PART 1 – GENERAL

1.01 SCOPE OF WORK

Work performed under this Section shall include all labor, materials, equipment, plant and incidentals required to complete all cast-in-place concrete work as indicated on the Drawings and as specified herein.

1.02 RELATED WORK

A. Section 02200, Earthwork
B. Section 03200, Reinforcing Steel
C. Section 03151, Polyvinyl Chloride Waterstops
D. Section 03152, Expansion – Contraction Joints,
E. Section 03400, Precast Concrete Structures

1.03 SUBMITTALS

A. The Contractor shall submit submittals in accordance with Section 01330.
B. Product Data: Submit manufacturer’s product data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, curing compounds, and others as requested by Engineer.
C. Shop Drawings, Reinforcement: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 “Manual of Standard Practice for Detailing Reinforced Concrete Structures” showing bar schedules, stirrup spacing, diagrams or bent bars, arrangement of concrete reinforcement. Include special reinforcement required and openings through concrete structures.
D. Shop Drawings, Formwork: Submit shop drawings for fabrication and erection of formwork necessary to produce specified finished concrete surfaces as indicated.

    Show general construction of forms, including jointing, special form joint or reveals location and pattern of form tie placement, and other items which affect exposed concrete visually.

    Engineer’s review is for general architectural applications and features only.
E. Samples: Submit samples of materials as specified and as otherwise requested by the Engineer including names, sources and descriptions.
F. Laboratory Test Reports: Submit laboratory test for concrete materials and mix design to the Engineer for approval as specified. Test reports to include sieve analysis of fine and course aggregates.

G. Material Certificates: Provide material certificates in lieu of material laboratory test reports where required by engineer. Material certificates shall be signed by manufacturer and contractor, certifying that each material item complies with specified requirements.

H. Material Safety Data Sheets (MSDS) for all concrete admixtures are curing agents.

I. Provide certification that admixtures used in the same concrete mix are compatible with each other and the aggregates.

J. Delivery Tickets: Furnish to the Engineer copies of all delivery tickets for each load of concrete delivered to the site. Provide items of information as specified in ASTM C94, Section 16.

1.04 REFERENCE STANDARDS

A. Codes and Standards: Comply with provisions of the following codes, specifications and standards, except where more stringent requirements are shown or specified.

1. American Concrete Institute (ACI)

   301 Specifications for Structural Concrete for Buildings
   304 Guide for Measuring, Mixing, Transporting and Placing Concrete
   395R Hot Weather Concreting
   306R Cold Weather Concreting
   315 Details and Detailing of Concrete Reinforcement
   318 Building Code Requirements for Reinforced Concrete
   347 Recommended Practice for Concrete Formwork
   350 Concrete Sanitary Engineering Structures


   ASTM A82 Spec for Steel Wire, Plain, for Concrete Reinforcement
   ASTM A185 Standard Specifications for Steel Welded Wire Fabric Plain for Concrete Reinforcement
   ASTM A497 Spec for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
   ASTM A615 Spec for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
   ASTM A767 Spec for Zinc-Coated (galvanized) Bars for Concrete Reinforcement
   ASTM A775 Spec for Epoxy-Coated Reinforcing Steel Bars
   ASTM C31 Practices for Making and Curing Concrete Test Specimens in the Field
   ASTM C33 Spec for Concrete Aggregates
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ASTM C39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94 Spec for Ready-Mixed Concrete
ASTM C143 Test Method for Slump of Portland Cement Concrete
ASTM C150 Spec for Portland Cement
ASTM C171 Spec for Sheet Materials for Curing Concrete
ASTM C172 Method of Sampling Freshly Mixed Concrete by the Pressure Method
ASTM C173 Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260 Spec for Air-Entraining Admixtures for Concrete
ASTM C309 Spec for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494 Spec for Chemical Admixtures for Concrete


B. Concrete Testing Service:

Materials and installed work may require testing and retesting, as directed by Engineer, at anytime during progress of work. Allow free access to material stockpiles and facilities. Tests, not specifically indicated to be done at Owner’s expense, including retesting of rejected materials and installed work, shall be done at Contractor’s expense.

1.05 QUALITY ASSURANCE

A. Reinforced concrete shall comply with ACI 318 AND 350R.

B. If during the progress of work, it is impossible to secure concrete of the required workability and strength with the materials being furnished, the Engineer may order such changes in proportion or materials, or both, as may be necessary to secure the required properties. All changes so ordered shall be made at the Contractor’s expense.
C. Materials and installed work may require testing and retesting, as directed by the Engineer, at anytime during the progress of work. All testing and inspection services required, unless otherwise specified, shall be provided and paid for by the Owner. Any retesting of rejected materials and installed units, or testing necessary to establish the concrete mixes shall be performed by and at the expense of the Contractor. Methods of testing shall comply with the latest applicable ASTM Methods.

1.06 DELIVERY, STORAGE AND HANDLING

A. Product shall be stored in conformance with the manufacturer’s recommendations.

B. Sand aggregates and cement shall be stored or stockpiled in conformity with the recommendations of ACI 301.

PART 2 – PRODUCTS

2.01 FORM MATERIALS

A. Forms for Exposed Concrete: Unless indicated, construct formwork for exposed concrete surfaces with plywood metal, metal framed plywood faced or other acceptable panel type materials, to provide continuous, straight, practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection.

Form materials are to be in “first class” condition. Samples are to be submitted to the Engineer for approval.

B. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.

C. Form Coatings: Provide commercial formulation form coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces. Coating shall be submitted for review of the Engineer.

2.02 CONCRETE MATERIALS

A. Portland Cement: ANSI/ASTM C150, Type II, unless otherwise acceptable to the Engineer. Use one brand of cement throughout project, unless otherwise acceptable to the Engineer.

B. Fine aggregate shall be washed inert natural and conforming to the requirements of ASTM C33.
C. Coarse aggregate shall be a uniformly-graded crushed stone or washed gravel conforming to the requirements of ASTM C33. Limits of Deleterious Substances and Physical Property Requirements shall be as recommended for severe weathering regions.

D. Water shall be potable, clean and free from injurious amounts of oils, acids, alkalis, organic matter, or other deleterious substances.

E. Concrete admixtures shall be free of chlorides and alkalis (except for those attributable to water). When it is required to use more than one admixture in a concrete mix, the admixtures shall be from the same manufacturer. Admixtures shall be compatible with the concrete mix including other admixtures and shall be suitable for use in contact with potable water after 30 days of concrete curing.

1. Air entraining admixture shall comply with ASTM C260 in accordance with manufacturer’s recommendations.

2. Water reducing admixtures. Proportions and mixing shall be in accordance with manufacturer’s recommendations.

3. Admixtures causing retarded or accelerated settling of concrete shall not be used without the written approval of the Engineer. When allowed the admixtures shall be retarding or accelerating water reducing admixtures.

F. Calcium Chloride: Not permitted.

2.03 AGGREGATES

A. The Contractor shall submit a new trial mix to the Engineer for approval whenever a different aggregate or gradation is proposed.

B. The Contractor shall submit to the Engineer for approval, a minimum of two (2) suppliers of aggregates he proposes to use.

C. The Contractor shall furnish confirmation to the Engineer that he can obtain 100% of the needed aggregates from one area prior to approval to pour concrete.

D. Fine Aggregate: Fine aggregate shall conform to ASTM Designation C33 and consist of natural sand, clean, sharp and free from loam, clay, lumps or other deleterious substances. Bank run (material as mined without further processing will not be allowed).

E. Coarse Aggregate (Typical):

1. Coarse aggregate shall be crushed stone or gravel. It shall conform to the requirements of ASTM Designation C33 and the latest revision thereof. It shall be clean, uncoated, processed aggregate free from loam, clay, lumps or other deleterious substances.
2.04 WATER

A. Water for use in concrete and mortar shall be from a potable domestic supply and free from injurious amounts of minerals and organic substances.

2.05 TESTS OF MATERIAL

A. The Engineer shall have the right to order the test of any material entering into the concrete or reinforced concrete to determine its suitability for the purpose. Test shall be made in accordance with the requirements of ASTM. The complete record of such tests shall be available for inspection during the progress of the Work.

2.06 RELATED MATERIALS

A. Moisture Barrier: Provide moisture barrier cover over prepared base material where indicated. Use only materials which are resistant to decay when tested in accordance with ASNI/ASTM E154, as follows:

1. Reinforced polyethylene sheet not less than 8 mils thick. Overlap joints 6” and tape with polyethylene tape.

B. Non-Shrink Grout: CE CRD-C621 factory premixed grout.

1. Available products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   * Type D, Non-metallic
     * “588 Grout”; W.R. Meadows, Inc.
     * “Sonogrouting”, Sonneborn-Contech
     * “Sika Grout 212”, Sika Corp.
     * “Five Star Grout”; U.S. Grout Co.
     * “Duragrouting”, L&M Const. Chemical Co.
     * “Axpandcrete-S”; Anti-Hydro Co.

C. Chemical Hardener (ChHd-Fn): Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 lbs. of fluosilicates per gallon.

D. Absorptive Cover: Burlap cloth made from jut or kenat, weighing approximately 9 oz per square yard, complying with AASHTO M182, class 2.

E. Moisture Retaining Cover: One of the following, complying with ANSI/ASTM C171.

   * Waterproof paper
   * Polyethylene film
   * Polyethylene-coated burlap
F. Liquid Membrane-Forming Curing Compound: Liquid type membrane-forming curing compound complying with ANSI/ASTM C309, Type 1, Class A, unless other type acceptable to Engineer.

1. Available products. Subject to compliance with requirements for future placement and coatings, products which may be incorporated in the work include, but are not limited to, the following:

   “Masterseal”, Master Builders
   “Ecocure”, Euclid Chemical Co.
   “Clear Seal”, W.R. Grace
   “Sealkure”, Toch Div., Carboline
   “Kure-N-Seal”, Sonneborn, Contech
   “Polyclear”, Upco Chemical/USM Corp.
   “L&M Cure”, L&M Construction Chemicals
   “Klearseal”, Setcon Industries
   “LR-151”, Protex Industries
   “Hardtop”, Gifford-Hill

Submit manufactures literature for review.

G. Bonding Compound: Polyvinyl acetate, rewettable type.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:

   “Weldcrete”, Larson Products
   “Everbond”, L&M Construction Chemicals
   “Eucoweld”, Euclid Chemical Co.
   “Daraweld C”, W.R. Grace
   “Sonocrete”, Sonneborn-Cotech

Submit manufacturers’ literature for the review of the Engineer.

2.07 PROPORTIONING AND DESIGN OF MIXES

A. Select proportions of ingredients to meet the design strength and materials limits specified in Table 1 and to produce concrete having proper placability, durability, strength, appearance and other required properties. Proportion ingredients to produce a homogenous mixture, which will readily work into corners and angles of forms and around reinforcement without permitting materials to segregate or allowing excessive free water to collect on the surface.
TABLE 1

<table>
<thead>
<tr>
<th>Class</th>
<th>Design Strength¹</th>
<th>Cement Content²</th>
<th>W/C³</th>
<th>WR⁴</th>
<th>Slump Range (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2500</td>
<td>Type II</td>
<td>440</td>
<td>0.62 max. Yes</td>
<td>1-4</td>
</tr>
<tr>
<td>B</td>
<td>3000</td>
<td>Type II</td>
<td>480</td>
<td>0.54 max. Yes</td>
<td>1-4</td>
</tr>
<tr>
<td>C</td>
<td>3500</td>
<td>Type II</td>
<td>540</td>
<td>0.45 max. Yes</td>
<td>3-5</td>
</tr>
<tr>
<td>D</td>
<td>4000</td>
<td>Type II</td>
<td>560</td>
<td>0.44 max. Yes</td>
<td>3-5</td>
</tr>
</tbody>
</table>

All concrete classes shall have 3.5 to 5 percent air entrainment, unless specified below.

NOTES:
1. Minimum compressive strength at 28 day.
2. Minimum cement content in lbs per cubic yard
3. W/C is water cement ratio
4. WR is water reducing admixture

B. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If the trial batch method is used, use an independent testing facility acceptable to the Engineer for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to the Engineer.

C. Submit written reports to Engineer of each proposed mix for each class of concrete at least 15 days prior to the start of work. Do not begin concrete production until mixes have been approved by the engineer.

D. Admixtures:
1. Use water-reducing admixture (plasticizer) in all concrete.
2. Use air-entraining admixture in all exposed concrete, unless otherwise indicated, add air-entraining admixture at manufacturer’s prescribed rate to result in concrete at point of placement having air content within following limits:
   a. Concrete, structure and slabs exposed to freezing and thawing or subjected to hydraulic pressure.
      - 4% to 8% for maximum ¾” aggregate
      - 6% to 9% for maximum ½” aggregate
   b. Other Concrete: 2% to 4% air
3. Use admixtures for water-reducing and set-control, when permitted, in strict compliance with manufacturer’s directions.
4. Slump limits: Proportion and design mixes to result in concrete slump at point of placement as follows:

3” plus or minus 1”, with plasticizers 7” maximum.

2.08 MEASURING, BATCHING, MIXING AND TRANSPORTING CONCRETE

A. Measuring, batching, mixing and transporting concrete shall conform to ASTM C94 and the requirements herein or as otherwise approved in writing by the Engineer.

B. Ready-mixed concrete, whether produced by a concrete supplier or the Contractor shall conform to the requirements of ANSI/ASTM C94. No hand mixing will be permitted.

During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required.

C. Admixtures shall be dispensed into the batch in conformity with the recommendations of the manufacturer of the admixtures.

D. Concrete shall be mixed until there is a uniform distribution of the materials and shall be discharged completely before the mixer is recharged. The mixer shall be rotated at a speed recommended by the mixer manufacturer and mixing shall be continued for at least one and one half minutes after all the materials are in the mixer. Concrete shall be placed within 1-1/2 hours of the time at which water was first added, otherwise it shall be rejected. Concrete which has been remixed or retempered, or to which an excess amount of water has been added, shall also be rejected.

E. All dry ingredients to be batch mixed at the plant. Water and any necessary admixtures to be added and mixed at the jobsite. Follow DHS inspection requirements for one inspected slump test on site without the admixtures, then admixture addition followed by second slump test after the admixture addition.

2.09 READY-MIXED CONCRETE

A. Ready-mixed concrete production methods and facilities shall comply with Standard Specifications for Ready-Mixed Concrete, ASTM C 94. Batch deliveries shall not exceed the rated capacity specified for the mixer by the manufacturer of that equipment.

B. Contractor shall submit affidavits from the ready-mixed concrete supplier certifying that the proposed mix to be supplied satisfied all the requirements under this item and those outlined under “Proportioning”. Such affidavits shall be subject to the approval of the Engineer.

2.10 EMBEDDED ITEMS

A. Items such as plates, angles, inserts, bolts and similar items not specified elsewhere shall be provided and installed under this Section unless specified otherwise. All embedded items shall be hot dip galvanized after fabrication (unless otherwise noted). All galvanized elements that will be embedded in or will come in contact with concrete and mortar will
require a chromate coating. This coating should be accomplished in the galvanizing plant by either dipping the galvanized elements in a solution of potassium dichromate acidified with sulfuric acid or by spraying this solution on the galvanized surface.

B. All aluminum items in contact with the concrete and motor shall receive a bituminous coating.

PART 3 - EXECUTION

3.01 FORMS

A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structures are of correct size, shape, alignment, elevation and position.

B. Design formwork to be readily removable without impact shock or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms complying with ACI 304, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grade, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and/or placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.

F. Chamfer exposed corners and edges as indicated, using wood, metal, PVC or rubber chamfer stripes fabricated to produce uniform smooth lines and tight edge joints.

G. Form Ties. Factory-fabricated, adjustable length, removable or snapoff metal form ties, removable or snapoff metal for tie, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

1. Unless otherwise indicated, provide ties so portion remaining within concrete after removal is at least 2” inside concrete.
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2. Unless otherwise shown, provide form ties, which will not leave holes larger than 1” diameter in concrete surface.

3. Submit samples of form ties to the Engineer for approval.

4. Wooden spacers/spreaders are unacceptable in forms.

H. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, woods, sawdust, dirt or other debris just before concrete is placed. Retighten forms and bracing after concrete placement if required to eliminate mortar leaks and maintain proper alignment.

3.02 JOINTS

A. Construction Joints: Locate and install construction joints, which are not shown on drawings, so as not to impair strength and appearance to the structure, as acceptable to the Engineer.

B. Provide Keyways at least 1-1/2” deep in construction joints in walls, slabs; and between walls and footings; accepted bulkheads designed for this purpose may be used for slabs.

C. Place construction joints perpendicular to the main reinforcement. Continue reinforcement across construction joints.

D. Waterstops: Provide waterstops in construction joints, where shown on drawings. Make provisions to support and protect exposed waterstops during progress of work. Provide factory fabricated waterstop corners and transitions leaving only straight butt joint splices for the field. Fabricate field butt joints in waterstops in accordance with manufacturer’s printed instructions. Penetrations through waterstop are unacceptable.

E. Isolation joints in slabs-on-ground. Construct isolation joints in slabs on ground at points of contact between slabs on ground and vertical surfaces, such as column, pedestals, foundation walls, grade beams and elsewhere as indicated.

   1. Joint filler and sealant materials are specified in section 03152 of these specifications.

F. Construction (control) joints in slabs-on-ground. Construct control joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4” wide x 1/5 to 1/4 of the slab depth, unless otherwise indicated.

   Form construction joints by inserting premolded hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured, remove inserts and clean groove of loose debris.

   1. Construction joints may be formed by saw cuts as soon after slab finishing without dislodging aggregate.
2. Joint sealant material is specified in Section 03152 of these specifications.

3.03 INSTALLATION OF EMBEDDED ITEMS

A. General: Provide, set and build into work, anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, templates, instructions and directions provided.

B. Sleeves and Wall Pipes

1. For pipe with nominal pipe sizes three (3) inches and larger, wall pipes or wall sleeves shall be provided in accordance with the following schedule except where noted when passing through new concrete or masonry structures

<table>
<thead>
<tr>
<th>From Above Grade</th>
<th>To Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Interior</td>
<td>Exterior, Block Wall, Sleeve with waterstop</td>
</tr>
<tr>
<td>Dry Interior</td>
<td>Wet Tank, Wall Pipe</td>
</tr>
<tr>
<td>Dry Interior</td>
<td>Earth Interior, Sleeve w/waterstop</td>
</tr>
<tr>
<td>Dry Interior</td>
<td>Dry Interior, Wall sleeve (no waterstop)</td>
</tr>
<tr>
<td>Wet Tank</td>
<td>Earth, Sleeve w/waterstop</td>
</tr>
<tr>
<td>Wet Tank</td>
<td>Wet Tank, Sleeve w/waterstop</td>
</tr>
<tr>
<td>Earth</td>
<td>Earth, Sleeve w/waterstop</td>
</tr>
<tr>
<td>Exterior</td>
<td>Exterior, Sleeve w/waterstop</td>
</tr>
<tr>
<td>Interior</td>
<td>Exterior, Sleeve w/waterstop</td>
</tr>
</tbody>
</table>

2. Except where noted, all wall pipes and castings shall be furnished with a waterstop and shall be ductile iron for all piping with nominal pipe size thirty (30) inches and smaller.

C. Sleeves

1. Wall sleeves shall be either ductile iron or gray cast iron pipe. Generally, sleeves shall have no waterstops unless otherwise shown on the contact drawings.

2. Sleeves 30-inches and larger shall be standard weight.

3. Shall be of sufficient size to pass the pipe and where applicable the insulation covering the pipe.

4. Shall be provided with cast brass or cast iron, nickel plated spool type escutcheon plates on each exposed side at all wall openings.
5. Shall terminate flush with walls except when furnished with flanges or mechanical joints, with flanges, sleeves shall project beyond the face of the walls as shown on the contract drawings.

6. At exterior walls applications, a wall penetration seal such as Thunderline Corporation (link seals) shall be provided and the sleeve shall be sized accordingly. A plug of silicone rubber caulk shall also be provided to assure weather tightness.

D. Wall Pipes

1. Shall be of sufficient length to pass through the wall in accordance with the details on the contract drawings.

2. Shall conform to the details shown on the contract drawings.

3. The end of the wall pipes shall be of a type consistent with the piping to be connected to them and shall conform to their standards and specifications.

4. All wall pipes shall have the same interior protection as specified for the connecting piping. Exterior piping shall be as specified in the piping schedule.

5. Wall pipes may have several combinations of joints depending on the joints allowed in the piping schedule. Joint ends such as flanged-flanged or flanged-mechanical joint are examples.

E. Edge forms and screed strips for slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

F. Cast-in-place concrete anchoring inserts shall be installed where shown on the contract drawings. They shall be stainless steel, continuous channel inserts containing foam fillers to prevent concrete intrusion. These inserts shall have a secure fastening anchor system to the concrete; similar to that manufactured by Halfen Anchoring System, North Carolina or equal. Submit samples and technical literature to the Engineer for review.

3.04 PREPARATION OF FORM SURFACES

A. Coat contact surfaces of forms with a form-coating compound before forms are in place.

B. Thin form-coating compounds only with thinning agent of type, and in amount, and under conditions of form-coating compound manufacturer’s directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer’s instructions.

C. Coat steel forms with a non-staining rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.
3.05 CONCRETE PLACEMENT

A. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work and cooperate with other trades in setting such work. Notify the Engineer and SCDHS of completions of formwork and reinforcement. Allow the Engineer and County one full working day to complete their inspection of the work prior to ordering delivery of concrete. When constructing walls, an additional inspection of the work is required prior to forming the interior sides of the walls.

B. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

C. General: Comply with ACI 304, and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

D. Placing concrete in forms: Deposit concrete in forms in horizontal layers not deeper than 24” and in a manner to avoid inclined construction joints, where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints. No drops over 4 feet will be allowed without the use of trunks.

E. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practice.

F. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and at least 6” into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.

G. Placing concrete for slabs: Deposit and consolidate concrete for slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.

H. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
I. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.

J. Maintain reinforcing in proper position during concrete placement operations.

K. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which would be caused by frost freezing actions, or low temperatures, in accordance with the applicable requirements of ACI 306.

When heavy frost or freezing is present or forecast, the Contractor shall provide an adequate number of workmen and protective materials at the site to protect the concrete from freezing. The contractor shall prepare and submit to the Engineer and the County for approval, a detailed plan of operations indicating materials and methods to be used and the number of workmen proposed to keep the concrete at the minimum temperatures for the periods recommended by ACI 306. The Contractor will provide in-place temperature recording devices to the satisfaction of the Engineer. The Engineer will monitor temperatures and inform the Contractor as to the adequacy of the protection.

Do not use calcium chloride, salt or other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in the mix designs.

L. Hot weather placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F (32 degrees C). Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is included in total amount of water in concrete mix.

Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

Wet forms thoroughly before placing concrete.

Use water-reducing retarding admixtures (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

3.06 FINISH OF FORMED SURFACES

A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finished work or both other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding ¼” in height rubbed down or chipped off.

B. Smooth form finish: For formed concrete surfaces coating material applied to concrete, or a covering material applied directly to concrete, such as waterproofing, painting or other similar system. This is as-cast concrete surface stained with selected form facing material,
arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

C. Related uniformed surfaces: At tops of walls and other horizontal offset surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.07 MONOLITHIC SLAB FINISHES

A. Scratch finish: Apply scratch finish to monolithic slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, and other bonded applied cementatious finish flooring material, and as otherwise indicated.

After placing slabs, plane surface to a tolerance not exceeding ¼” in 2’ when tested with a 2’ straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms or rakes.

B. Float finish: Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing and as otherwise indicated.

1. After screeding and consolidating concrete slabs, do not work surface until ready for floating. Begin floating when surface with has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level surface planes to a tolerance not exceeding ¼” in 10’ when tested with a 10’ straight edge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth granular texture.

C. Trowel finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, paint or other thin film finish coating systems

1. After floating, begin first trowel finish operation using a power driven trowel. Begin finish trowelling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-trowelling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8” in 10’ when tested with a 10’ straightedge. Grind smooth any surface defects which would telegraph through supplied floor covering.

D. Non slip broom finish: Apply non-slip broom finish to exterior concrete platforms, steps and ramps, and elsewhere as indicated.
1. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with engineer before application.

E. Chemical hardener finish: Apply chemical hardener finish to interior concrete floors where indicated. Apply liquid chemical hardener after complete curing and drying of the concrete surface. Dilute liquid hardener with water, and apply 3 coats, first coat, 1/3 strength, second coat ½ strength, third coat, 2/3 strength. Evenly apply each coat and allow 24 hours for drying between coats.

1. Apply proprietary chemical hardeners, in accordance with manufacturer’s printed instructions.

2. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

3.08 CONCRETE CURING AND PROTECTION

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Curing for watertight structures shall be in accordance with ACI 224 and 350.

B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting; keep continuously moist for not less than 7 days.

C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

D. Curing methods: Perform curing of concrete by moist curing, by moisture retaining cover curing, by membrane curing, or by combinations thereof, as herein specified. The method to be used will be chosen by the engineer.

1. Provide moisture curing by the following methods:

   a. Keep concrete surface continuously wet by covering with water.

   b. Continuous water-fog spray

   c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4” lap over adjacent absorptive cover.

2. Provide moisture cover curing as follows:

   Cover concrete surfaces with moisture retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3” and sealed with
waterproof tape or adhesive. Immediately repair any holes or tears which may appear during curing period using cover material and waterproof tape.

3. Provide curing compound to slabs as follows:

Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within 2 hours). Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer’s directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.

Do not use membrane curing compounds on surfaces which are to be covered with coating materials applied directly to concrete such as, fill concrete liquid floor hardener, waterproofing, damp proofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the Engineer.

4. Curing formed surfaces: Cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

5. Curing unformed surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing, compound.

6. Final cure concrete surfaces to receive liquid floor hardener, paint or finish flooring by use of moisture retaining cover, unless otherwise directed.

3.09 SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

B. Extend shoring from ground to roof, unless otherwise permitted.

C. Remove shores and reshape in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate reshoring to safely support work without excessive stress or deflection.

D. Keep rehares in place a minimum of 15 days after placing upper ties, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.
3.10 REMOVAL OF FORMS

A. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulatively curing at not less than 50 degrees F for 96 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

B. Formwork supporting weight of concrete, such as beam soffits, joints, slabs and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of inplace concrete by testing field-cured specimens representative of concrete location or members.

C. When high-early strength concrete is specified, a schedule for removal of forms will be developed in the field from the age/strength relationships established for the materials and proportions used by tests in accordance with ACI-301, Section 3.8.

D. When, in the opinion of the Engineer, conditions of the Work or weather justify, forms may be required to remain in place for longer periods.

3.11 RE-USE OF FORMS

A. Clean and repair surfaces of forms to be reused in work. Split, frayed, delaminated or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use “patched” forms on exposed concrete surfaces.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling in: Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place and cure concrete as herein specified, to blend with in place construction. Provide other miscellaneous concrete filling shown or required to complete the work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel troweling surfaces to a hard, dense finish with corners intersections and terminations slightly rounded.

C. Equipment bases and foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
3.13 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas: Repair and patch defective areas with cement mortar immediately after removal of forms, when acceptable to Engineer.

1. Cut out honeycomb rock pockets, voids over ¼” in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1”. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush coat the area to be patched with specified bonding agent. Place non-shrink patching mortar after bonding compound has dried.

B. For exposed to view surfaces, blend non-shrink white portland cement and non-shrink gray portland cement so that, when dry, patching mortar will match color of surrounding material. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.

C. Repair of formed surfaces. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Engineer, surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surfaces, and stains and other discolorations that cannot be removed by cleaning. Flush out form tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

D. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

E. Repair of unformed surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having slope.

F. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01” wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling pop-outs, honeycomb, rock pockets, and other objectionable conditions.

G. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.

H. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh non-shrink concrete. Finish repaired areas to blend into adjacent concrete. Proprietary non-shrink patching compounds may be used when acceptable to Engineer.

I. Repair defective areas, except random cracks and single holes not exceeding 1” diameter, by cutting out defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least ¼” clearance all around. Dampen concrete surfaces in contact with patching concrete and brush with a neat cement grout, or concrete bonding agent. Mix non-shrink patching concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
J. Repair isolated random cracks and single holes not over 1” in diameter by non-shrink dry-pack method. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and brush with neat cement grout, or apply concrete bonding agent. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve using only enough water as required for handling and placing. Compact non-shrink dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

K. Use epoxy-based mortar for structural repairs, where directed by the Engineer.

3.14 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Contractor will assist the Testing Laboratory in performing all necessary tests.

B. Sampling and testing for quality control during placement of concrete will include the following minimum as directed by the Engineer.

1. Sampling of fresh concrete: ASTM C172, except modified for slump to comply with ASTM C94.

2. Slump: ASTM C143, one test for each concrete load at point of discharge; and one test for each set of compressive strength test specimens.

3. Air content: ASTM C173, volumetric method for lightweight concrete ASTM C231 pressure method for normal weight concrete; and for each set of compressive strength test specimens.

4. Concrete temperature: Test hourly when air temperature is 40 degrees F (4 degrees C) and below, and when 80 degrees F (27 degrees C) and above; and each time a set of compressive test specimens is made.

5. Compression test specimen: ASTM C31, one (1) set of four (4) standard cylinders for each 50 cubic yards of concrete or fraction thereof unless otherwise directed. Mold and store cylinders for laboratory cured test specimens in a secure, safe specimen storage box of a type approved by the Engineer and provided by the Contractor. Field cured cylinders shall be stored near the area of concrete placement in conditions representative of the placement.

6. Compressive strength tests: ASTM C39, one set for each 50 cubic yards or fraction thereof, of each concrete class placed in any one day; 1 specimen tested at 7 days, 1 specimen tested at 14 days, and two specimens tested at 28 days.

7. The basis of acceptance of the strength will be the result of the field-cured specimens. The laboratory specimens will determine the performance of the supplier.

C. Test results will be reported in writing to the Engineer and the Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete
type and class, location of concrete batch in structure design compressive strength at 28 days; concrete mix proportions and materials, compressive breaking strength and type of break for both 7 day tests and 28 day test.

D. Additional tests: The testing service will make additional tests of in-place concrete where test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Engineer. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required.

3.15 SCHEDULE

A. The following (Table 2) are the general applications for the various concrete design strengths to be used, unless otherwise noted:

<table>
<thead>
<tr>
<th>Class</th>
<th>(psi)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2,500</td>
<td>Concrete fill and duct encasement</td>
</tr>
<tr>
<td>B</td>
<td>3,000</td>
<td>Concrete thrust blocks</td>
</tr>
<tr>
<td>C</td>
<td>3,500</td>
<td>Not used</td>
</tr>
<tr>
<td>D</td>
<td>4,000</td>
<td>Walls, slabs on grade, suspended slab and beam systems, columns, grade beams and all other structural concrete</td>
</tr>
</tbody>
</table>

3.16 CUTTING AND PATCHING

A. Where concrete areas are to be patched, the perimeter of the area is to be saw cut, and all deteriorate concrete is to be removed to a minimum depth of at least ¾” behind the exposed reinforcing. The perimeter of the saw cut area shall be under cut all around. Any exposed reinforcing shall be spliced by flap welding where more than 25% of the cross sectional area of the rebar is lost. The exposed concrete and reinforcing shall then be sandblasted. The concrete surface now exposed shall be moistened and exposed reinforcing shall be cured with an anticorrosion, cementitious coating. The saw cut shall be filled to match the level of the existing surface with repair motor and cured with a membrane covering.
3.17 EQUIPMENT FOUNDATIONS

A. All equipment pads and foundation not otherwise noted on the Drawings or in this Specification shall be formed, reinforced and poured to the dimensions shown. All exposed surfaces, except those surfaces subsequently required to receive grout and support equipment bases shall, unless otherwise noted elsewhere in the Specification, be finished as detailed in ACI 301, Chapter 10 to a “smooth form finish”. Exterior angles shall be chamfered. The Contractor shall build in all anchor bolts, sleeves and other built-in fittings as required for the equipment. Surfaces which will later receive grout shall, before the concrete takes it final set, be made rough by removing the sand and cement that accumulates on the top to the extent that the aggregate will be exposed with indentions in the surface of ½” and irregularities.

3.18 CONCRETE THRUST BLOCK

A. General: The Contractor shall provide poured concrete thrust blocks at all changes in direction as shown on the Drawings. Concrete thrust blocks and piers shall be poured between solid ground and the fitting to be supported. The thrust blocks shall conform to the dimensions shown on the Contract Drawings and shall be so placed that the pipe and fitting will be accessible for repair.

PART 4 – TESTING

4.01 SCOPE

Watertight Structures: Make watertight, concrete structures designed to contain water, sewage or sludge, and where intended, among other things to prevent the entry of groundwater and moisture. Water tightness is interpreted to signify the absence of active leakage visible streams, trickles or drops, and also complete freedom from dampness resulting from the penetration of moisture into the concrete. Make tunnels, galleries and basements dry and free of exterior moisture.

Place a layer of polyethylene film eight (8) mils thick on the ground and in forms for grade beams, as a moisture barrier prior to the placement of slabs, and beams on grade. Make joints lap a minimum of six (6) inches and seal by means of polyethylene tape.

Demonstrate the water-tightness of all structures as required. Under the requirements of watertight structures, remedy provided defects, even to the extent of replacing concrete work. Any leaks shall be repaired by methods and materials approved by the Department prior to the start of corrective action, and all leakage shall be corrected prior to the performance of equipment testing.

Prior to backfill, individual tank shall be isolated from other tanks by plugs, etc., and filled with clean water to the maximum operating level. After a suitable stabilization period, the maximum operating level shall be reestablished and an eight-hour test shall be performed. During the test period no water shall be added to or removed from the tank and the drop in the water level shall be recorded at the end of the eight-hour period. Report any change in the surface elevation to the Engineer. The structure will remain filled until it has been determined, to the satisfaction of the
Engineer that no leakage exists. Water for such testing shall be furnished by the Contractor at his expense.

END OF SECTION