PART ONE - GENERAL

DESCRIPTION

SECTION INCLUDES: Perform all work required to complete the Cast-In-Place Concrete work, including but not limited to:

1. FLOORS AND SLABS ON GRADE
2. PLACING, FINISHING, CURING.

RELATED SECTIONS:

1. GENERAL CONDITIONS and Division 1
2. READY MIX CONCRETE: Section 03 305.

REFERENCES

REFERENCE STANDARDS of the following codes, specifications and standards, except where more stringent requirements are shown or specified.

1. AMERICAN CONCRETE INSTITUTE (ACI):
   a. ACI 301, "Specifications for Structural Concrete for Buildings".
   b. ACI 305, "Recommended Practice for Hot Weather Concreting".
   c. ACI 306, "Recommended Practice for Cold Weather Concreting".
   d. ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   e. ACI 318, "Building Code Requirements for Reinforced Concrete".
   f. ACI 315, "Manual of Standard Practice for Detailing Reinforced Concrete Structures.
   g. ACI 347, "Recommended Practice for Concrete Formwork".
2. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):
   a. ASTM C171 "Sheet Materials for Curing Concrete".
   b. ASTM C309 "Liquid Membrane-Forming Compounds for Curing Concrete".

SUBMITTALS

PRODUCT DATA: Submit for products named on Product List.

POUR SCHEDULES: Advise Architect at least 30 days before pouring floors, so that final floor outlet locations, if any, can be furnished 20 days before the pour.

TEST REPORTS: Furnish as specified under Testing.

CONCRETE MIX: After it has been reviewed by the Testing Agency.

QUALITY ASSURANCE

INSTALLER QUALIFICATIONS: Concrete work shall be performed by skilled, experienced workers under competent supervision.

PERFORMANCE CRITERIA: All concrete work shall be in accordance with the A.C.I. Code, the Reference Specifications. The quality, tolerances, and level of performance of the work shall be as specified herein.

FINISHES

1. FINISHES OF FORMED SURFACES:
   a. Rough Form Finish: Concrete surfaces not exposed to view in the finished work shall have a rough form finish as defined by ACI 301, Paragraph 10.2.1.
   b. Smooth Form Finish: Concrete surfaces exposed to view in the finished work, shall have a smooth form finish as defined by ACI 301, Paragraph 10.2.2.
2. SLAB FINISHES:
   a. Trowel Finish: Exposed concrete floors, and concrete floors to receive resilient flooring or carpet shall be screeded to an even, level plane, floated and given a Troweled Finish as specified in ACI 301, 5.3.4.2 C. Slope to floor drains as applicable. Use curing-hardening compound.

TESTING AGENCY: Refer to Section 03 305 Ready Mix Concrete, and Section 01 410.

ALLOWABLE TOLERANCES:

1. FORMED SURFACES: Per Section 03 100.
2. REINFORCING: Per Section 03 200.

3. SLAB TOLERANCES: Per Paragraph 5.3.4.3. of ACI 301 and as follows. Finished floor surfaces shall be level and shall pitch to floor drains, as applicable. Wet grind high spots which interfere with drainage or with a proper floor covering installation. Fill low areas with a filler compatible with the finish flooring material, as approved by the respective flooring manufacturer.
   a. Trowel Finish: Within 1/8" in 10 feet.
   b. Scratched Finish: Within 1/4" in 10 feet.
   c. Broom or Belt Finish: Within 1/4" in 10 feet.
4. REFER to the various Specification Sections for more stringent tolerances which may be applicable for the various flooring conditions.

WEATHER PROTECTION:
1. HOT OR COLD WEATHER PROTECTION: Shall be provided, per ACI 305 and ACI 306 respectively. Min 40 degrees; Max. 90 degrees F.
2. MOISTURE PROTECTION: Protection during wet weather shall be sufficiently weathertight to prevent entry of rain, sleet, or snow on the surfaces to receive concrete and into fresh concrete.

DELIVERY, STORAGE AND HANDLING

DELIVER: Store and handle materials in a manner that will prevent damage.

PROJECT CONDITIONS

INSPECT EXISTING CONDITIONS: For improper conditions which may prevent a proper installation before commencing the work. Do not proceed until improper conditions are satisfactorily corrected. Installation of the work of this Section constitutes acceptance of existing conditions and preceding work.

ENVIRONMENTAL REQUIREMENTS: Concrete shall not be placed when the temperature of the atmosphere is 40 ° F. and below , nor 90° F. and above or when other climatic conditions which will cause too rapid drying of concrete, nor during wet weather such as rain, sleet, or snow, unless precautionary measures are taken and protection is provided.

WEATHER PROTECTION:
1. HOT OR COLD WEATHER PROTECTION: Shall be provided, as specified.
2. MOISTURE PROTECTION: Protection during wet weather shall be sufficiently weather tight to prevent entry of rain, sleet, or snow on the surfaces to receive concrete and into fresh concrete. Weather protection materials shall be stored at the site ready for use in the event of unforeseen weather changes after the start of concrete placing operations.
3. MECHANICAL INJURY PROTECTION: Shall be provided to protect concrete from damaging mechanical disturbances, particularly load stresses, heavy shock, and excess vibrations.

COORDINATION: Take care not to disturb the subgrade during placement of vapor barrier, reinforcement, embedded items and concrete.
1. CHECK WITH: Other trades particularly mechanical and electrical trades regarding provisions for subsequent work.

GUARANTEE

ONE YEAR WRITTEN GUARANTEE: In accordance with the Conditions of the Contract. All concrete shall be warranted not to fail in bond and not to show excessive wear or weathering.

PART TWO - PRODUCTS

PRODUCTS/MATERIAL

CONCRETE CLASS AND USAGE
1. CONCRETE: Specifications are included under Section 03 305 Ready Mix Concrete.
2. CONCRETE USAGE: Shall be as follows unless otherwise noted on the drawings.
   a. Floor Slabs and other flat work: Inside the building and not exposed to weather: 3500 psi non-air-entrained.

MATERIALS

NON-SHRINK GROUT: Cement-based, non-metallic, non-corrosive, non-staining. ASTM C1107, CRD-C621.

1. ACCEPTABLE MANUFACTURERS:
   a. Euclid Chemical Co.; Product: NS Grout
   b. L & M Construction Chemicals; Product: CRYSTEX
   c. BASF Corporation; Product: Masterflow 713 Plus
   d. Five Star Products; Product: Five Star Grout
   e. Sika Corporation; Product: SikaGrout 328

CONCRETE CURING MATERIALS

1. ABSORPTIVE COVER: AASHTO M182, Burlap Cloth made from jute or kenaf and cotton mats.
2. MOISTURE-RETAINING COVER: ASTM C171 curing paper, polyethylene film or white-burlap-polyethylene sheet material for curing concrete.
3. WATER: For curing, clean, clear, free from deleterious substances.
4. EXTERIOR MEMBRANE FORMING CURING COMPOUND: ASTM C 309, Type II, Class A, water-based, white pigmented.
   a. Acceptable Manufacturers:
      .1 W.R. Meadows, Inc.; Product: 1600 – White
      .2 Dayton Superior; Product: Type II, Class A Cure
5. INTERIOR MEMBRANE FORMING CURING COMPOUND: ASTM C 309, Type I, Class A, clear.
      .1 W.R. Meadows, Inc.; Product: 1300 – Clear
      .2 Dayton Superior; Product: Type I, Class A Cure

CONCRETE FINISHING MATERIAL:

1. HORIZONTAL and VERTICAL SURFACE SEALER:
   a. Acceptable Manufacturer: Dayton Superior; Product: EDOCO Ultra Seal 30 EF

FORM MATERIALS

PLYWOOD: A/C exterior grade; sound, undamaged sheets with clean true edges.
LUMBER: Smooth; graded according to finish necessary.
PREFABRICATED: Aluminum or steel panels specifically designed for each use.
TUBULAR COLUMN TYPE: Round, spirally wound laminated materials, inside surface treated with release agent, of size required; Sonnetube or equal.
FORM TIES: Snap-off metal type.
FORM RELEASE AGENT: Colorless mineral oil or specifically manufactured compound which will not stain concrete

MIXES

READY-MIX: As specified and per ASTM C-94. Refer to Drawings.

1. RATE OF DELIVERY: Shall be such that the interval between placing successive batches shall not exceed 30 minutes. An elapsed time greater than 1-1/2 hours between introductions of mixing water and completion of discharge from the truck shall be sufficient cause for rejecting the batch.
2. WORKABILITY: The concrete will fill the forms without voids or honeycombs and completely embed and bond to the reinforcing without permitting materials to separate or excess water to collect on the surface.

ACCESSORIES

FORMED CONSTRUCTION JOINTS: Tooled joint formed in wet concrete as shown on the Drawings.
SLAB EDGE JOINT FILLER: (Isolation Joint) Premolded asphaltic board, ½ inch thick in width as required. Meadows Co; product – Seal Tight Fiber Expansion Joint, or approved substitute.

PART THREE - EXECUTION

PREPARATION FOR CONCRETE PLACING

GENERAL:

1. ALL SURFACES AGAINST WHICH CONCRETE is to be placed shall be free of debris, loose materials, standing water, snow, ice and other deleterious substances before the start of concrete placing.

2. STANDING WATER shall be removed without washing over freshly deposited concrete. Any flow of water shall be diverted through side drains provided for such purpose.

SUBGRADE UNDER SLABS ON GROUND: Before placing concrete, underground mechanical and electrical work, and compaction and grading of backfill materials under floor slabs shall be completed and approved.

REINFORCING STEEL: Tie in place before placing concrete

WELDED WIRE FABRIC: Place as shown on drawings.

LAYOUT: Depress slabs as detailed or required. Increase slab thickness at least 2 inches below embedded items such as electrical ducts. Verify floor drain locations so that floors pitch to drains (from 3/4" to 1" below the finish floor level.

COORDINATE installation of joint materials and vapor retarders with placement of forms and reinforcing steel.

CONVEYING CONCRETE

TRANSFER OF READY-MIXED CONCRETE AT PROJECT SITE: Concrete shall be handled from the point of delivery and transferred to concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods which will prevent segregation and loss of concrete mix materials and in a manner which will assure that the required quality of the concrete is maintained.

EQUIPMENT FOR CONVEYING CONCRETE: Shall be of a size and design that detectable setting of concrete shall not occur before adjacent concrete is placed.

1. RUNWAYS for wheeled concrete conveying equipment shall be provided from the ready-mixed concrete delivery point to the locations of final deposit.
2. CHUTES shall be metal or metal lined and shall have a slope not exceeding one vertical to three horizontal; chutes more than 20 feet long may be used provided they discharge into a hopper before distribution.
3. INTERIOR SURFACES of concrete conveying equipment shall be maintained free of hardened concrete, debris, water, snow, ice, and other deleterious materials.

PLACING CONCRETE

WORK SHALL CONFORM: To ACI 301 and ACI 304. Concrete shall be deposited continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause formation of seams or planes of weakness within the section.

1. CONCRETE PLACING shall be performed at such a rate that the concrete which is being integrated with fresh concrete is still plastic.
2. CONCRETE SHALL BE DEPOSITED as nearly as practicable in its final position to avoid segregation due to rehandling or flow.
3. CONCRETE WHICH HAS PARTLY HARDENED or has been contaminated by foreign materials shall not be deposited, such concrete shall be removed from the work and disposed of in an approved location.
4. CONCRETE TO RECEIVE OTHER CONSTRUCTION shall be screeded to the proper level to avoid excessive skimming or grouting.
5. HOT WEATHER PLACEMENT: Conform to ACI 305.
6. COLD WEATHER PLACEMENT: Conform to ACI 306.

INSPECT SUBGRADES AND FORMS: Do not pour until all reinforcing steel and embedded items are in place. Monitor form work and centering. If defects become apparent, stop the pour. Do not resume until bracing or strengthening is completed and formwork is in a safe and proper condition.

PLACING CONCRETE IN FORMS: Concrete shall be deposited in horizontal layers not deeper than 18 inches in manner to avoid inclined horizontal layers and inclined construction joints. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their service unnecessary.

1. ALL CONCRETE placed in forms shall be consolidated by internal vibrators. Equipment shall be adequate in number and power.
2. DO NOT USE vibrators to transport concrete within the forms. Do not vibrate forms or reinforcement.

3. WORK AROUND reinforcement, embedded fixtures and into form corners in a manner to prevent voids. Do not over vibrate.

PLACING FLOOR SLABS: Place continuously between predetermined construction, isolation, and control joints.

1. DO NOT INTERRUPT successive placements; Do not permit cold joints to occur.
2. PLACE FLOOR SLAB in a checker board or sawcut pattern.
3. MAINTAIN REINFORCING in proper position during concrete placement.
4. HORIZONTAL POUR: Shall not exceed 80 feet. Provide joints as specified.
5. CONTRACTION JOINTS: Provide panel layout as shown. Min. 1/8" wide one quarter of slab thickness in depth formed with insert strip or sawcut. If no pattern is shown; provide joints not exceeding 15' in either direction. Conform to bay spacing where possible (column centerlines, 1/2 bay, 1/3 bay).
6. ISOLATION OF JOINTS, as indicated, and where floor slab is restrained at walls, columns. Minimum 1/4" non-bituminous joint filler, full thickness of slab.
7. CONSOLIDATE CONCRETE so it is thoroughly worked around reinforcement and other embedded items and into corners.
8. BRING SURFACE: To the correct level, strike off, and float to a smooth surface, free of humps and hollows.
9. SAWCUT CONTROL JOINTS within 24 hours after placing. Use 3/16" blade, 1/4" of slab depth; unless otherwise noted.

WEATHER CONDITIONS

COLD WEATHER PLACEMENT: Protect concrete work from physical damager or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. WHERE AIR TEMPERATURE HAS FALLEN to or is expected to fall below 40 deg F uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. DO NOT USE FROZEN MATERIALS or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. DO NOT USE CALCIUM CHLORIDE, SALT, and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
4. DO NOT place concrete during rain, sleet, or snow. Protect surfaces from damage by rain, sleet or snow.
5. PROVIDE adequate means such as heating, insulation covering, or housing, for maintaining concrete at a temperature of at least 50 degrees f. five days or for such time as is necessary to insure proper curing of the concrete.

HOT WEATHER PLACEMENT: Conform to ACI 305.

1. PROTECT fresh concrete from high temperature and winds which may tend to produce rapid surface drying, reduce strength, increased shrinkage, rapid setting and poor control of air entrainment. Subgrade, forms and reinforcement shall be sprinkled and protected from direct exposure to sun and wind.
2. WHERE POSSIBLE concrete deliveries shall be scheduled for late afternoon and care shall be exerted to avoid excessive mixing or delays in placing.
3. FORMS SHALL BE WET-CURED for at least 24 hours during hot weather, with curing started as soon as concrete is hard enough to withstand surface damage.

FINISHING MONOLITHIC SLABS

GENERAL: Tamp concrete to force coarse aggregate down from surface. No coarse aggregate shall be at the surface. Surface depth of 1/8" to 1/4" shall consist of sand, cement, and small aggregate.

1. REFER to ACI requirements under Quality Assurance Paragraph.

TROWEL FINISH: For slab surfaces to be exposed to view or to receive chemical hardener, non-slip broom finish, or finish floor covering such as resilient tile, carpet, hard tile, or thin film finish coating system.

1. FLOOR FLATNESS, FF of 20; FL 17.

2. STEEL TROWEL to a smooth, uniform finish, free of defects. Steel trowel a second time to final burnish finish, free of trowel marks. Use edger on exposed edges. Grind smooth surface defects which would telegraph thorough applied floor covering system.

CURING CONCRETE

GENERAL: Conform to ACI 301 freshly placed concrete shall be protected as required to maintain the temperature of the concrete at not less than 50^{O}F., no more than 80^{O}F. and in a moist condition continuously for the period of time necessary for the hydration of the cement and proper hardening of the concrete.

1. CHANGES IN TEMPERATURE of the concrete during curing shall be as uniform as possible and shall not exceed 5°F. in any 24-hour period.
2. INITIAL CURING: As soon as water has disappeared after finishing, concrete shall be kept continuously moist for at least 72 hours.
3. FINAL CURING: Shall follow initial curing and before concrete has dried. Continue final curing for at least 168 hours (7 days) of cumulative (not necessarily consecutive) hours during which the air temperature is above 50°F.
    a. Rapid drying: At the end of final curing shall be prevented.

CURING METHODS: Shall be by moist curing, by moisture-retaining cover curing, or by membrane curing.

1. TEMPERATURE: During curing, comply with ACI 300, ACI 305.

MOIST CURING: By keeping the surface of the concrete continuously wet by spraying with water, or by covering with an absorptive cover that is thoroughly and continuously saturated with water. Overlap edges of cover.

MOISTURE-COVER CURING: By covering the concrete surfaces with moisture-retaining cover.

1. THE COVER shall be placed directly on the concrete in the widest possible width, with sides and ends lapped at least 3 inches and sealed with waterproof adhesives or pressure-sensitive waterproof tape. Cover shall be weighted to prevent displacement.
2. TEARS OR HOLES appearing in the cover during the curing period shall be immediately repaired by patching with pressure sensitive waterproof tape or other approved method.

MEMBRANE CURING: By applying the required membrane forming curing compound to damp concrete surfaces as soon as the moisture film has disappeared.

1. APPLY UNIFORMLY: in a two-coat continuous operation by power spraying equipment, using a sprayer equipped with a wind guard. The second coat shall be applied in a direction approximately at right angles to the direction of the first coat.
2. TOTAL COVERAGE of the two coats shall be not more than 200 square feet per gallon of curing compound.
3. CONCRETE SURFACES which are subjected to heavy rainfall within three hours after the curing compound has been applied shall be resprayed by the method, and at the rate specified above.
4. CONTINUITY OF THE COATING shall be maintained for the entire curing period and any damage to the coating during the curing period shall be immediately repaired.
5. DO NOT USE: Membrane Curing on surfaces to receive scratch finish, liquid waterproofing, hardener, flooring or other materials applied directly to the concrete or to be bonded to the concrete.

CURING FORMED SURFACES:

1. WHILE FORMS ARE IN PLACE, curing of formed surfaces shall be accomplished by moist curing.
2. IF FORMS ARE REMOVED before the end of the curing period, final curing of concrete surfaces shall be accomplished as follows:
    a. By moist curing: for surfaces to receive waterproofing or dampproofing.
    b. By any of the curing methods: Specified for all other surfaces.

CURING SLABS AND OTHER FLAT SURFACES:

1. CURING SHALL START as soon as the free water has disappeared from the surface of the concrete after finishing.
2. INITIAL CURING: Shall be Moist Curing.

3. FINAL CURING of slab surfaces which will receive finish flooring shall be accomplished by moisture-retaining cover curing.
4. FINAL CURING of slabs and other flat surfaces, except as specified above, shall be accomplished by any of the specified methods, as applicable.

FLOOR FINISH MATERIAL INSTALLATION
IN STRICT ACCORDANCE with manufacturer's instructions for inspections, preparation, application, curing and protection.

WEATHER PROTECTION OF CONCRETE DURING CURING
COLD WEATHER PROJECTION: When he temperature of the atmosphere is 40°F and below, the concrete shall be protected by heating, insulation covering, housing or combination thereof as required to maintain the temperature of the concrete at or above 50° F, and in a moist condition continuously for the concrete curing period.
1. COMPLY WITH ACI 306.
HOT WEATHER PROTECTION: When the temperature of the atmosphere is 90°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, the concrete shall be protected by windbreaks, shading, fog spraying, light-colored moisture-retaining covering, or a combination thereof as required to maintain the temperature of the concrete below 80°F and in a moist condition continuously for the concrete curing period.

PROTECTION
PROTECTION OF FINISHED CONCRETE: Permit no traffic on flat concrete for 5 days and only light traffic for 10 days. Provide protective cover as required to protect from subsequent rough work, scaffold, etc., over slabs.
DIMENSIONAL TOLERANCES: Embedded items, including anchor bolts, which are embedded or grouted in place in the wrong location shall be rejected. Reset such items, pay for the reworking of related work to properly fit incorrectly embedded items.

FIELD QUALITY CONTROL
DIMENSIONAL TOLERANCES: Embedded items, including anchor bolts, which are embedded or grouted in place in the wrong location shall be rejected. Reset such items, pay for the reworking of related work to properly fit incorrectly embedded items.
1. FLOORS: Shall slope to their respective drains.
MAINTAIN RECORDS OF CONCRETE PLACEMENT: Record data, location, quantity, air temperature, and test samples taken.
STRENGTH OF STRUCTURE: If the strength of the structure appears deficient, the Architect may require structural analysis or additional testing, per ACII 301, Para. 18.4.

ADJUSTMENT AND CLEANING
AFTER COMPLETION OF CONCRETE CURING in an area, remove all moisture-retaining curing materials, weather protection materials, and rubbish and debris resulting from specified work.
1. CLEAN AND REPAIR: All soiled or damaged surfaces.

JOINT SEALER SCHEDULE
FLOOR AT PERIMETER WALL: Seal where exposed to view.

END OF SECTION

PART ONE - GENERAL

DESCRIPTION

WORK INCLUDED: Perform all work necessary to complete the furnishing and delivery of the ready-mix concrete, as required and as specified.

RELATED WORK:

1. GENERAL CONDITIONS and Division 1.
2. CAST-IN-PLACE CONCRETE: Section 03 300.

QUALITY ASSURANCE

MANUFACTURER QUALIFICATIONS: Concrete shall be manufactured and delivered to the Project Site by a ready-mix concrete manufacturer thoroughly experienced in ready-mix concrete.

TESTING AGENCY: The inspection and testing agency provided under Section 01 400 will perform the following services:

1. REVIEW AND CHECK-TEST: the proposed concrete materials for compliance with the specifications. Review aggregate material, approve Mix Design.
2. SECURE PRODUCTION SAMPLES of materials at the ready-mix manufacturer's plant during the course of the work and test for compliance with the specifications. If requested by Architect.
3. CONDUCT STRENGTH TESTS OF CONCRETE during construction in accordance with good practice and the following:
    a. Secure composite samples: in accordance with ASTM C172. Each sample shall be obtained from a different batch of concrete on a random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placing.
    b. Mold and cure 3 specimens for each sample: in accordance with ASTM C31. Any deviations from the requirements of ASTM C31 shall be reported in the test reports. Cure one specimen in the field and cure two specimens in the laboratory.
    c. Test specimens: in accordance with ASTM C39. The field cured specimen shall be tested at seven days for information and the two laboratory cured specimens shall be tested at 28 days for acceptance. The acceptance test results shall be the average of the strength of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. In the event both specimens in a test show any of the above defects, the entire test shall be discarded. When high early strength concrete is used, the field cured specimen shall be tested at 3 days for information and the two laboratory cured specimens shall be tested at 7 days for acceptance.
    d. Make at least one strength test for each 100 cu. yd. or fraction thereof, of each concrete class designation placed in any one day except that in no case shall any concrete class designation be represented by less than 5 strength tests.
    e. Determine slump of the concrete sampled for each strength test and whenever consistency of concrete appears to vary. Measure slump in accordance with ASTM C143. One test per load.
    f. Determine air content of the concrete sampled for each strength test in accordance with either ASTM C231, ASTM C173, or ASTM C138, non-air entrained, and one test per truck for air-entrained.
    g. Determine temperature of concrete sampled for each strength test.

EVALUATION OF QUALITY CONTROL TESTS

1. CONCRETE COMPRESSIVE TESTS SHALL BE CONSIDERED SATISFACTORY if the average of any group of 5 consecutive compressive strength tests which may be selected is in each instance equal to or greater than the 28-day design compressive strength of the concrete class designation or if not more than one compressive strength test in ten has a value less than 90% of the 28-day design compressive strength.

2. IF THE COMPRESSIVE STRENGTH TESTS FAIL to meet the minimum requirements specified above, the Engineer may, at the Contractor's expense, require changes in the concrete mix proportions; require testing concrete structure for strength, as approved by the Engineer, or may declare all concrete work, of which the above mentioned strength tests are representative samples, in violation of the Specifications.
3. IF AIR CONTENT TESTS indicate at any time that the concrete being produced does not have a total air content within the specified limits, the Contractor shall modify the materials, proportions, or procedure of mixing materials as may be necessary for compliance, at no expense to the Owner.

REFERENCE STANDARDS: Comply with the current edition of the following:

1. AMERICAN CONCRETE INSTITUTE (ACI):
   a. ACI 211.1 Recommended Practice for Selecting Proportions for Normal and Heavyweight Concrete.
   b. ACI 318 Building Code for Reinforced Concrete.
   c. ACI 301 Concrete for Buildings.
2. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM):
   a. ASTM C31 Standard Method of Making and Curing Concrete Test Specimens in the Field.
   b. ASTM C33 Standard Specification for Concrete Aggregates.
   c. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. ASTM C94 Standard Specification for Ready-Mixed Concrete.
   e. ASTM C109 Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50-mm Cube Specimens).
   f. ASTM C138 Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
   g. ASTM C143 Standard Test Method for Slump of Portland Cement Concrete.
   h. ASTM C150 Standard Specification for Portland Cement.
   i. ASTM C172 Standard Method of Sampling Fresh Concrete.
   j. ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
   k. ASTM C192 Standard method of Making and Curing Concrete Test Specimens in the Laboratory.
   l. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   m. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete.
   n. ASTM C494 Standard Specification for Chemical Admixtures for Concrete.

SUBMITTALS

READY-MIXED CONCRETE MANUFACTURER'S EVIDENCE OF EXPERIENCE: Submit a written description of proposed ready-mixed concrete manufacturer giving qualifications of personnel, location of batching plant, list of projects similar in scope to specified work and other information as may be requested by the Engineer.

PRODUCT DATA: If admixtures are proposed to be used in the concrete mix, submit manufacturer's product data covering description of each proposed admixture and instructions for adding the admixture to the concrete mix.

READY-MIX CONCRETE DELIVERY TICKETS: Submit one copy of each delivery ticket to the Architect.

GUARANTEE

FURNISH A ONE YEAR WRITTEN guarantee in accordance with the Conditions of the Contract. All concrete work shall be warranted not to fail in bond and not to show excessive wear or weathering.

PART TWO - PRODUCTS

MATERIALS

CEMENT

1. PORTLAND CEMENT: ASTM 150, Type I, or high early strength Type III. Cement types or brands shall not be intermixed.
2. AIR ENTRAINING PORTLAND CEMENT: ASTM C-175, Type IA or IIIA.

NORMAL WEIGHT AGGREGATES

1. FINE AGGREGATE: ASTM C33, natural sand.
2. COARSE AGGREGATE: ASTM C33, either gravel or crushed stone. Maximum size not to exceed 1-1/2" for footings, or 3/4" for all other concrete. Conform to severe weathering requirements under Table 3. Concrete exposed to weather shall have less than 2% soft particles.

ADMIXTURES: May be used subject to its successful performance in trial concrete mix and with Architect's permission and within the following limitations:

1. AIR-ENTRAINING CONCRETE: ASTM C260. Use for all air-entrained concrete. Certified by manufacturers to be compatible with other required admixtures.
2. WATER REDUCING ADMIXTURE: ASTM C494, Type A, will be considered to meet the requirements for water-cement ratio and to improve consistency, use only Portland cement, Type I or III.
3. ACCELERATING ADMIXTURE: ASTM C494, Type C or Type E, will be considered when the predicted mean daily temperature for any subsequent 24 hour period falls below 40°F.
4. RETARDING ADMIXTURE: ASTM C494, Type B or Type D, will be considered when the predicted mean daily temperature for any subsequent 24 hour period is above 80°F.
5. CALCIUM CHLORIDE or admixtures containing calcium chloride shall not be used.
6. PREDICTED MEAN DAILY TEMPERATURE shall be as forecast by U.S. Weather Bureau.
7. ACCEPTABLE ADMIXTURE MANUFACTURERS: W.R. Grace, Master Builders Co., Sika Chemical Corp., Euclid Chemical Co.

WATER:

1. CLEAN, free from oil, acid, strong alkalies or vegetable matter, and potable.
2. NONPORTABLE WATER may be used only if it produces mortar cubes with 7-day and 28-day strength equal to similar specimens made with distilled water, when tested in accordance with ASTM C109.

MIXES

PROPORTIONING OF CONCRETE MIXES

1. GENERAL: The proportioning of concrete ingredients shall be such as to produce a mixture which will work readily into the corners and angles of the forms and around reinforcement by the methods of placing and consolidation to be employed on the Work, but without permitting the materials to segregate or excessive free water to collect on the surface.
2. MIX DESIGN: Determination of concrete mix designs for each concrete class designation to be used in the Work shall be done by trial mixes made in advance of the beginning of concreting operations in accordance with the following:
    a. Materials used for trial mixes: shall be similar to those to be used in the work. Measuring of materials shall be in accordance with ASTM C94.
    b. Normal-weight concrete trial mixes having proportions and consistence suitable for the work shall be made based on ACI 211.1, using at least three different water-cement ratios within the limits for minimum cement content and maximum water content specified in "Limits of Concrete Proportions" hereinafter, which will produce a range of strengths encompassing the concrete class designation required by the Work. Trial mixes shall be designed to produce a slump within the allowable range and, for air-entrained concrete, the maximum air content. Control in the field shall be based upon maintenance of proper cement content, slump, and air content.

c. For each normal-weight concrete water-cement ratio: at least 3 compression test cylinders for each test age shall be made and cured in accordance with ASTM C192. The test cylinders shall be tested for compressive strength at 7-days and 28-days in accordance with ASTM C39.

d. From the results of the above tests: a curve shall be plotted showing the relationship between the water-cement ratio and the compressive strength. From this curve, the water-cement ratio to be used in the concrete shall be selected to produce an average strength for the concrete class designation, unless otherwise specified. When the ready-mixed concrete manufacturer has a quality control record, based on at least 30 consecutive strength tests of a similar mix or mixes obtained within the past 12 months representing similar materials and conditions to those expected, and the standard deviation is 400 psi or less, the average strength used as a basis for selecting concrete proportions shall exceed the specified compressive strength by at least 550 psi.

3. ADMIXTURES: Add mixtures into the concrete mix in accordance with the manufacturer's printed directions.
   a. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F.
   b. Use air-entraining admixture: in exterior exposed concrete, unless otherwise indicated.

LIMITS OF NORMAL-WEIGHT CONCRETE PROPORTIONS

Min. 28-day Strength Compressive PSI	Min. Cement Lbs. Per Cu Yd.	Max. W/C Ratio Decimal Lb. of Water Per Lb. of Cement
1. NON-AIR ENTRAINED CONCRETE:		
1000	282	-
3000	517 (5.5 bags)	0.58 (6.6 G/Bag)
3500	564 (6.0 bags)	0.51 (5.8 G/Bag)
4000	611 (6.5 bags)	0.44 (5.0 G/Bag)
2. AIR-ENTRAINED CONCRETE:		
3000	517 (5.5 bags)	0.46 (5.2 G/Bag)
3500	564 (6.0 bags)	0.40 (4.5 G/Bag)
4000	611 (6.5 bags)	0.35 (4.0 G/Bag)

Notes Regarding Table for "Limits of Normal-Weight Concrete Proportions:"

a. The above table is based on using Type I Portland cement without admixture for non air-entrained concrete and with air-entraining admixture for air-entrained concrete, slump within the limits of 2" to 4" maximum water content includes the free moisture in the aggregate. If Type III Portland cement is used, the concrete shall have 7-day compressive strength equal to the 28-day compressive strength listed above.

b. The table indicates the limits for concrete mixes; is not intended as a concrete mix design; and does not supersede nor eliminate the requirements for trial mixes.

c. The trial mixes will establish the exact proportions for all concrete ingredients for the normal-weight concrete to be used in the Work.

AIR CONTENT LIMITS FOR AIR-ENTRAINED CONCRETE:

Maximum Size Coarse Aggregate	ASTM C33 Size No.	Air Content By Volume
1-1/2"	467	4 to 6%
1"	57	5 to 7%
3/4"	67	4 to 8%
3/8"	8	6 to 10%

a. Measure air content limits in accordance with ASTM C231 or ASTM C173 or ASTM 138.

SLUMP LIMITS: Proportion and design mixes to result in concrete slump at point of placement as follows:

1. RAMPS, SLABS, AND SLOPING SURFACES; not more than 3".
2. REINFORCED FOUNDATION SYSTEMS: Not less than 1", not more than 3".
3. OTHER CONCRETE: Not less than 1"; not more than 4".

CONCRETE USAGE

CONCRETE usage for each class designation is specified as noted under Section 03 300 Cast in Place Concrete.

PRODUCTION OF CONCRETE

1. GENERAL: Ready-mixed concrete shall be batched, mixed and transported in accordance with ASTM C94, except as otherwise specified in this Section.
   a. Ready-mixed concrete shall be mixed and delivered to the point of discharge at the Project site by means of truck-mixed concrete.
   b. No water from the truck water systems or elsewhere shall be added after the initial introduction of the mixing water for the batch unless authorized by the Engineer. Under no circumstances shall the approved maximum water content be exceeded nor shall the slump exceed the maximum specified.
   c. Discharge of normal-weight concrete shall be completed within 1-1/2 hours, or before the drum has revolved 300 times, whichever comes first after the introduction of the mixing water to the aggregates, except that in hot weather (air temperature 80^{O}F and above) or under conditions contributing to quick stiffening of the concrete, the time shall be reduced to one hour.
   d. Concrete delivered in cold weather shall conform to the following temperature limitations:

Air Concrete Temperature	Minimum Temperature	Min Temp. When Least Dimension is Greater than 12"
30 to 45^{O}F	60^{O}F	50^{O}F
0 to 30^{O}F	65^{O}F	55^{O}F
Below 0^{O}F	70^{O}F	60^{O}F

   e. Concrete delivered in air temperature of 90°F, and over or under hot weather conditions contributing to quick stiffening of the concrete, shall have a temperature between 60 and 80°F.

2. DELIVERY TICKETS: With each load of concrete delivered to the Project Site, there shall be furnished two copies of delivery tickets in accordance with the requirements of Section 15 ASTM C94 and as follows:
   a. Type and name of each admixture and amount of same.
   b. Type and brand of cement.
   c. Cement content in pounds per cubic yard.
   d. Total water content by producer (W/C ratio).
   e. Coarse aggregate size number and class designation per ASTM C33.
   f. Signature of ready-mixed concrete manufacturer's representative.

EXECUTION

(Not Applicable)

END OF SECTION