

CONCRETE WORK

I. SCOPE

This section includes the standards for concrete, reinforcing steel, formwork, concrete placement, curing, and construction joints. Concrete work for structures and duct bank shall be done in accordance with these requirements.

II. APPLICABLE STANDARDS

- II.1. All concrete work shall be in accordance with the following standards of the American Concrete Institute (ACI), except as may be modified by these specifications:
- II.2. ACI 318 (latest revision) "Building Code Requirements for Reinforced Concrete."
- II.3. ACI 301 (latest revision) "Building Code Requirement for Structural Concrete."
- II.4. ACI 306 (latest revision) "Recommended Practice for Cold Weather Concreting."
- II.5. ACI 305 (latest revision) "Recommended Practice for Hot Weather Concreting."
- II.6. ACI 613 (latest revision) "Recommended Practice for Selecting Proportions for Concrete."

III. MATERIALS

III.1. CEMENT:

Cement shall be a single brand of approved Portland Cement conforming to ASTM "Specifications for Portland Cement" (ASTM C 150). Unless otherwise permitted or required, cement shall be Type I, ASTM C 150, or Type II.

III.2. AGGREGATES:

Fine Aggregate shall consist of sand meeting the requirements of "Standard Specification for Concrete Aggregates" (ASTM C 33). Coarse aggregate shall consist of gravel, crushed gravel, crushed stone or air-cooled blast furnace slag or a combination thereof, conforming to the requirements of ASTM C 33.

III.3. PROPORTIONING:

Concrete shall be of plastic consistency such that it can be worked readily into all parts of the form and around embedded work without segregation of constituent material or collection of free water on the surface.

III.4. STRENGTH:

Concrete shall be proportioned and mixed to obtain a 28-day compressive strength of 3000 PSI. On occasion, 3500 PSI, 4000 PSI or 5000 PSI, 28-day strength concrete may be specified.

III.5. SLUMP:

The slump shall be 4 inches to 6 inches for concrete which is to be mechanically vibrated and 5 inches to 7 inches for concrete which is to be placed without consolidation. The minimum slump shall be waived on concrete used in sloping construction.

III.6. MIXING AND DELIVERY:

All concrete shall be ready-mixed and mixed and delivered in accordance with the requirements set forth in "Specifications for Ready-Mixed Concrete", (ASTM C-94). Attention

is directed to the importance of dispatching trucks from the plant so that they shall arrive at the site just before the concrete is required, thus avoiding excessive mixing of concrete while waiting. Concrete shall be discharged into forms within 1-1/2 hours after water was first added to the mix and shall be mixed at least five (5) minutes after all water has been added.

III.7. TEST SAMPLES:

The number and frequency of test samples for the purpose of determining the strength of the concrete placed shall be in accordance with the following or as required by the Project Inspector.

III.7.1. One set of four cylinders shall be made for each 30 cubic yards or fraction thereof, placed each day.

III.7.2. The number and frequency of test samples required above shall apply to each design and each plant batch, separately.

III.8. CORE TEST:

III.8.1. If specimen strength tests do not conform to the requirements of these specifications, approval may be given by the Engineer for the Contractor to have alternate strength tests made on specimens secured from the structure in accordance with ASTM C-42 (Core test). These alternate tests shall be made at the contractor's expense.

III.8.2. If the concrete does not meet the required specifications, the concrete so represented or the entire structure, if concrete not meeting these specifications is a part thereof, shall be removed and replaced by the contractor at his expense.

III.8.3. In structure elements for which the strength of the concrete is not critical and the structural integrity is not affected, the Engineer may, at his discretion, allow the concrete to remain in place.

III.9. ADDITIONAL PLATES:

Listed below are plates not otherwise covered by a construction standard Plate and Drawing.

	DESCRIPTION	UNIT
CONC-3	3000 PSI Concrete	CY
CONC-3.5	3500 PSI Concrete	CY
PLATE	5000 PSI Concrete	CY
GROUT1:10	1:10 Grout	CY
MGROUT1:10	1:10 Grout	CY

IV. REINFORCING STEEL

IV.1. GRADE OF BARS:

All bars shall conform to the "Standard Specification for Deformed and Plain Billet Steel bars for Concrete Reinforcement", Grade 60 (60,000 PSI minimum yield strength) ASTM 615. Size to be as specified in details.

IV.2. DETAILS OF REINFORCEMENT:

Reinforcing steel shall be fabricated and placed in conformance with the specification of "Building Code Requirements for Reinforced Concrete" (ACI-318 Latest).

- IV.3. CUTTING BARS:
Bars may be cut by shearing, sawing, or acetylene torch.
- IV.4. BENDING BARDS:
Bars shall be bent to the tolerances prescribed by ACI-318.
- IV.5. SURFACE CONDITION OF REINFORCEMENT:
Reinforcement, at the time that the concrete is placed, shall be free from mud, oil, ice, or other non-metallic coatings. Bars with rust, mill scale, or a combination of both, shall be considered satisfactory, provided the minimum dimensions, including height or deformations, and weight of a hand brushed specimen are not less than the ASTM specifications.
- IV.6. PLACING REINFORCEMENT:
Reinforcement, ducts and other embedded objects shall be placed and adequately supported to provide the minimum concrete cover required, and shall be secured against displacement within tolerances permitted by ACI-318.
- IV.7. LAP SPLICES:
Lap splices shall be lapped the distance specified in the rebar schedule.

V. FORMWORK

- V.1. DESIGN:
 - V.1.1. Forms shall result in a final structure that conforms to shapes, lines, and dimensions of the members as required by the design drawings.
 - V.1.2. Earth cuts shall not be used as forms for vertical surfaces unless approved by the engineer.
 - V.1.3. Forms shall be substantial and sufficiently tight to prevent the leakage of mortar.
 - V.1.4. Forms shall be properly braced or tied together to maintain position and shape.
 - V.1.5. Design of formwork shall include consideration of the rate and method of placing concrete and construction loads, including vertical, horizontal, and impact loads.
- V.2. REMOVAL OF SHORING:
No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to support safely its weight and loads placed thereon.
- V.3. REMOVAL OF FORMS:
Forms shall be removed in such manner as not to impair safety and serviceability of the structure. All concrete to be exposed by form removal shall have sufficient strength not to be damaged thereby.

VI. PLACING CONCRETE

- VI.1. GENERAL:
Concrete shall be placed in accordance with ACI-301 (latest revision), "Specifications for Structural Concrete for Buildings."

VI.2. PREPARATION BEFORE PLACING:

The subgrade should be moist, but free of standing water and soft spots. If limestone base course is used it should be sprinkled sufficiently to eliminate suction. Forms and ducts should be moist.

DEPOSITING:

Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. Temporary spreaders in forms shall be removed when the concrete has reached an elevation rendering their service unnecessary. Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to falling, rehandling or flowing.

VI.3. CONSOLIDATION:

All concrete shall be consolidated by vibration, spading, rodding, or forking so that the concrete is thoroughly around the reinforcement, around embedded items, and into corners of forms. Over-vibrating and use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at many points, from 18 to 30 inches apart. At each insertion, the duration shall be sufficient to consolidate the concrete, but not sufficient to cause segregation, generally from 5 to 15 seconds duration.

VI.4. WEATHER CONDITIONS:

Detailed recommendations for placing concrete in hot and cold weather are contained in ACI-305 and ACI-306, respectively.

VI.5. PROTECTION:

Unless adequate protection is provided, concrete shall not be placed during rain, sleet or snow. Rain water shall not be allowed to increase the mixing water.

VI.6. PLACING TEMPERATURE:**VI.6.1. Cold Weather:**

When the air temperature falls below 40°F, the minimum temperature of concrete as placed shall be 50 degrees F, or warmer.

VI.6.2. Hot Weather:

Concrete deposited in hot weather shall have a placing temperature which will not cause difficulty from loss of slump, flash set, or cold joints (usually somewhat less than 90° F).

VII. CURING CONCRETE**VII.1. GENERAL:**

Freshly deposited concrete shall be protected from premature drying and excessively hot or cold temperatures, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period of time necessary for the hydration of the cement and proper hardening of the concrete

VII.2. TEMPERATURE:**VII.2.1. Cold Weather:**

When the mean daily air temperature is less than 40° F, the temperature of the concrete shall be maintained between 50°F and 70°F for 48 hours after placement.

VII.2.2. 7.2.2. Hot Weather:

VII.2.2.1. When necessary, arrangements for installation of windbreaks, shading, fog spraying, sprinkling, etc. shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening will allow.

VII.2.2.2. On hot days when the humidity is low it is advisable to place the concrete late in the day and to insure that the forms and trench are well-moistened just prior to placement.

VIII. CONSTRUCTION JOINTS, DUCT BANK

VIII.1. GENERAL:

In the construction of duct banks, construction joints need to be made more frequently than in normal concrete work, in order to avoid the creation of shear planes, special precautions are required. The below specifications shall be strictly followed.

VIII.2. LOCATION:

The construction joint shall be made between spacers. No spacer should fall in the sloping plane of the joint.

VIII.3. CONCRETE:

The surface of the joint shall be at an angle of 30° to 45° with the horizontal plane of the duct bank. The concrete shall be allowed to flow outward at the bottom and slope back toward the top of the freshly poured duct at the angle specified above. The concrete in the area shall be consolidated about the duct and reinforcement.

VIII.4. REINFORCING STEEL:

The reinforcing steel bars shall extend beyond the surface of the concrete a distance which will allow a lap splice to be made as specified in the details for the particular size of bar.

VIII.5. DUCT:

Ducts shall extend beyond the joint surface and finished to accept a coupling. A plug will be installed in each duct.

VIII.6. CLEANING:

Prior to continuing the placement of the next section of concrete, the surface of the concrete joint shall be thoroughly cleaned with clean water to remove all dirt, loosened particles of aggregate, and laitance.

VIII.7. BONDING AGENT:

VIII.7.1. Where new concrete is to be placed against concrete which has reached its initial set, the existing concrete surface shall be coated with a bonding agent prior to placing new concrete.

VIII.7.2. The bonding agent shall be "ProcoBond" manufactured by Protective Coatings Co. or equal.

VIII.7.3. Application shall be in strict accordance with the manufacturer's recommendations.

IX. CONSTRUCTION JOINTS – STRUCTURES**IX.1. GENERAL:**

Joints not shown on the drawings shall be made and located as to least impair the strength of the structure and shall be approved. Joints shall be perpendicular to the main reinforcement. All reinforcing steel shall be continued across joints. Longitudinal keys at least 1–1/2" deep shall be provided in all joints in walls and between walls and slabs.

IX.2. CLEANING:

The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed.

IX.3. BONDING:

Bond shall be obtained either by:

IX.3.1. The use of an approved adhesive such as "Procobond".

IX.3.2. By roughening the surface of the concrete in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.

REBAR-

STEEL REINFORCING BAR

REBAR CONVERSION FORMULAS:

Rebar must be converted to pounds and item coded by size.

To calculate the number of pounds required, use the following formulas:

$$\text{REBAR - S}^* = (\text{Number of bars same length \& size}) \times (\text{Length of bar 'feet'}) \times (\text{Weight of rebar 'pounds per foot'})$$

$$\text{REBAR - L}^* = (\text{Number of bars same size}) \times (\text{Weight of rebar 'pounds per foot'}) \times (\text{Length of duct bank span 'feet'}) \times \left\{ 1 + \frac{(\text{Rebar Lap splice "Feet"})}{20'} \right\}$$

$$\text{REBAR - T}^* = (\text{Length of duct bank span 'feet'}) \times (\text{Length of rebar 'inches'}) \times (\text{Weight of rebar 'pounds per foot'}) / \text{divided by (Number of inches rebar on center.)}$$

Bar Sizes	Weight (pounds per foot)
# 3	0.376
# 4	0.668
# 5	1.043
# 6	1.502
# 7	2.044
# 8	2.670
# 9	3.400
# 10	4.303

REBAR – S* = Rebar used in cast-in place structures (manholes, pads, etc.) Bar sizes available – # 3, # 4, # 5, # 6, # 7, & # 8 (e.g. REBAR – S*5).

REBAR – L* = Longitudinal Rebar used in concrete encased duct bank construction Bar sizes available – #6, #7, #8, #9, & #10 (e.g. REBAR – L*8).

REBAR – T* = Transverse Rebar used in concrete encased duct bank construction Bar sizes available – # 6 & # 7 (e.g. REBAR – T*6)

EXAMPLE:

REBAR-S*3

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