

CITY OF SAN ANGELO**ITEM 421****PORTLAND CEMENT CONCRETE****421.1. DESCRIPTION.**

This Item shall govern for Portland Cement Concrete to be used in concrete pavement, concrete structures and other concrete construction.

421.2. MATERIALS.

The concrete shall be composed of Portland Cement, (with or without) fly ash, fine and coarse aggregates and water.

(1) **Cement.** Portland Cement shall conform to TxDOT Item 524, "Hydraulic Cement".

(2) **Mixing Water.** Water for use in concrete and for curing shall be free from oils, acids, organic matter or other deleterious substances and shall not contain more than 1000 parts per million of chlorides as Cl nor more than 1000 parts per million of sulfates as SO₄.

Water from municipal supplies approved by the State Health Department will not require testing, but water from other sources will be sampled and tested before use in concrete. Tests shall be made in accordance with AASHTO T26.

Water used in white Portland Cement Concrete shall be free from iron and other impurities which may cause staining or discoloration.

(3) **Coarse Aggregate.** Coarse aggregate shall be washed and shall consist of durable particles of gravel, crushed blast furnace slag, crushed stone, or combinations thereof and shall be free from frozen material or injurious amounts of slat, alkali, vegetable matter, or other objectionable material either free or as an adherent coating. When white Portland cement is specified, the coarse aggregates used in the concrete shall be light colored. Quality shall be reasonably uniform throughout. Coarse aggregate shall not contain more than 0.25 percent by weight of clay lumps, nor more than one (1) percent by weight of shale, nor more than five (5) percent by weight of laminated and/or friable particles when tested in accordance with Test Method Tex-413-A. Coarse aggregate from each source shall have a wear of not more than 40 percent when tested in accordance with Test Method Tex-410-A.

When tested in accordance with Test Method Tex-401-A, the coarse aggregate, including combinations of aggregates when used, shall conform to the gradation requirements shown in Table 1.

**TABLE 1
COARSE AGGREGATE GRADATION CHART**

Aggregate Grade No.	Nominal Size Inches	Percent Retained on Each Sieve								
		2-1/2 in.	2 in.	1-1/2 in.	1 in.	3/4 in.	1/2 in.	3/8 in.	No. 4	No. 8
1	2	0	0-20	15-50		60-80			95-100	
2	1-1/2		0	0-5		30-65		70-90	95-100	
3	1-1/2		0	0-5		10-40	40-75		95-100	

The loss by decantation in accordance with Test Method Tex-406-A plus the allowable weight of clay lumps, shall not exceed one (1) percent, or the value shown on the Plans, whichever is smaller. In the case of aggregates made primarily from the crushing of stone, if the material finer than the 200 sieve is definitely established to be the dust of fracture, essentially free from clay or shale, as established by Part III of Test Method Tex-406-A, the percent may be increased to 1.5.

(4) Fine Aggregate. Fine aggregate shall be washed and consist of clean, hard, durable and uncoated particles of natural or manufactured sand or a combination thereof, with or without a mineral filler. When white Portland Cement is specified the fine aggregate used in the concrete shall be light colored. It shall be free from frozen material or injurious amounts of salt, alkali, vegetable matter or other objectionable material and it shall not contain more than 0.5 percent by weight of clay lumps. When the aggregate is subjected to the color test for organic impurities in accordance with Test Method Tex-408-A, the test result shall not show a color darker than standard.

Unless otherwise shown on the Plans, the acid insoluble residue of fine aggregate used in concrete subject to direct traffic shall be not less than 60 percent by weight when tested in accordance with Test Method Tex-612-J.

When tested in accordance with Test Method Tex-401-A, the fine aggregate or combinations of aggregates, including mineral filler, shall conform to the gradation requirements shown in Table 2.

**TABLE 2
FINE AGGREGATE GRADATION CHART**

Aggregate Grade No.	Percent Retained on Each Sieve							
	3/8 in.	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
1	0	0 to 5	0 to 20	15 to 50	35 to 75	65 to 90	90 to 100	97 to 100

Where manufactured sand is used in lieu of natural sand, the percent retained on the No. 200 sieve shall be 94 to 100.

Where the sand equivalent value is greater than 85, the retainage on the No. 50 sieve may be 65 to 94 percent.

Fine aggregate will be subjected to the Sand Equivalent Test (Test Method Tex-203-F / ASTM D 2419). The sand equivalent shall not be less than 80 unless otherwise shown on the Plans.

For all classes of concrete, the fineness modulus shall be between 2.30 and 3.10 as determined by Test Method Tex-402-A.

(5) Mineral Filler. Mineral filler shall consist of stone dust, clean crushed sand, or other approved inert material. When tested in accordance with Test Method Tex-401-A, it shall conform to the following gradation:

Retained on No. 30 Sieve	0 percent
Retained on No. 200 Sieve	0-35 percent

(6) Admixtures. Admixtures and their use shall conform to the requirements of TxDOT Item 437, "Concrete Admixtures". Calcium chloride will not be permitted.

(7) Mortar and Grout. Unless otherwise specified or approved by the City, mortar and grout shall consist of one part Portland cement, two parts finely graded sand and sufficient water to provide the desired consistency. Mortar may contain admixtures.

Post tensioning grout shall be in accordance with TxDOT Item 426, "Prestressing".

Mortar shall have a consistency such that the mortar can be easily handled and spread by trowel. Grout shall have a consistency such that the grout will flow into and completely fill all voids.

When required to prevent color difference, white cement shall be added to produce the color required. When shown on the Plans or in the specifications, or when required by the City, latex adhesive conforming to the requirements of TxDOT Departmental Material Specification D-9-8110 shall be added to the mortar.

421.3. STORAGE OF MATERIALS.

(1) Cement, and Mineral Filler. All cement and mineral filler shall be stored in well-ventilated weatherproof buildings or approved bins, which will protect them from dampness or absorption of moisture. Each shipment of packaged cement shall be kept separated to provide easy access for identification and inspection.

(2) Aggregates. The method of handling and storing concrete aggregates shall prevent contamination with foreign materials. If the aggregates are stored on the ground, the sites for the stockpiles shall be clear of all vegetation and shall be level. The bottom six-inch layer of aggregate shall not be disturbed or used without re-cleaning.

(3) Admixtures. Admixtures shall be stored in accordance with TxDOT Item 437, “Concrete Admixtures”.

421.4. MEASUREMENT OF MATERIALS.

Except as noted below, the measurement of materials used in batches of concrete shall be by weight.

Water may be measured by volume or by weight.

Cement shall be weighed separately from other materials. Weighing of sacked cement will not be required. When sacked cement is used, the quantity of cement per batch shall be based upon using full bags of cement. Batches involving use of fractional bags will not be permitted except for small hand mixed batches of approximately five (5) cubic feet or less and when an approved method of volumetric measurement is used.

Where two (2) or more sizes or types of aggregates are used, each type and/or size shall be measured separately.

When determining aggregate batch weights, proper allowance shall be made for the water content in the aggregate (free water and/or absorption).

Admixtures shall be measured and dispensed in accordance with TxDOT Item 437, “Concrete Admixtures”.

Measuring materials by volumetric methods may be used where permitted by the specifications. When a mixer using volumetric batching of materials is used, an accurate method of measuring by volume shall be provided. Continuous volumetric mixers shall be calibrated to assure correct measurement of materials.

The amount of each ingredient in the batch shall be measured to within plus or minus one percent of required amount except that water shall be measured to within plus or minus one gallon and admixture tolerances shall be in accordance with TxDOT Item 437, “Concrete Admixtures”.

421.5. EQUIPMENT.

(1) Weighing and Measuring Equipment. Weighing and measuring equipment shall conform to TxDOT Item 520, “Weighing and Measuring Equipment”.

(2) Mixing Equipment.

(a) General. All equipment, tools, and machinery used for hauling materials and performing any part of the work shall be maintained in such condition as to insure completion of the work under way without excessive delays for repairs or replacement.

The mixer shall be of an approved type and size that will produce uniform distribution of the material throughout the mass and shall be capable of producing concrete meeting the requirements of these specifications.

For all mixers, an adequate water supply and an accurate method of measuring the water shall be provided.

Delivery of concrete to the work site and the discharge from the hauling equipment, agitating, or non-agitating, shall be in accordance with the requirements shown on the Plans or in the governing specifications.

Specific requirements for batch plants, mixers and other equipment shall be in accordance with Item 360, "Concrete Pavement", or TxDOT Item 522, "Portland Cement Concrete plants", or other specifications.

421.6. MIXING.

(1) General. Mixed concrete, which does not conform to specification requirements, shall not be placed. Mixing shall be in accordance with TxDOT Item 522, "Portland Cement Concrete plants", except that mixing with continuous volumetric mixers will be in accordance with Section 421.6.(2) and except as set out in Section 421.6.(3).

(2) Continuous Volumetric Mixers. Mixing shall be in accordance with mixer manufacturer's recommendations unless otherwise revised by the City.

(3) Mixing of concrete by hand methods or by the use of a small motor driven mixer will be permitted for small placements of approximately two (2) cubic yards or less when authorized by the City. Hand mixed batches shall not exceed a two-sack batch in volume. For such placements the mix may be proportioned by approved volumetric methods.

421.7. CLASSIFICATION AND MIX DESIGN.

The Contractor shall furnish the mix design, using a coarse aggregate factor acceptable to the City, for the class(s) of concrete specified, to conform with the requirements contained herein and in accordance with Construction Bulletin C-11. The Contractor shall perform, at his entire expense, the work required to substantiate the design. Sampling and testing of concrete will be the responsibility of the City. Complete concrete design data shall be submitted to the City for approval.

The Contractor shall determine and measure the batch quantity of each ingredient, including all water, not only for batch designs but also for all concrete produced for the project. The mixes shall conform to these specifications and other requirements shown on the Plans.

The Contractor may accept a design from the City; however, this acceptance will not relieve the Contractor of the responsibility of providing concrete meeting the requirements of these specifications.

Mix designs from previous or concurrent jobs may be used without trial batches if it is shown that no substantial change in any of the proposed ingredients has been made.

No charge will be made for existing designs furnished by the City. The cost to the City of preparing a new mix design will be charged to the Contractor and deducted from the payment for the work.

Concrete for pneumatically placed concrete shall be in accordance with Item 431, “Pneumatically Placed Concrete”.

The Contractor shall have the option of using chemical admixtures with all classes of concrete in accordance with Item 437, “Concrete Admixtures”, except where the use of specific admixtures is required or prohibited in this or other items. For example, a mid-range water reducer can help maintain the water/cement ratio below the maximum allowed and provide a better workability to the concrete mix than if a mid-range water reducer was not used.

When a retarding admixture is required for hot weather concreting, the amount to be used will be as required in TxDOT Item 437, “Concrete Admixtures”, subject to change by the City when required. When used for extended retardation, the amount to be used will be established by several trial batches with varying retarder content and simulating the placing conditions to be encountered and tested in accordance with Tex-440-A.

When entrained air is required, the concrete shall be designed to entrain five (5) percent air when Grade 1 or 2 coarse aggregate is used, six (6) percent when Grade 3 or 4 coarse aggregate is used, and seven (7) percent for Grades 5,6 or 7 unless otherwise specified by the City. Concrete as placed shall contain the proper amount of entrained air as required herein with a tolerance of plus or minus 1-1/2-percentage points. Acceptance of concrete with occasional variations between 1-1/2 and three (3) percentage points over the specified amount will be based on strength tests as required by the City. When the quantity of entrained air is found to be more than three (3) percentage points over or two (2) percentage points under those values given herein, the concrete will be rejected.

Entrained air will be required for bridge slabs, top slabs of direct traffic culverts, concrete pavement, dense and regular concrete overlays, piers, bents, precast piling (non-prestressed), drilled shafts placed in water, bridge railing, concrete traffic barrier and for other items of work as may be specified, on the Plans or in other specifications.

**TABLE 3
SLUMP REQUIREMENTS**

Concrete Designation	Desired Slump Inches	Max Slump Inches
A. Structural Concrete		
(1) All drilled shafts	6	7
(2) Thin-Walled Section (9" or less)	4	5
(3) Slabs, Concrete Overlay, Caps, Columns, piers, Wall sections over 9", etc.	3	4
(4) Prestressed Concrete Members	4	5
(5) Concrete traffic Barrier (cast-in-place or precast), Concrete Bridge Railing	4	5
(6) Dense concrete overlay	¾	1
(7) Concrete placed underwater	6	7
(8) Concrete with High Range Water Reducer	-	8
B. Concrete Pavement	1-1/2	3 max 1 min
C. Riprap, curb, gutter, slipformed and extruded concrete	As Approved by the City	

Note: No concrete will be permitted with a slump in excess of the maximums shown. When high-range water reducing admixtures are used, the slump shall not exceed eight (8) inches.

421.8. QUALITY OF CONCRETE.

The concrete shall be uniform, workable and of a consistency acceptable to the City. The cement content, maximum allowable water/cement ratio, the desired and maximum slump, the proper amount of entrained air and the strength requirement for all classes of concrete shall be the responsibility of the Contractor to provide concrete meeting these requirements.

During the progress of the work, a certified testing laboratory technician will cast test cylinders and/or beams, perform slump and entrained air tests and will make temperature checks, as required, to ensure compliance with the specifications.

Unless otherwise shown on the Plans, the Contractor shall furnish and properly maintain all test molds. The test molds shall meet the requirements of Test Methods Tex-418-A / ASTM C 39 and Tex-448-A / ASTM C 78 and, in the opinion of the City, must be satisfactory for use at the time of use. In addition, the Contractor shall be responsible for furnishing personnel to remove the test specimens from the molds and transport them to the proper curing location at the schedule designated by the City and in accordance with the governing specification. For all concrete items the Contractor

shall have a wheelbarrow, or other container acceptable to the City, available to use in the sampling of the concrete.

All labor and equipment furnished by the Contractor will be considered subsidiary to the various bid items and will not be paid for directly.

A strength test is defined as the average of the breaking strength of two (2) cylinders or two (2) beams as the case may be. Each specimen will be tested in accordance with Test Methods Tex-418-A / ASTM C 39 or Tex-448-A / ASTM C 78.

Slump tests will be performed in accordance with Test Method Tex-415-A / ASTM C 143. Entrained air tests will perform in accordance with Test Method Tex-416-A / ASTM C 231.

If the required strength or consistency of the class of concrete being produced cannot be secured with the minimum cement specified or without exceeding the maximum water/cement ratio, the Contractor will be required to furnish different aggregates, use a water reducing agent, an air entraining agent or increase the cement content in order to provide concrete meeting these specifications.

All test specimens, beams or cylinders, representing tests for removal of forms and/or falsework shall be cured using the same methods and under the same conditions as the concrete represented.

“Design Strength” beams and cylinders shall be cast and cured in accordance with Test Method Tex-447-A / ASTM C 31.

When the specified concrete strength is by 28-day compressive strength tests, job control testing will be by 7-day compressive strength tests. The minimum strength requirement for 7-day tests will be 70 percent of the specified minimum 28-day compressive strength. If the required 7-day strength is not obtained with the quantity of cement specified in Table 4, changes in the batch design will be made as specified in this article. For an occasional failure of the 7-day compressive test, the concrete may be tested at 28-days for final evaluation. Strength test requirements for Type II cement will govern when Type I/II cement is used.

**TABLE 4
CLASSES OF CONCRETE**

Class of Concrete	Cement per C.Y. Min. (sacks)	Min. Comp. Strength 28 day psi	Min. Flexural Strength 7 day psi	Max. Water / Cement Ratio Gal/sk	Coarse Aggregate Grade No.	General Usage (information only)
A	5.0	3,000	425 390 (c)	6.5	1-2- 3-4- 8 (a) (d)	Drilled Shafts; Culverts, except Top Slab of Direct Traffic Culverts; Inlets; Manholes, Headwalls; Approach Slabs; Curb; Gutter, Conc. Retards; Sidewalks; Driveways; Conc. Pavement; Back-up Walls; Anchors
B	4.0	2,000	280	8.0	2-3-4-5- 6-7	Riprap, Small Roadside Signs and Anchors
C	6.0	3,600	510 470 (c)	6.0	1-2-3-4- 5 (d)	Drilled Shafts; Bridge Substructure; Bridge Railing; Culverts, except Top Slab of Direct Traffic Culverts; Wing Walls; Approach Slab; Concrete Traffic Barrier (cast-in-place)
D	2.0 to 3.0	1,000 to 1,500	215±	11.0±	2-3-4-5- 6-7	Riprap Fill Voids Fills
E	6.0	3,000	425	6.0	2-3-4-5	Seal Concrete
S	6.5	4,000	570 525 (c)	5.0	2-3-4-5	Bridge Slab; Top Slab of Direct Traffic Culvert; Bridge Substructure
P	5.0	3,500	555 (b)	6.25	2-3	Concrete Pavement
DC	8.75	5,500	720	3.6	6	Dense Concrete Overlay
CO	7.0	4,600	640	4.5	6	Concrete Overlay

- (a) Grade 8 aggregate for use in extruded curbs, unless the City approves a larger size.
- (b) Minimum running average for concrete pavement (in accordance with Construction Bulletin C-II).
- (c) When Type II or Type I/II cement is used.
- (d) Unless otherwise permitted by the City, Grade I coarse aggregate may be used only in massive foundations with four (4) inch minimum clear spacing between reinforcing steel bars. Grade I aggregate may be used in drilled shafts.

421.9. MEASUREMENT AND PAYMENT.

The work performed, materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this Item will not be measured or paid for directly, but will be considered subsidiary to the various bid items of the contract.