

SECTION 03304

PORTLAND CEMENT CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Portland cement concrete material requirements.
- B. Mix design requirements.

1.02 REFERENCES

- A. AASHTO T- 26: Standard Method of Test for Quality of Water to be Used in Concrete.
- B. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
- C. ACI 211.3: Standard Practice for Selecting Proportions for No-Slump Concrete.
- D. ACI 214: Recommended Practice for Evaluation of Strength Test Results of Concrete.
- E. ACI 306: Cold Weather Concreting.
- F. AASHTO M-157: Standard Specification for Ready-Mix Concrete.
- G. AASHTO M-85: Standard Specification for Portland Cement.
- H. AASHTO M-154: Standard Specification for Air-Entraining Admixtures for Concrete.
- I. AASHTO M-194: Standard Specification for Chemical Admixtures for Concrete.
- J. AASHTO M-295: Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

1.03 DEFINITIONS

- A. Average Strength (f_{cr}): The required average strength for 3 consecutive strength tests which statistically assures no more than the permissible proportions of tests will fall below specified strength.
- B. Specified Strength (f_c'): The indicated strength.

1.04 SUBMITTALS

- A. Mix Design: Submit each proposed mix design 48 hours prior to use in the Work. Indicate whether mixes have been designed for pumping. Include the report the following information.
 - 1. Water-cement ratio.
 - 2. Proportion of materials in the mix.

3. Source and type of cement.
4. Analysis of water to be used.
5. Type and name of admixtures applied. Indicate when accelerating or retarding admixtures are to be used.
6. Slump, air content and temperature of samples.
7. Unit weight of fresh and dry light weight concrete.

1.05 QUALITY ASSURANCE

- A. Use the same source and type of cement, air-entraining agent, water reducing agent, other admixtures, and aggregate.
- B. In proportioning materials for mixing, use scales certified by the State of Utah. Do not use volume measurement except for water and liquid admixtures.
- C. Do not change the quantity of cement per cubic yard.
- D. Use of admixtures will not relax hot or cold weather placement requirements.
- E. Ready-mixed concrete, in accordance with AASHTO M-157 and requirements in this Section.
- F. Testing Concrete: In accordance with Section 01450.

PART 2 PRODUCTS

2.01 CEMENT

- A. Type II (moderate sulfate resistance) or Type V (high sulfate resistance), in accordance with ASTM M-185.

2.02 WATER

- A. Water used in mixing concrete shall be clean and free from oil, acid, salt, injurious amounts of alkali, organic matter or other deleterious substances. Clean, non-staining and not detrimental. Comply with AASHTO T 26.

2.03 AGGREGATES - GENERAL

- A. Gravel, crushed slag, crushed stone, or other inert material, composed of hard, strong, durable particles free of injurious coatings.
- B. The materials passing the No. 200 sieve shall not exceed 1.75 percent by weight in the combined coarse and fine aggregate.

2.04 ADMIXTURES

- A. Air Entrainment: pH 2.0 maximum type in accordance with AASHTO M-152.
- B. Water Reducing and Water Retarding Agents: In accordance with AASHTO M-194.

1. Type A: Water reducing.
2. Type B: Retarding.
3. Type C: Accelerating.
4. Type D: Water reducing and water retarding.
5. Type E: Water reducing and accelerating.
6. Type F: High range water reducing (super plasticizer). *
7. Type G: High range water reducing and retarding. *

*The relative durability factor of water reducing admixtures shall not be less than 90 and the chlorides content (as Cl-) shall not exceed 1 percent by weight of the admixtures.

C. Calcium Chloride: None allowed.

D. Pozzolan: Pozzolan conforming to the requirements of ASTM C 618, Class F, is allowed as Portland cement replacing agent under the following conditions:

1. If a blended aggregate passes an unmodified ASTM C 1293 test, use of a pozzolan is allowed. If aggregate does not pass ASTM C 1293, select a pozzolan (or blended cement, or both) and determine the effective dosage to meet one of the following tests:
 - a. ASTM C 1567. The expansion of the cement-pozzolan-aggregate job-mix mortar bar is less than or equal to 0.10 percent at 16 days. Do not use the test if a lithium admixture is used in the job-mix.
 - b. ASTM C 441. The expansion of a test mixture at 56 days is less than or equal to a control mixture prepared with cement with equivalent alkalis between 0.5 and 0.6 percent.
2. Do not replace more than 10 percent of the Portland Cement.
3. The ratio of replacement by weight of Pozzolan to cement shall be 1.25 to 1.0.
4. The minimum cement content shall be used in the design formulas before replacement is made.
5. Loss of ignition of pozzolan is less than 3 percent and the water requirement shall not exceed 100 percent.
6. All other requirements of this section still apply.
7. Mix designs including trial batches are required for each aggregate source and for each concrete class.

E. Fly Ash: Class F fly ash allowed as a cement replacement under the following conditions:

1. Before replacement is made, use the minimum cement content in the design formula to establish the water/cement ratio.

2. Replace up to 20 percent of the cement by weight on a one (1) part fly ash to one (1) part cement basis.
3. Submit to Engineer a quality history of the fly ash identifying a minimum of 20 of the most current ASTM C 618 analysis.

2.05 ENTRAINING AGENT

- A. An air-entraining agent shall be used in all concrete exposed to the weather. The agent shall conform to AASHTO Designations M-152.

2.06 ACI MIX DESIGN

- A. The amount by which the average strength of a concrete mix exceeds the specified strength shall be based upon no more than 1 in 100 random individual strength tests falling below the specific strength.
- B. Proportion the materials in accordance with ACI 211.1, 211.2 or 211.3 as applicable to produce concrete having the following properties or limitations:

CONCRETE MIX PROPERTIES			
Properties	Concrete Class		
	4000	3000	2500
Specified Compressive Strength f_c' at 28 days, psi	4000	3000	2500
Compressive Strength at 7 days, psi ^(a)	2680	2010	1675
Water-cement ratio (by weight), max	0.44	(c)	
Cement content (94 lb. sacks of cement per cubic yard of concrete)	6.5	5.5	5
Entrained air content, (% by volume) based on aggregate size	Entrained air content, (% by volume) based on aggregate size	Entrained air content, (% by volume) based on aggregate size	Entrained air content, (% by volume) based on aggregate size
2"	4.0 to 7.0	4.5 to 7.5	3.0 to 6.0
1-1/2"	4.5 to 7.5	4.5 to 7.5	3.0 to 6.0
1"	5.0 to 7.5	4.5 to 7.5	3.0 to 6.0
3/4"	5.0 to 7.5	4.5 to 7.5	3.0 to 6.0
Slump Range, in. ^(b)	2 to 4	2 to 4	2 to 4
(a) Used for monitoring purposes only.			
(b) Not more than 8" after adding high range water reducer admixture (super-plasticizer) to verified 2" to 3" slump concrete.			
(c) Specific to exposure conditions and finishing need			

- C. The use for each class of concrete is as follows:

1. 4000 psi: Reinforced structural concrete.
2. 4000 psi: Sidewalks, curb and gutter, cross gutters, concrete collars, pavements and unreinforced footings and foundations.
3. 3000 psi: Thrust blocks, anchors and mass concrete.

D. Water:

1. Sufficient water shall be added to produce concrete with the minimum practicable slump.
2. The slump of mechanically vibrated concrete shall not exceed 4 inches.
3. No concrete shall be placed with a slump in excess of 5 inches.
4. The maximum permissible water cement ratio (including free moisture of aggregates shall be 5 and 5 3/4 gallons per bag of cement respectively for 4000 and 3000 psi air entrained concrete.

2.07 HAND MIXING

- A. Do not hand mix batches exceeding 0.5 cubic yards.

2.08 HEATING, WATER AND AGGREGATE

- A. Do not allow products of fuel combustion to contact the aggregate.
- B. Heat aggregate and mixing water to 150 degrees F. maximum. Heat aggregates uniformly.
- C. Maintain mixed concrete temperature at time of placement between 60 and 90 degrees F.
- D. Do not mix cement with water or with mixtures of water and aggregate greater than 90 degrees.

PART 3 EXECUTION

3.01 DELIVERY

- A. Slump: Do not transport concrete to the work location if concrete is greater than permissible slump.
- B. Discharge: After the introduction of mixing water to the cement and aggregates at the batch plant, discharge concrete from truck mixer within 90 minutes.

3.02 RE-TEMPERING

- A. Adding Water: When concrete arrives at site with slump below specified, water may be added once if neither the maximum approved water/cement ratio nor the maximum slump is exceeded provided that the drum turns a minimum of 90 revolutions.
- B. Super-plasticizer: Premeasure and add high range water reducers (super-plasticizer) in accordance with manufacturer's instructions. Add super-plasticizer at site using truck-mounted power injection equipment capable of rapidly and uniformly distributing the admixture to the concrete. Mix for a minimum of 3 minutes prior to discharge.

C. Re-tempering after delivery time with super-plasticizer is prohibited.

3.03 CONCRETE PLACEMENT

A. In accordance with Section 03310.

END OF SECTION