Subsection 4.07
Concrete

I. Scope: This item includes materials for Portland cement concrete.

II. Materials

A. **General:** Unless otherwise specified on the plans, materials shall conform to the requirements of this Subsection.

The cement shall be Type II Portland cement. Type III cement shall be used when high-early strength concrete is required by the plans or special provisions. The Contractor shall obtain written permission of the Engineer, and shall assume all additional costs incurred by his use of another type of cement. Cement shall conform to DMS-4600 "Hydraulic Cement. When Type III cement is used, the average strength of briquettes at the age of 7 days shall be higher than that attained at 3 days. Either the tensile or the compressive tests may be used for either type cement.

Any cement storage shall be a suitable weather-tight building or bin which will protect the cement from dampness, and cement shall be so placed as to provide easy access for proper inspection and identification of each shipment.

Concrete will be the type shown in Table 1 for the usage shown. Usages not shown will be determined as shown on the plans or determined by the Engineer or ODR. When required, the air-entraining agent shall be used in such an amount as will affect the entrainment of between 3% and 7% of air, by volume, of the concrete as discharged by the mixer. Other admixtures or blends may be used with the approval of the Engineer.

Table 1
Concrete Classes

Design Strength	Max. w/cm Ratio	Coarse Aggregate Grades	Cement Types	General Usage
3000 psi	0.60	1-6	II, III[1]	Curb, gutter, curb & gutter, sidewalks, non-reinforced drilled shafts, thrust block, riprap, wing walls, headwalls
4000 psi	0.45	2-5	II, III[1 2]	Paving[2], driveways, valleys, spandrels, inlets, manholes, direct traffic culverts

[1] Type III must be approved for use.
[2] See Subsection 4.12 for Concrete Paving

B. Cement Types: Portland cement shall conform to Types II, III in ASTM C 150 "Portland Cement."

C. Admixtures: Unless otherwise provided in the plans or special requirements, approved types of admixtures to minimize segregation, to improve workability, or to reduce the amount of mixing water may be used in the rate of dosage specified by the Engineer. Admixtures shall not be used to replace cement. The following types of

admixtures are generally used:

1. Air-Entraining Admixtures: Air-entraining admixtures shall conform to DMS-4640 "Chemical Admixtures for Concrete." An air entraining agent shall be used in all concrete. The air entraining agent shall be between 3% and 7% of air, by volume, of the concrete as discharged by the mixer.

2. Chemical Admixtures: Accelerating, retarding, and water-reducing admixtures, if used, shall conform to DMS-4640 "Chemical Admixtures for Concrete." Calcium chloride, if used, shall not exceed 2% percent by weight of the cement**.**

3. Pozzolanic Admixtures: Fly ash and other pozzolans, when used as an admixture shall conform to DMS-4610 "Fly Ash."

D. Coarse Aggregate: Coarse aggregate shall consist of durable particles of gravel, or crushed stone of reasonably uniform quality throughout, free from injurious amounts of salt, alkali, vegetable matter or other objectionable material, either free or as an adherent coating on the aggregate. Aggregate will meets the requirements of Table 2.

Table 2
Coarse Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Lumps, % Max	Tex-413-A	0.25
Weight of Shale, % Max		1.0
Weight of Laminate and Friable Particle, % Max		5.0
L.A. Abrasion Wear, %Max	Tex-410-A	40
5-Cycle Magnesium Sulfate Soundness, % Max	Tex-411-A	18
Loss by Decantation, % Max	Tex-406-A	1.5

Provide coarse aggregate that conforms to the gradation requirements shown in Table 3 when tested in accordance with Tex-401-A.

Table 3
Coarse Aggregate Gradation Chart

Aggregate Grade No.	Nominal Size	Percent Retained on Each Sieve								
		2-1/2 Inch	2 Inch	1-1/2 Inch	1 Inch	3/4 Inch	1/2 Inch	3/8 Inch	No. 4	No. 8
1	2 1/2	0	0-20	15-50		60-80			95-100	
2 (467)*	1 1/2		0	0-5		30-65		70-90	95-100	
3	1		0	0-5		10-40	40-75		95-100	
4 (57)*	1			0	0-5		40-75		90-100	95-100
5 (67)*	3/4				0	0-10		45-80	90-100	95-100
6 (7)*	1/2					0	0-10	30-60	85-100	
7	3/8						0	5-30	75-100	
8	No. 4						0	0-5	35-60	90-100

*Numbers in parenthesis indicate that these gradations conform to corresponding ASTM gradation from ASTM C 33. The number ranges are the percentages retained on individual sieves.

All aggregates shall be handled and stored in such a manner as to prevent size segregation and contamination by foreign substances. When segregation is apparent, the aggregate shall be re-mixed. At the time of its use, the aggregate shall be free from frozen material and aggregate containing foreign materials will be rejected. Coarse aggregate that contains more than 0.5 percent free moisture by weight shall be stockpiled for at least 24 hours prior to use.

E. Fine Aggregate: Fine aggregate shall consist of sand or a combination of sands, and shall be composed of clean, hard, durable, uncoated grains.

1. Fine Aggregate Exclusive of Mineral Filler: Fine aggregate shall be free from injurious amounts of salt, alkali, or vegetable matter. Provide fine aggregate meeting Table 4.

Table 4
Fine Aggregate Requirements

Description	Test Method	Limit
Weight of Clay Clumps, % Max	Tex-413-A	0.5
Organic Impurities	Tex-408-A	Lighter than standard
Sand Equivalent	Tex-203-F	80
Fineness Modulus	Tex-402-A	2.3 to 3.1

When the fine aggregate is mixed with Type III cement in the proportion of 1:3, the average strength of not less than 3 standard mortar briquettes at the age of 3 days shall be equal to or greater than the strength of Ottawa sand mortar briquettes of the same proportions and consistency when tested at the age of 3 days.

Fine aggregate when tested in accordance with Tex-401-A shall meet the following gradation shown in Table 5.

Table 5
Fine Aggregate Gradation Chart (Grade 1)

Sieve Size	Percent passing
3/8"	100
#4	95-100
#8	80-100
#16	50-85
#30	25-65
#50	10-35[1]
#100	0-10
#200	0-3[2]

[1]6-35 when sand equivalent is greater than 85.
[2]0-6 for manufactured sand.

Where fine aggregate is delivered to the job in two or more sizes or types, each type and or size of material shall be batched and weighed separately.

At the time of its use, the fine aggregate shall be free from frozen material, and aggregate containing foreign material will be rejected.

All fine aggregate shall be stockpiled for at least 24 hours prior to use.

2. Mineral Filler: Mineral filler shall consist of clean stone dust, crushed sand, crushed shell, or other approved inert material. When tested in accordance with TxDOT's Bulletin C-11, it shall meet the requirements of Table 6.

Table 6
Gradation for Mineral Filler

Sieve Size	Percent Retained
#30	0%
#200	0 to 35%

Where mineral filler is used, it shall be batched and weighed separately.

F. Water: Water usage shall conform to Subsection 3.04 "Requirements for Water Usage."

G. Concrete Mortar: Mortar shall consist of 1 part cement, 2 parts finely graded sand and sufficient water to make the mixture plastic.

III. Equipment

A. Concrete Plants: All plants must be certified by the National Ready Mixed Concrete Association (NRMCA) or have an inspection report signed and sealed by a Texas licensed professional engineer showing concrete measuring, mixing, and delivery equipment meets all requirements of ASTM C94. A new certification or signed and sealed report is required every time a plant is moved. Plants with a licensed professional engineer's require re-inspection every 2 years. Provide a copy of the certification or signed and sealed inspection report to the ODR.

Inspect concrete trucks and furnish inspection reports on the condition of blades and fins and their percent wear from the original manufacturer's design for truck agitators

annually and fins are free of concrete buildup. Concrete trucks must be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass and capable of discharging the concrete so at least 5 of the 6 requirements of Tex-472-A are met..

B. Scales. Provide a scale certification every 6 months in compliance with ASTM C94.

IV. Acceptance of Concrete: The contractor will test the fresh and hardened concrete for acceptance. The results will be reported to the ODR. Investigate the quality of the materials, the concrete production operations, and other possible problem areas to determine cause for any concrete that fails to meet the required strengths. Concrete failing strength requirements will be evaluated by the ODR to determine if the concrete will be accepted or required to be removed and replaced. The Contractor will make and test 7 day and 28 day concrete cylinders. Acceptance will be on strengths required in Table 1.

Table 7
Concrete Testing Frequency

Test For	Test Number	Sampling Location	Frequency of Testing	Remarks
Compressive Strength	Tex-418-A	At point of placement	4 cylinders for each 60 CY or fraction thereof for 4000 psi concrete 4 cylinders for each 100 CY or fraction thereof for 3000 psi concrete.	Sampling shall be in accordance with Tex-407-A. 2 cylinders shall be tested at 7 days and if the average is below the design strength as defined in Table 1 of this Subsection, the remaining 2 cylinders shall be tested at 28 days. If the average value of the 2 cylinders broken at 7 days the 2 remaining cylinders are not required to be tested.
Slump	Tex-415-A	At point of placement	When cylinders are taken.	When placing bridge decks check first load and when cylinders are taken. ODR may require additional slump tests on loads that appear to have slump outside of specification.
Entrained Air	Tex-416-A or Tex-414-A	At point of placement	When cylinders are taken.	Air entrainment will be 3% to 7% unless otherwise noted on the plans. When placing bridge decks check first load and when cylinders are taken.
Temperature	Tex-422-A	At point of placement	When cylinders are taken.	Check first load of all placements. For bridge slabs check each load.

In general, the consistency of the concrete mixture shall be such that:

1. The mortar will cling to the coarse aggregate;

2. The concrete is not sufficiently fluid to segregate when transported to the place of deposit;

3. The concrete, when dropped directly from the discharge chute of the mixer, will flatten out at the center of the pile; but the edges of the pile will stand up and not flow;

4. The mortar will show no free water when removed from the mixer;

5. The concrete will settle into place when deposited in the forms; and when transported in metal chutes at an angle of 30° with the horizontal, it will slide and will not flow into place;

6. The surface of the finished concrete will be free from laitance or a surface film of free water; and

Shrinkage Crack Control: Concrete shall be below the allowable temperature as determined by the Contractor by using (ACI 305 chart modified). The rate of evaporation of water from the concrete shall not exceed 0.15pounds per square foot per hour. The Contractor shall keep a log of air temperatures, relative humidity, wind velocity, and allowable concrete temperature for each day he places concrete. The log shall be readily available for review by the Project Representative. For air temperature, relative humidity and wind speeds other than what is listed, the next highest temperature shown, next lowest relative humidity, and next highest wind velocity interval shall be used to determine acceptable concrete temperature.

Contractor is to inform the concrete supplier of the temperature requirements prior to delivery to the project. The concrete temperature limit shall not be exceeded at least until fifteen minutes after surface finishing. Appropriate curing methods shall be used to prevent shrinkage cracks in conjunction with these concrete temperature requirements.

Concrete shall not be poured when wind or weather conditions are such that dirt, sand, or debris enters the concrete. No concrete will be placed when wind speeds exceed 25 miles per hour. The concrete shall be protected to maintain temperatures of not less than 50°F for 5 days after placement. If aggregate and water are heated, they shall not be heated above 175°F. Concrete shall not be placed when ambient temperature is less than 40°F. It shall be the responsibility of the Contractor to anticipate as nearly as possible changes in weather conditions which would affect the placement and protection of the concrete and to be prepared to protect freshly placed concrete when sudden changes in the weather make such protection necessary.

V. Construction

A. Trial batches: Perform preliminary and final trial batches when previous

satisfactory field data is not available. Test at least one set of 7 day cylinders and one set of 28 cylinders to verify that minimum strength is achieved.

B. Mixing and delivering concrete

1. Maintain concrete delivery and placement rates sufficient to prevent cold joints.

2. When water is added, do not exceed the approved water-cement ratio. Mix concrete 30 revolutions after adding water. Do not add water after discharge of concrete has begun.

3. Each load of concrete shall have a batch ticket showing material used.

VI. Measurement and Payment: The work performed, materials furnished, equipment, labor, tools, and incidentals will not be measured or paid for directly, but will be subsidiary to pertinent Items.

LAST PAGE OF THIS SUBSECTION