

Special Specification 4003

Type CAC Concrete



1. DESCRIPTION

Remove unsound concrete and replace with Type CAC (calcium aluminate cement) concrete, for ultra-rapid concrete repairs.

2. MATERIALS

Provide materials that meet the following material requirements and in accordance with the requirements of the following Items:

- Item 420, "Concrete Substructures"
- Item 440, "Reinforcement for Concrete"

- 2.1. **Binder.** Provide cement binder meeting the following chemical composition, including the addition of supplementary cementing materials (SCMs) in accordance with Table 1.

Table 1
Chemistry Range for CAC + SCMs

Element	Range (%)
Al ₂ O ₃	20–55
CaO	28–42
SiO ₂	3–22
TiO ₂	0.5–3
Fe ₂ O ₃	0.5–18
MgO	0.2–8.5
SO ₃	0–3
K ₂ O + Na ₂ O	0–1.6

- 2.2. **Coarse Aggregate.** Supply mechanically crushed gravel or stone aggregates that meet the definitions in Tex-100-E. Provide coarse aggregate from sources listed in the Department's *Concrete Rated Source Quality Catalog* (CRSQC). Provide aggregate from non-listed sources only when tested and approved before use. Allow 30 calendar days for the Engineer to sample, test, and report results for non-listed sources. Do not combine approved material with unapproved material. The aggregate must conform to the quality requirements listed in Item 421, "Hydraulic Cement Concrete," and meet the gradation requirements of Grade 5 (67).
- 2.3. **Chemical Admixtures.** Use only chemical admixtures that are currently on the Department's MPL and of a type and dosage approved by the cement manufacturer before use. Submit the manufacturer's approval to the Engineer.
- 2.4. **SCMs.** The use of SCMs are permitted as an addition to the required cement content, provided that trial batches have demonstrated it to be suitable as determined by the Engineer and the cement manufacturer.

3. CERTIFICATION

The concrete supplier must be certified by the Volumetric Mixer Manufacturers Bureau (VMMB) or have an inspection report signed and sealed by a licensed professional engineer demonstrating that the equipment meets all requirements of ASTM C685. Provide documentation of the certification and calibration records.

4. PROPORTIONING

The Contractor will be responsible in determining the proportions of the concrete. In addition, the following requirements shall be met unless otherwise approved:

Table 2
Proportions of Concrete

Material/Properties	Unit	Type CAC
Cement Binder	lb./cu.yd., Min	675
	sacks/cu.yd., Min	7.2
Coarse Aggregate	Aggregate weight (%)	58 ±2
Fine Aggregate	Aggregate weight (%)	42 ±2
Total Water	lb./cu. yd., Max.	256
Slump	inches, Max.	10.00
Entrained Air	%	As shown on the plans
Water to Cement Ratio ¹	w-cm, Max.	0.35
Minimum Required Early Age Compressive Strength (Tex-418-A)	psi	3,000 @ 3 hr.
Minimum Required Ultimate Compressive Strength (Tex-418-A) ²	psi	4,000

1. Max w-cm ratio is based on the calcium aluminate cement binder quantity only.
2. As discussed under the "Job Control Compressive Strength Testing" section in this specification.

5. EQUIPMENT

Provide equipment as outlined below:

- 5.1. **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.
- 5.2. **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.
- 5.3. **Proportioning and Mixing Equipment.** Mix the concrete using volumetric trucks or as determined by the Engineer. Provide all necessary equipment needed to transport, mix, and place the concrete as determined by the manufacturer. Any special equipment needed will be proposed by the Contractor and be subject to approval.
- 5.4. **Placing and Finishing Equipment.** Provide sufficient and appropriate hand tools for placing and finishing stiff plastic concrete 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.

6. TRIAL BATCHES

Secure the Engineer's approval of the sources and the proportions of the cement binder, fine aggregate, coarse aggregate, water, SCMs, and chemical admixtures proposed for use with the Type CAC concrete. Perform all trial batches and testing necessary to substantiate the proposed mix designs, and provide documentation including mix design, material proportions, and test results substantiating that the mix design conforms to specific requirements. The trial batches will be conducted by the area office.

- Early Age Compressive Strength—minimum of 3,000 psi at 3 hr. of age cured at ambient temperature

- Ultimate Compressive Strength—minimum of 4,000 psi at 1 day of age cured under adiabatic conditions

7. CONSTRUCTION

Perform repairs, mix, and place the Type CAC concrete in accordance with manufacturer recommendations and as described in this specification. 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.

- 7.1. **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 two 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.
- 7.2. **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.
- 7.3. **Anchors.** When reinforcing steel is required, support it using bar supports, 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 three 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 1 in. between the reinforcing steel and anchors and the finished surface of the repair area.
- 7.4. **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.
- 7.5. **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.
- 7.6. **Substrate Preparation.** 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. An SSD condition is achieved when the surface remains damp when exposed to sunlight for 15 min.

- 7.7. **Initial Discharge.** Discharge a minimum of 2 cu. ft. or until the concrete is well mixed before discharging the concrete into the forms.
- 7.8. **Placement.** Avoid cold joints by pouring sequentially.
- 7.9. **Curing Concrete.** Wet mat cure in accordance with Section 420.4.10.2., "Water Curing," until repair is opened to traffic or as directed by the Engineer.

8. JOB CONTROL COMPRESSIVE STRENGTH TESTING

The specific procedure for determining the early age and ultimate compressive strength is as follows.

- 8.1. **Early Age Compressive Strength Determination.** For early compressive strength determination, one set of two 6 in. × 12 in. cylinders will be taken to determine the 3 hr. compressive strength. The test cylinders will be collected and delivered to the laboratory within 30 min. of the compressive strength test at the specified age. Exercise enough care to ensure that the test cylinders are not transported before reaching final (hardened) set.
- 8.2. **Ultimate Compressive Strength Determination.** The ultimate compressive strength will be determined by testing two sets of two 6 in. × 12 in. cylinders. The cylinders will be cured in an adiabatic box supplied or approved by the Engineer. Immediately place the cylinders into the box after casting. Measure and record the maximum temperature during the first 24 hr. of curing. Two specimens will be tested for compressive strength after 24 ±2 hr. and 48 ±4 hr. of adiabatic curing. The lowest compressive strength measured will be considered as the ultimate compressive strength and will meet the minimum requirements of 4,000 psi.
- 8.3. **Additional Field Cylinders.** In addition to the cylinders used for the early age and ultimate compressive strength determination, an additional set of three 4 in. × 8 in. cylinders will be cast, field cured for 24 ±2 hr., de-molded, and then moist cured at 73°F (22.8°C) until testing at 7 days of age.
- 8.4. **Frequency of Testing in the Field.** A total of six 6 in. × 12 in. and three 4 in. × 8 in. cylinders for 3-hr., ultimate, and 7-day compressive strength determination will be taken from every 30 cu. yd. of concrete or fraction thereof on each production day during construction, or more frequently as directed.

9. MEASUREMENT

When Type CAC concrete is shown on the plans to be a pay item, measurement will be by the cubic yard measured in place.

10. PAYMENT

Unless otherwise specified on the plans, the work performed, materials furnished, trial batches, equipment, labor, tools, and incidentals will not be paid for directly, but will be considered subsidiary to pertinent items.

When Type CAC concrete is specified as a pay item, 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 "Type CAC Concrete." This price is full compensation for concrete removal and preparation; formwork; furnishing, hauling, and placing concrete and for all labor, tools, equipment, concrete, and incidentals necessary to complete the work. The preparation of trial batches described will not be paid for directly and are considered subsidiary to this Item.