’s expense.

**429.5. Measurement.** This Item will be measured by the square foot, in place, as measured on the surface of the completed repair. When a repair involves multiple surfaces, such as a corner, measurement will be made of all surfaces repaired.

**429.6. Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Concrete Structure Repair.” This price is full compensation for furnishing and placing all repair materials; removing all loose and defective concrete; saw-cutting; cleaning reinforcing steel; supplying and installing replacement or supplemental reinforcing steel, drive pins, studs, or expansion bolts; and equipment, labor, and incidentals.