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Design Standards

Section 5

Portland Cement Concrete

SECTION V

PORTLAND CEMENT CONCRETE

5-1 GENERAL

This section of the specifications defines materials to be used in all Portland Cement concrete work and requirements for mixing, placing, finishing, and curing.

The concrete shall be composed of coarse aggregate, fine aggregate, Portland Cement and water.

5-2 MATERIALS

Materials used in Portland Cement concrete and reinforcing of Portland Cement shall meet the following requirements:

5-2.1 CEMENT. Portland Cement shall be Type V and shall comply with the standards specification for Portland Cement, ASTM C-1 50.

5-2.2 AGGREGATES. Except as otherwise specified herein, concrete aggregates shall conform to all applicable provisions of the latest revision of ASTM Standard Specification C-33.

5-2.2.1 FINE AGGREGATE. Fine aggregate shall consist of natural sand or, subject to approval, other inert materials with similar characteristics, having clean, hard durable, uncoated, well-rounded (not flat or sharply angular) grains and shall conform to the requirements of these specifications.

The amount of deleterious substances shall not exceed the following limits:

Percent

Clay lumps	1.0
Coal and Lignite	0.5
Material passing No.2 sieve	3.0
Other deleterious substances such as shale, alkali, mica, coated grains, soft and flaky particles.	3.0

The sum of the percentage of all deleterious substances shall not exceed five percent by weight.

Fine aggregate shall be well graded and shall range in size from the fine to coarse within the following percentages by weight:

<u>Sieve Size</u>	<u>Percent Passing By Weight</u>
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10

5-2.2.2 COARSE AGGREGATE. Coarse aggregate shall consist of crushed stone, gravel, slag or other approved inert material with similar characteristics or combination

thereof, having clean, hard, durable, un-coated particles free from deleterious matter.

Deleterious substances shall not be present in the aggregate in excess of the following limits:

	<u>Percent By Weight</u>
Soft fragments	5.00
Coal and Lignite	1.00
Clay lumps	0.25
Materials passing No. 200 sieve	1.00
All local deleterious substances	3.00

The sum of the percentages of all deleterious substances in any size or delivered to the mixer shall not exceed five percent by weight. Coarse aggregate may be rejected if it fails to meet the following test requirements:

(a) LOS ANGELES ABRASION TEST. If the percent of loss by weight exceeds ten percent at 100 revolutions, or forth percent at 500 revolutions.

(b) SODIUM SULFATE TESTS FOR SOUNDNESS. If the weighted average loss after five cycles is more than ten percent by weight.

Coarse aggregate shall be graded by weight as follows.

<u>Sieve Size</u>	<u>Percent Passing</u>
	<u>By Weight</u>
1"	100
3/4"	90-100
3.8"	20-55
No. 4	0-10
No. 8	0-5

5-3 CONCRETE MIX

For the purpose of practical identification, concrete has been divided into three classes: Class A, B and C. Basic requirements and uses for each class are as defined below.

<u>Class</u>	<u>(sack/c.y.)</u>	<u>(Psi)</u>	<u>Minimum 28-day Comp. Strength</u>	<u>Primary Use</u>
A	6	3,500		Reinforced structural concrete sidewalks,curbs,gutters, cross gutters,footing
B	5½	3,000		Minor nonstructural items such as electrical boxes,etc.
C	5	2,500		Thrust blocks, anchors, massconcrete

Unless specifically waived by the Engineer, all concrete placed shall be class A, six bag mix and the minimum allowable compressive strength of concrete at the age of twenty-eight days shall be 3,500 psi. Strengths shall be determined in accordance with current ASTM c-39 and C-31.

All concrete shall also comply with the following requirements:

5-3.1 AGGREGATES. The maximum size of the aggregate shall not be larger than 1/5 of the narrowest dimension between forms within which the concrete is to be encased, and in no case larger than 3/4 of the minimum clear spacing between reinforcing bars or between reinforcing bars and forms. For unreinforced concrete slabs, the maximum size of aggregates shall not be larger than 1/4 the slab thickness.

5-3.2 Water. Sufficient water shall be added to the mix to produce concrete with the minimum practical slump. The slump of mechanically vibrated concrete shall not exceed four inches. No concrete shall be placed with a slump in excess of five inches.

The maximum permissible water/cement ration (including free moisture on aggregates) shall be five and five 3/4 gallons per bag of cement.

5-3.3 ENTERTAINING AGENT. Shall be used in all concrete exposed to the weather. The agent shall conform to ASTM designations C-175 and C-260. Air content for

air-entrained concrete shall comply with the following:

Sizes (inches)	(Percent)
1 ½ to 1	5 +/- 1
1 to ¾	6 +/- 1
¾ to ½	7 +/- 1

The air-entraining agent shall be added as a liquid to the mixing water by means of mechanical equipment of accurate measurement and control.

5-3.4 ADMIXTURES.

5-3.4.1 POZZOLAN. If permitted by the Engineer, pozzolan conforming to the requirements of ASTM C-618 Class N may be added to the concrete mix with no reduction in cement.

Pozzolan shall be sampled and tested as prescribed in ASTM C-613 and ASTM C-311. The Contractor shall obtain and deliver to the Engineer a certification of compliance, signed by the pozzolan supplier, identifying the pozzolan, stating that the pozzolan delivered to the batching site complies with applicable specifications. Pozzolan material shall be handled and stored in the same manner as Portland Cement. When facilities for handling bulk pozzolan are not available, the pozzolan shall be delivered in original unopened sacks bearing the name and brand of supplier, the type and source of the pozzolan, and the weight contained in each sack plainly marked thereon.

Pozzolan shall not be mixed with any other brand or type unless written permission has first been obtained from the Engineer. All pozzolan used in the manufacture of concrete for any individual structure shall be of the same type, and from the same source unless otherwise approved by the Engineer.

5-3.4.2 CALCIUM CHLORIDE. Calcium Chloride may be added as an accelerator during cold weather with the maximum amount being two pounds per sack of cement. Calcium Chloride shall conform to ASTM Standard Specification D-98.

5-4 CONSTRUCTION STANDARDS

5-4.1 FORMS. Forms shall be substantially built and adequately braced so as to withstand the liquid weight of concrete. All linings, studding, walling, and bracing shall be such as to prevent bulging, spreading, or loss of true alignment while pouring and displacement of concrete while setting. Exposed vertical and horizontal edges of the concrete in structures shall be chamfered by the placing of moldings in the forms.

5-4.2 PREPARATIONS. Before batching and placing concrete, all equipment for mixing and transporting the concrete shall be cleaned, all debris and ice shall be removed from the places to be occupied by the concrete, forms shall be thoroughly wetted (except in freezing weather) or oiled, masonry filler units that will be in contact with concrete shall be well drenched (except in freezing weather), and the reinforcements shall be thoroughly cleaned of ice or other coatings. Water shall be removed from spaces to receive concrete.

When placing concrete on earth surfaces, the surfaces shall be free from frost, ice, mud and water. When the sub-grade is dry soil or pervious material, it shall be sprayed with water immediately before placing of concrete or shall be covered with waterproof sheathing paper or a plastic membrane. No concrete shall be placed until the surfaces have been inspected and approved by the Engineer or Inspector.

5-4.3 CONCRETE MIXING. The concrete shall be mixed until there is a uniform distribution of the materials. Sufficient water shall be used in concrete in which reinforcement is to be embedded to produce a mixture which will flow sluggishly when worked and which, at the same time, can be conveyed from the mixer to the forms without separation of the coarse aggregate from the mortar. In no case shall the quantity of water used be sufficient to cause the collection of a surplus in the forms.

Ready-mixed concrete shall be mixed and delivered in accordance with the requirements set forth in specifications for ready-mixed concrete (ASTM C-95). Concrete shall be delivered and deposited in its final position within sixty minutes after adding the cement and water to the mixture.

5-4.4 DEPOSITING. Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. The concrete placing shall be carried on at such a rate that the concrete is at all times plastic and flows readily into the corners of forms and reinforcing bars. No concrete that has partially hardened or been contaminated by foreign material shall be deposited in the work, nor shall re-tempered concrete be used.

AU concrete in structures shall be vibrator compacted during the operation of placing and shall be thoroughly worked around reinforcement and embedded fixtures and into the corners of the forms.

5-4.5 PLACING CONCRETE IN COLD WEATHER. No concrete shall be poured where the air temperature is lower than 40°F at locations where the concrete cannot be covered or protected from the surrounding air. When concrete is poured below a temperature of 35°F the ingredients of the concrete shall be heated so that the temperature of the mixing shall not be less than 50°F or more than 100°F. Before mixing, the heated aggregates shall not exceed 125°F and the temperature of the heated water shall not exceed 175°F. Cement shall not be added while the temperature of the mixed aggregates and water is greater than 100°F. When there is likelihood of freezing during the curing period, the concrete shall be protected by means of an insulating cover to prevent freezing of the concrete for a period of not less than seven days after placing.

Equipment for protecting concrete from freezing shall be available to the job site prior to placing concrete. Particular care shall be exercised to protect edges and exposed corners from freezing. In the event heating is employed, care shall be taken to ensure that no part of the concrete becomes dried out or is heated to temperature above 90°F. The housing, covering, or other protection used shall remain in place and intact at least twenty-four hours after the artificial heating is discontinued.

5-4.6 FINISHING. After the concrete for slabs has been brought to the established grade and screeded, it shall be worked with a magnesium float and then given a light broom finish. In no case shall dry cement or a mixture of dry cement and sand be sprinkled on the surface to absorb moisture or hasten hardening. Surface edges of all slabs shall be rounded to a radius of 1/2 inch with standard concrete finishing tools.

5-4.7 CURING AND PROTECTION. As soon as the concrete has hardened sufficiently to prevent damage, the finished surface shall be covered with burlap, cotton, sand or earth and kept wet for at least seven days. When authorized by the Engineer, "Hunt's Process" may be used in lieu of water curing, provided it is applied in accordance with the manufacturer's specifications.

The freshly finished surface shall be protected from hot sun and drying winds until it can be sprinkled or covered as above specified. The concrete surface must not be damaged or pitted by rain. The contractor shall provide and use, when necessary, sufficient tarpaulins to completely cover all sections that have been placed within the preceding twelve hours. The Contractor shall erect and maintain suitable barriers to protect the finished surface. Any section damaged from traffic weather or other causes occurring prior to its official acceptance shall be repaired or replaced by the Contractor at his own expense in a manner satisfactory to the Engineer.

5-5 QUALITY CONTROL

The average of any three consecutive strength tests should equal or exceed the minimum twenty-eight day strength. If the average of any three consecutive strength tests is below specification, the Contractor shall increase the strength of the concrete at his expense. If any individual strength test is below the specified strength, the concrete may be accepted at a reduced price. The price reduction shall apply to the amount of concrete represented by the strength test in accordance with Table VI.

Concrete with a compressive strength of more than 400 psi below the required strength shall be evaluated by the Engineer for capabilities necessary to the integrity of the structure. The Engineer shall make the final decision. For subdivision construction the Contractor shall pay a penalty equal to the reduction in payment to the Kanab City before final acceptance.

If additional tests are requested to determine if strength tests are representative, they shall be performed by coring in accordance with AASHTO designation 1-24 or an acceptable nondestructive method. The retested strength shall be the average of three cores (or other means). All costs incurred in re-sampling and retesting shall be paid by the Contractor if the retested strength is below standard, and shall be assumed by the Kanab City if the retested strength is above standard.

TABLE VI**ACCEPTANCE-SCHEDULE FOR CONCRETE**

PSI Below Specified

<u>Strength Specification</u>	<u>Pay Factor</u>
1-100	98
101-200	94
201-300	88
301-400	80

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