

ITEM 431

PNEUMATICALLY PLACED CONCRETE

431.1. Description. This Item shall govern for furnishing and placing of "Pneumatically Placed Concrete" for encasement of designated structural steel members, the repair of deteriorated or damaged concrete and for other work as shown on the plans.

431.2. Materials. Unless otherwise specified on the plans, Class II concrete shall be used for encasement and Class I concrete shall be used for repair.

All material shall conform to the pertinent requirements of the following items:

Item 421, "Portland Cement Concrete"

Item 433, "Joint Sealants and Fillers"

Item 437, "Concrete Admixtures"

Item 440, "Reinforcing Steel"

with the following exceptions:

(1) Portland Cement Concrete. Fine aggregate shall conform to the requirements of Table 2, Grade 1, and coarse aggregate shall conform to the requirements of Table 1, Grade 7, unless otherwise shown on the plans.

(2) Joint Sealants and Fillers. Unless otherwise shown on the plans, Preformed Bituminous Fiber Material shall be used.

(3) Reinforcing Steel. Steel drive pins, studs or expansion bolts used for the attachment of reinforcement for repair of deteriorated or damaged concrete shall have a minimum diameter of 1/8 inch and a minimum length of two (2) inches. Size and location of drive pins or studs and method of attachment of reinforcement shall be as specified herein or as shown on the plans.

The equipment used for driving the pins or studs shall be of the type which uses an explosive for the driving force and shall be capable of inserting the stud or pin to the required depth without damage to the surrounding concrete.

Expansion hook bolts (1/4 inch diameter) shall be placed in a drilled hole of the size and depth recommended by the manufacturer.

The Engineer may require that a test be made of the driving equipment for steel drive pins and check the resistance to pullout of the expansion bolts, prior to approving their use.

431.3. Proportioning and Mixing. The Contractor shall submit a mix design for approval of the Engineer. The basic mix design shall conform to the following:

TABLE 1

CLASSES OF CONCRETE

Class	Ratio of Cement of Total Aggregate*	Minimum 7 Day Compressive Strength Cores (psi)**
I	1:4	2520
II	1:5	2100
III	1:7	1400

* The Contractor may use a design containing more cement than required by this specification, when approved by the Engineer.

** 7 Day compressive strength is based on 70% of 28 day compressive strength.

The cement and aggregates shall be measured by volume with enough water added to bring the materials to the desired consistency.

Test panel(s) will be required prior to approval of the mix design. The concrete shall be applied to a plywood sheet and each test panel shall be a minimum size of 18 x 18 x 3 inches. The panel(s) shall be shot with approximately the same air pressure, nozzle tip and position to be used for the production work. The panel(s) shall be cured in the same manner required for the work.

Three (3) cores, two (2) inch diameter, will be taken from each test panel and tested in compression at seven (7) days. The average strength of the cores shall conform to the strengths shown in Table 1, herein. Testing of cores shall be in accordance with Test Method Tex-424-A.

The Engineer may require additional test panels during the progress of the work if there is any change in materials, equipment or nozzle operator.

Unless otherwise specified, mixing and application may be done by either the dry mix or wet mix process. The materials shall be thoroughly and uniformly mixed using a mixer designed for use with pneumatic application. It may be either a paddle type or drum type mixer. Transit mix concrete may be used for the wet process.

All mixing and placing equipment shall be cleaned at regular intervals and be kept in acceptable working condition. The nozzle liner, water and air injection system should be inspected daily and replaced when the parts are worn.

431.4. Construction Methods.

(1) Surface Preparation. All surfaces on which pneumatically placed concrete is to be applied shall be cleaned thoroughly of all paint, rust, loose mill scale, grease or oil, deteriorated or loose concrete, or any other foreign materials which are likely to prevent adequate bond. Concrete and reinforcing steel surfaces which will be in contact with pneumatically placed concrete shall be abrasion blasted clean, and then the surface cleaned of loose material with filtered compressed air.

Concrete surfaces on which pneumatically placed concrete is to be applied shall be thoroughly moistened by wetting just prior to placement. Excess water shall be allowed to drain or shall be removed by filtered air blasting.

Where standing or running water is encountered it shall be removed before applying the concrete.

The periphery of repair areas shall be saw cut one (1) inch deep and existing concrete removed as necessary to prevent feather edges.

Concrete adjacent to a crack shall be removed in such a manner as to leave the existing reinforcing steel throughout the repair area as intact as possible.

(2) Reinforcement. All reinforcement to be embedded in pneumatically placed concrete shall be clean and free from loose mill scale, rust, oil or other coatings which might prevent adequate bond.

Reinforcement shall be secured rigidly in the position shown on the plans. The clear distance between reinforcing bars shall be at least 2-1/2 inches.

Minimum clear distance between forms and reinforcement and for cover shall be as shown on the plans. Space shall be provided for splicing bars in the approved manner.

For repair of structures, welded wire fabric shall be held securely approximately 3/4 inch out from the surface to be covered. Adjacent sheets shall lap at least six (6) inches and sheets shall be fastened together securely by tying at intervals not to exceed 18 inches. For attaching wire fabric, steel drive pins shall be driven to a penetration of not less than one (1) inch into the face of the designated portions to be covered or repaired. In lieu of steel drive pins, the Contractor may use 1/4 inch hook bolts installed in accordance with the manufacturer's recommendation. The wire fabric shall be fastened securely to each pin or bolt. Any pin that does not reach the desired depth or hook bolt that does not anchor properly in its hole may remain in place but must be supplemented by an additional pin or bolt installation. The welded wire fabric shall have a minimum of one (1) inch cover to the finished concrete surface.

For the encasement of designated portions of steel structures, the welded wire fabric shall be bent to a template to conform as nearly as possible to the outlines of the steel members to be encased. Drilled holes not less than 1/2 inch nor more than one (1) inch in diameter shall be provided in the webs of the members as near as practicable to the flanges for the purpose of attaching the reinforcing fabric. These holes shall be spaced approximately three (3) feet on centers. The welded wire fabric shall be held securely approximately 3/4 inch out from the surfaces of the members to be encased. Adjacent sheets shall lap at least six (6) inches and sheets shall be fastened together securely by tying at intervals not to exceed 18 inches. In placing the wire fabric, 3/8 inch diameter rods shall be placed through the holes provided in the webs of the structural steel members to be encased, and the wire fabric tied securely to these rods. Ties shall be spaced approximately 12 inches on centers.

(3) Placing of Pneumatically Placed Concrete.

(a) General. The existing concrete surface shall be in approximately a saturated surface dry condition when concrete is placed.

The mix shall be sufficiently wet to adhere properly and sufficiently dry so that it will not sag or fall from vertical or inclined surfaces, or separate in horizontal work.

No work shall be done without the permission of the Engineer when the temperature is lower than 35 F. Concrete shall not be applied to a surface containing frost or ice. After placing, the concrete shall be protected from freezing and/or quick drying.

The concrete may be applied in one coat; however, if the concrete begins to sag, it shall be applied in two or more coats. In covering vertical surfaces, placing of the concrete shall begin at the bottom and be completed at the top.

Any sag or other defects shall be corrected to proper section by the Contractor at his expense and as directed by the Engineer.

The nozzle shall be held at approximately two (2) to four (4) feet from the surface and positioned so

that the concrete shall impact as nearly as possible at right angles to the surface. Any deposit of loose sand shall be removed prior to placing any initial or succeeding layers of pneumatically placed concrete. Should any deposit of loose sand be covered with pneumatically placed concrete, the concrete shall be removed and replaced with a new coat of pneumatically placed concrete after the receiving surface has been properly cleaned.

The original surface and the surface of each layer which is permitted to harden before applying succeeding layers shall be washed with water and filtered air blasted to remove loose material. Any material which rebounds and does not fall clear of the work or which collects on horizontal surfaces shall be blown off from time to time to avoid leaving sand pockets.

A steel edged screed shall be used to cut the fresh concrete to proper section followed by floating, as necessary, and a final steel trowel finish.

The use of the wet mix process will not be permitted for the repair of deteriorated or damaged concrete.

(b) Dry Mix Process. The compressor or blower used to supply air shall be capable of delivering a sufficient volume of oil free air, at the pressure shown in Table 2. Steady pressure must be maintained throughout the placing process.

The water pump shall be of sufficient size and capacity to deliver the water to the nozzle at a pressure of not less than 15 psi in excess of the required air pressure.

TABLE 2
COMPRESSOR CAPACITIES

Compressor Capacity CFM	Host Diameter, Inches	Maximum Size of Nozzle Tip, inches	Operating Air Pressure Available, psi
250	1	3/4	40
315	1 1/4	1	45
365	1 1/2	1 1/4	55
500	1 5/8	1 1/2	65
600	1 3/4	1 5/8	75
750	2	1 3/4	85

The values shown in Table 2 are based on a hose length of 150 feet with the nozzle not more than 25 feet above the delivery equipment. Operating pressures shall be increased approximately five (5) psi for each additional 50 feet of hose and approximately five (5) psi for each 25 feet the nozzle is raised.

(c) Wet Mix Process. The pump shall operate so that the line pressure is between 100 psi and 300 psi for delivery hoses from 1-1/2 inches to three (3) inches in diameter. The mixing equipment shall be capable of thoroughly mixing the materials in sufficient quantity to maintain continuous placement. When transit mix concrete is used, the equipment shall conform to Item 522, "Portland Cement Concrete Plants".

(4) Construction Joints. Particular care shall be given to the formation of construction joints. Unless otherwise noted on the plans, all joints subject to compressive stress or over existing construction joints shall be square butt joints. Tapered joints will be permitted at other locations except the outside one (1) inch shall be perpendicular to the surface.

(5) Rebound. Accumulation of loose particles of concrete which do not adhere to the surface being covered shall be removed and discarded. Concrete shall not be placed over such material.

(6) Curing. Encasements shall be water cured for four (4) curing days.

The repair area shall be cured using a piece of wet cotton mat taped into place over the repaired area followed with a covering of four (4) mil minimum sheet plastic also taped into place. The sheet plastic shall be larger than the mat and shall be continuously taped at the edges with three (3) inch minimum width tape (air duct tape or better) to completely enclose the mat and hold in the moisture. After four (4) days or longer, the mat and cover may be removed.

After the required curing period, the repaired area will be tested by striking with a hammer to check for soundness and bond to existing concrete.

431.5. Measurement. Measurement of pneumatically placed concrete for encasement of structural members will be by the square foot, in place, of the actual contact area.

Measurement of pneumatically placed concrete for repair and restoration of concrete structures, will be by the cubic foot, in place, using the surface area times the average depth of the patch.

431.6. 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 per square foot for "Pneumatically Placed Concrete (Encasement)", or per cubic foot for "Pneumatically Placed Concrete (Repair)".

This price shall be full compensation for all cement, aggregate, water, reinforcement, furnishing and driving all steel drive pins, furnishing and placing expansion bolts, for the removal of deteriorated concrete, for mixing and placing and curing pneumatically placed concrete, and for all labor, tools, equipment and incidentals necessary to complete the work.