

SECTION 03100
CONCRETE FORMWORK

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor materials and equipment necessary to erect formwork for cast-in-place concrete, with shoring, bracing, and anchorage along with openings, form accessories, and stripping of forms as specified herein.

1.2 REFERENCES

- A. This section references the latest edition of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ACI 301	Specifications for Structural Concrete for Buildings
ACI 347-89	Recommended Practice for Concrete Formwork
IBC/ICC	International Building Code
APA PS 1	Construction and Industrial Plywood

1.3 SYSTEM DESCRIPTION

- A. Design, engineer, and construct formwork, shoring, and bracing to meet design and code requirements, so that resultant concrete conforms to required shapes, lines and dimensions.

1.4 QUALITY ASSURANCE

- A. Construct and erect concrete formwork in accordance with ACI 301 and 347.
- B. Construction tolerances shall be in accordance with ACI 301 modified as follows:
1. Straight vertical or horizontal wall surfaces shall be flat planes within the following tolerances.
 - a. Walls shall be plumb within 1/8 inch in any 10 feet, and within 1/2 inch for the entire length of the wall.

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- b. Make joints in forms watertight.
 - c. Limit panel deflection to $1/360$ of each component span to achieve tolerances specified.
 - d. Depressions in a wall surface shall not be more than $3/16$ inch when a 10 foot straight-edge is placed upon high points in any direction or at any location.
 - e. Wall thickness shall not be more than $3/16$ inch minus nor $1/2$ inch plus from dimensions shown.
 - f. Walls shall not vary from the linear building lines more than $1/4$ inch in 20 feet, nor more than $1/2$ inch over their entire length.
2. Depressions or rises in slab surfaces shall be no more than $3/16$ inch when a 10 foot straight-edge is placed upon the slab surface in any direction or any location.
- C. Any concrete work not meeting the above construction tolerances will be rejected.

1.5 REGULATORY REQUIREMENTS

- A. Conform to International Building Code, Latest Edition.

1.6 SUBMITTALS

- A. Shop Drawings shall be submitted in accordance with SECTION 01340.

PART 2 PRODUCTS

2.1 FORM MATERIALS

- A. All materials shall conform to ACI 301.
- B. Fillets for chamfered corners shall be of wood strips or rigid plastic in maximum lengths.
- C. Forms for all exposed concrete shall be equivalent to PS-1 B-B Plyform Class I as designated by the American Plywood Association or as accepted by the Engineer.

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2.2 FORMWORK ACCESSORIES

- A. Form Release Agent: Non-toxic colorless material compatible with concrete tints and which will not stain concrete, absorb moisture, or impair subsequent applications. Forms used for concrete in contact with process water shall use a form release agent approved by the U.S. Food and Drug Administration for use in potable water systems.
- B. Form ties for Non-Water Structures shall be metal, factory fabricated removable or snap-off, that will leave holes no greater than 1/2 to 1 inch in diameter and not less than 1 1/2 inches deep in surfaces to be exposed or painted and shall not project beyond the concrete elsewhere.
- C. Form ties for Water and Earth Retaining Structures shall be snap off metal of fixed length, with a minimum 1 inch diameter core, a 1-1/2 inch breakback and waterstop.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify lines, levels, and measurements before proceeding with formwork.

3.2 PREPARATION

- A. Hand-trim sides and bottoms of earth forms, remove any loose materials prior to placing concrete.
- B. Minimize form joints. Symmetrically align joints and make watertight to prevent leakage of mortar.
- C. Arrange and assemble formwork to permit stripping, so that concrete is not damaged during its removal.
- D. Arrange forms to allow stripping without removal of principal shores, where shores are required to remain in place.

3.3 ERECTION

- A. The Contractor shall provide bracing to ensure stability of formwork. Strengthen formwork liable to be overstressed by construction loads.

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- B. The Contractor shall construct formwork to maintain tolerances in accordance with ACI 301/347.
- C. Form 3/4" X 3/4" beveled edge with chamfer strips at all exposed edges or corners of concrete unless labeled otherwise.

3.4 APPLICATION OF FORM RELEASE AGENT

- A. The Contractor shall apply form release agent on formwork in accordance with manufacturer's instructions. Apply prior to placing reinforcing steel, anchoring devices, and embedded items.
 - 1. Thoroughly clean form surface in contact with concrete prior to coating surface with release agent.
 - 2. Exposed wood forms in contact with concrete: apply form sealer as recommended by the sealer material manufacturer.
 - 3. Steel forms: apply form sealer to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.
- B. Do not apply form release agent where concrete surfaces are scheduled to receive applied coverings or special finishes which may be affected by agent. Soak contact surfaces of untreated forms with clean water and maintain in wet condition until concrete is placed.

3.5 INSERTS, EMBEDDED PARTS AND OPENINGS

- A. The Contractor shall provide formed openings where required for work embedded in or passing through concrete.
- B. The Contractor shall coordinate work of other Specifications Sections in forming and setting openings, slots, recesses, chases, sleeves, plates, bolts, anchors, and other inserts.
- C. The Contractor shall install accessories in accordance with manufacturer's instructions, level and plumb. Ensure items are not disturbed during concrete placement.

3.6 FORM REMOVAL

- A. The Contractor shall not remove forms and shoring until concrete has sufficient strength to support its own weight, and construction and design loads which may be imposed upon it. Remove load supporting forms when concrete has attained 80 percent of required 28 day compressive strength, as determined by test cylinders provided construction is reshored.

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- B. Column and wall formwork may be removed at not less than 50°F for 48 hours provided acceptable curing compound is applied immediately. If contractor elects not to utilize curing compound, forms must remain in place 7 days minimum.
- C. Remove formwork progressively so no unbalanced loads are imposed on structures.
- D. Any concrete surfaces damaged during form removal shall be repaired in accordance with SECTION 03300.
- E. All form tie holes shall be patched with a dry pack cement mortar fill as specified in SECTION 03300.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, materials and equipment necessary to place reinforcing and reinforcing accessories including reinforcing steel bars and welded steel wire fabric for cast-in-place concrete along with support chairs, bolsters, bar supports and spacers for supporting reinforcement as specified herein and as shown on the Drawings.

1.2 REFERENCES

- A. This section references the latest edition of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ACI 301	Specifications for Structural Concrete for Buildings.
ACI 315	Details and Detailing of Concrete Reinforcement.
ACI 318/318R	Building Code Requirements for Reinforced Concrete
ACI 350/350R	Code Requirements for Environmental Engineering Concrete Structures
ACISP-66	Detailing Manual
ANSI/ASTM A185	Welded Steel Wire Fabric for Concrete Reinforcement.
ASTM A615	Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
AWS D12.1	Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction.
ANSI/AWSDI-4-98	Structural Welding Code - Reinforcing Steel.
CRSI	Manual for Standard Practice
CRSI 63	Recommended Practice for Placing Reinforcing Bars.
CRSI 65	Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.

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ASTM A775 Standard Specifications for Epoxy-Coated Reinforcing Steel Bars.

1.3 QUALITY ASSURANCE

- A. The Contractor shall perform concrete reinforcement work in accordance with CRSI Manual of Standard Practice, and Documents 63 and 65.
- B. The Contractor shall conform to ACI 301 and 315.

1.4 SHOP DRAWINGS

- A. The Contractor shall submit shop drawings under provisions of SECTION 01340.
- B. On the shop drawing prepare in accordance with CRSI 1996 manual of standard practice and ACISP-66 (94) detailing manual. The Contractor shall indicate sizes, spacings, locations and quantities of reinforcing steel, bending and cutting schedules, splicing, stirrup spacing, supporting and spacing devices.
- C. The Contractor shall submit mill test certificates of supplied concrete reinforcing, indicating physical and chemical composition.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Reinforcing bars produced in the USA have converted to the Soft Metric designations for size identification. All reinforcing bars called out in these specifications and shown on the Drawings are Inch-Pound designations. The following Table shall be used in converting reinforcing bar designations (Inch-Pound) to Soft Metric designations:

SOFT METRIC Bar Size Designation	INCH-POUND Bar Size Designation
#10	#3
#13	#4
#16	#5
#19	#6
#22	#7
#25	#8
#29	#9
#32	#10
#36	#11

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- B. Reinforcing Bars: ASTM A615, Grade 60 billet-steel deformed bars, uncoated finish.
- C. Epoxy-Coated Reinforcing: ASTM A775, Grade 60 billet-steel deformed bars, coated finish.
- D. Welded Steel Wire Fabric: ANSI/ASTM A185-90a or A497-90b and ACI 318/318R-89 plain type in flat sheets (rolled sheets not permitted) using ASTM A82-90a wire of 75-ksi minimum tensile strength.

2.2 ACCESSORY MATERIALS

- A. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for strength and support of reinforcement during installation and placement of concrete. Material shall be manufactured from standard bright basic wire.
- B. Ties shall be made with a minimum 16 gage annealed type tie wire.

2.3 FABRICATION

- A. Concrete reinforcement shall be fabricated in accordance with ACI 315 and CRSI 1996 Manual of Standard Practice.
- B. Locate reinforcing lap splices not indicated on the Drawings at points of minimum stress. Indicate location of splices on shop drawings.
- C. Bend all bars cold.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Before placing concrete, clean reinforcement of foreign particles or coatings.
- B. The Contractor shall place, support, and secure reinforcement against tie bars securely using a minimum 50% tie for all bars.
- C. Where walls or other items are shown as built integrally with other sections, but are placed in separate pours, keys and dowels must be provided. Dowels shall be the same size and spacing as reinforcing. Dowels shall be lapped per the schedule shown on the plans.

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- D. Unless otherwise shown on drawings, the Contractor shall fabricate reinforcing to provide clearances as follows:
1. Where concrete is deposited against ground without use of forms: not less than 3 inches.
 2. For concrete wall faces interior to a structure no less than 3/4 inch.
 3. Where concrete walls are exposed to weather or to ground, but placed in forms: not less than 1-1/2 inches for #5 and smaller bars and not less than 2 inches for #6 and larger bars.
 4. To beam and column bars; not less than 1-1/2 inches to stirrups or ties.
- E. At all openings in structural slabs and walls provide two No. 5 bars top and bottom of slab or faces of wall at 45 degrees on all four corners, unless labeled otherwise on the Drawings.
- F. The Contractor shall notify the Engineer when reinforcing is in place a minimum of 48 hours prior to scheduled placement of concrete so that a field review of reinforcement placement can be made.
1. All reinforcing must be reviewed by the Engineer prior to concrete placement as one condition of acceptance of the work.
- G. Bar placement tolerances
1. Between bars: 1/4 inch (plus or minus) or in accordance with CRSI publication "Placing Reinforcing Bar".
 2. Vertical position of bars in slabs and beams:
 - a. Members 10 inches deep or less: 1/4 inch (plus or minus).
 - b. Members over 10 inches deep, less than 2 feet deep: 1/2 inch (plus or minus).
 - c. Members 2 feet or deeper: 1 inch (plus or minus).
- H. Bars may be moved to avoid interference with other reinforcing steel, conduits, or embedded items. If moved more than one bar diameter or stipulated tolerances, consult with Engineer to determine final placement.
- I. Straightening and re-bending. Field bending of reinforcing steel bars is not permitted.

END OF SECTION

SECTION 03251

CONCRETE JOINTS

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. The work includes furnishing all labor, materials and equipment necessary for the placement of construction, control, isolation and expansion joints in concrete as specified herein and as shown on the Drawings.

1.2 DEFINITIONS

- A. Construction Joint: Joints in concrete which establish the boundary of concrete placement and where two successive placements of concrete meet. Reinforcement is continuous through joint.
- B. Control Joint: Integrally formed partial depth grooved joint in concrete designed to control random cracking. Reinforcement is continuous through joint.
- C. Isolation Joint: Joints used in slab-on-grade to provide full depth separation from abutting surfaces. Reinforcement is not continuous through joint unless shown on the Drawings.
- D. Expansion Joint: Full width (depth) separation joint allowing expansion and contraction due to thermal and moisture changes. Reinforcement is not continuous through joint. Shear reinforcement is added at the joint.
- E. Existing concrete: Drill and doweling are tied into original concrete.

1.3 REFERENCES

- A. This section references the latest edition of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ASTM D412	Test Method for Rubber Properties in Tension
ASTM D746	Test Method for Brittleness and Temperature of Plastics and Elastomers by Impact

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ASTM D747	Test Method for Apparent Bending Modulus of Plastics By Means of a Cantilever Beam
ASTM D994	Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type) (R1872) (AASHTO M33-81)
ASTM D792	Test Method for Specific Gravity and Density of Plastics by Displacement
ASTM D1190	Sealing Compound
ASTM D1751	Preformed Expansion Joint Filler for Concrete Paving and Structural Construction
ASTM D2240	Test Method for Rubber Properties Durometer Hardness
CRD-C-572-74	Corps of Engineers Specifications for Polyvinylchloride Waterstop

1.4 SUBMITTALS

- A. Location of proposed joints shall be submitted for review and acceptance as defined by SECTION 01340.

PART 2 PRODUCTS

2.1 PREFORMED JOINT MATERIAL

- A. Control Joints: Shall be premolded, perforated plastic tee strips 1/8 inch thick by 1/4 of the slab thickness in depth (2 inch max. depth). The tee cap shall be removed after the concrete has been allowed to cure.
- B. Sealants: Specified in SECTION 07900.
- C. Isolation Joints: Joint filler shall be comprised of closed cell polyethylene, to the widths and depths shown on the drawings. Fillers shall be Sonneflex F, as manufactured by ChemRex, Inc. or an approved equivalent.

2.2 PLASTIC WATER STOP

- A. Minimum weight per foot of water stop:
 - 1. 0.09 pound for 3/16 inch by 4 inch.
 - 2. 1.62 pound for 3/8 inch by 6 inch.
 - 3. 2.30 pound for 3/8 inch by 9 inch.

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- B. Manufacturers and Catalog Number
 - 1. A.C. Horn, Inc. Beltsville, MD, Catalog No. CSP-162 (1987) Type 3 (4-inch by 3/16-inch), Type 9 (6-inch by 3/8-inch) and Type 10 (3/8-inch by 9-inch).
 - 2. Greenstreak Plastic Products, St. Louis, MO, Catalog No. 03250/GRD. (1987) Style (6-inch by 3/8-inch).

PART 3 EXECUTION

3.1 CONSTRUCTION JOINTS

- A. Construction joints shall be formed to conform with details shown on the Drawings and shall be made as watertight as possible. Place waterstops at construction joints as indicated on the Drawings and in all water-holding structures where joint is in contact with water. Before new concrete is deposited on or against concrete which has set, the surface of the set concrete shall be thoroughly cleaned of foreign matter. Roughen surface of construction joints to expose aggregate uniformly. Set retarder may not be used to facilitate removal of cement paste.
- B. Construction joint locations not shown on the Drawings shall be subject to acceptance by the Engineer.
- C. Sealant and backer rod in joint opening required.

3.2 CONTROL JOINTS

- A. Form integral control joints at locations indicated on the Drawings, and as described in these specifications.
- B. Reinforcement shall not be lapped at control joints.
- C. Sealant and backer rod in joint required.

3.3 ISOLATION JOINTS

- A. Locate isolation joints as indicated on the Drawings. Place isolation joint filler material and sealant in joint as shown.

3.4 EXPANSION JOINTS

- A. Form expansion joints to conform with details shown on the Drawings. Place expansion material, waterstop (where required) and sealant as indicated. The

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premolded filler shall be cut to the same shape as that of the surfaces being joined. The filler shall be fixed firmly against the surface of the concrete already in place in such a manner that it will not be displaced when concrete is deposited against it.

3.5 JOINTS FOR CONCRETE SLABS ON GRADE

A. Construction Joints

1. When required, locate construction joints at control joint positions. Form by using bulkhead fitted with a beveled strip to form a key through the middle third of slab edge. Remove bulkhead within 24 hours after placing concrete, and brush slab edge with accepted curing compound to retain moisture and to form bond-breaking film for new concrete.
2. The rate and method of placing concrete and arrangement of construction joint bulkheads shall be such that the concrete between construction joints shall be placed in one continuous operation. Location of joints shall be as described on the Drawings or as accepted by the Engineer. The maximum pouring unit shall be not more than 60 lineal feet or an area of 1200 square feet for slabs. Construction joints shall conform to ACI-318 or as shown on the Drawings. Location of proposed construction joints shall be submitted for review and acceptance by the Engineer.

B. Control Joints

1. Provide control joints to form independent slab unit about 15 to 20 feet square or as shown on the Drawings. All control joints shall be plastic tee-shaped strips.
2. After the concrete slab has been bull-floated, install premolded, perforated tees as per the manufacturer's direction at all control joints. Finish concrete. Remove top of tee as specified by manufacturer. Ribbed-strip remains in slab as joint filler.
3. No sawed or tooled control joints will be allowed.
4. Isolation Joints
 - a. Provide isolation joints at slab edges which abut walls, piers, columns, curbs, separate foundations and other vertical surfaces. Form joint with premolded filler strip extending down through the full depth of slab. At exterior joints set top of premolded filler 1/2 inch below surface of concrete to allow for placement of joint sealant. Joints shall be installed where noted and shown on the Drawings.

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- C. Expansion Joints
 - 1. Form as in 3.4, above.

3.6 JOINTS BETWEEN ORIGINAL CONCRETE AND NEW CONCRETE

- A. Roughen interface surface to 1/4-inch amplitude. Interface surface shall be completely free from loose aggregate, dust, concrete chips, etc., that would interface with bonding.
- B. Drill holes for splicing bars. Holes shall be of sufficient size such that epoxy grout will completely surround the splicing bars. Splice bars shall be easily removed by hand prior to grouting.
- C. Grout all splice bars in place and allow to cure prior to placement of new concrete.
- D. Apply concrete glue or epoxy bonding agent to interface prior to placement of new concrete in accordance with manufacturer's instructions.
- E. Joint sealant shall be applied as shown on the Drawings.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, materials and equipment necessary to place cast-in-place concrete as specified herein and as shown in the Drawings.

1.2 REFERENCES

- A. This section references the latest edition of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304/304R	Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
ACI 305R	Recommended Practice for Hot Weather Concreting
ACI 306R	Recommended Practice for Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
ACI 318/318R	Building Code Requirements for Reinforced Concrete
ACI 350/350R	Code Requirements for Environmental Engineering Concrete Structures
ASTM C31	Methods of Making and Curing Concrete Test Specimens in the Field
ASTM C33	Concrete Aggregate
ASTM C39	Test Method for Compression Strength of Cylindrical Concrete Specimens
ASTM C94	Ready-Mixed Concrete
ASTM C150	Portland Cement
ASTM C230	Flow Table for Use in Tests of Hydraulic Cement
ASTM C260	Air-Entraining Admixtures for Concrete
ASTM C309	Liquid Membrane Forming Compounds for Curing Concrete
ASTM C494	Chemical Admixtures for Concrete

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ASTM C881	Specifications for Epoxy-Resin-Borse Bonding Systems for Concrete
ASTM D412	Test Method For Rubber Properties in Tension
ASTM D746	Test Method For Brittleness and Temperature of Plastics and Elastomers By Impact
ASTM D747	Test Method For Apparent Bending Modulus of Plastics By Means of a Cantilever Beam
ASTM D792	Test Method For Specific Gravity and Density of Plastics By Displacement
ASTM C1107	Packaged Dry Hydraulic Cement Grout (Non-Shrink)
ASTM D1190	Sealing Compound
ASTM D1751	Preformed expansion Joint Filler for Concrete Paving and Structural Construction
ASTM D2240	Test Method For Rubber Properties Durometer Hardness
IBC/ICC	International Building Code
COE	Corps of Engineers
CRD-C-572	Corps of Engineers Specification for Polyvinylchloride Waterstop
CRD-C-611	Flow of Grout for Preplaced Aggregate Concrete
CRD-C-621	Non-Shrink Grout

1.3 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301, and other standards listed under 1.2.A REFERENCES as applicable.
- B. Obtain materials from same source throughout the work.

1.4 TESTS

- A. Testing and analysis of concrete shall be performed under provisions of ACI 301 and the General Conditions.
- B. Testing firm will perform slump and air entrainment tests in accordance with the standard recognized testing procedures.
- C. Testing firm will cast three concrete test cylinders, in accordance with ASTM C31 for every 25 cubic yards, or fraction thereof, of concrete placed each day. Testing firm will deliver the cylinders to an approved lab for curing under laboratory conditions.

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- D. Cylinders shall be broken at the following schedule: 7 days: one cylinder, 28 days; one cylinder, two cylinders if the first fails strength requirements. Cylinders will be tested in accordance with ASTM C39.
- E. One additional test cylinder will be taken during cold weather and cured on site under same conditions as the concrete pour from which it was taken.
- F. In hot weather or low humidity the Engineer may make additional test specimens.
- G. One slump and air test will be taken by the testing firm for each set of test cylinders taken.
- H. Cost of testing concrete cylinders shall be paid for by the Contractor. Any additional costs resulting from sub-standard concrete as indicated by test cylinders such as core drilling, additional tests, removal and replacement of such concrete shall be paid by the Contractor, at no additional cost to Owner

1.5 SUBMITTALS

- A. The Contractor shall provide submittals in accordance with SECTION 01340.
- B. Manufacturer's Data: Concrete Work: Submit five copies of manufacturer's data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, waterstops, joint systems, dry-shake finish materials and others as requested by the Engineer.
- C. Placement Schedule: Prepare a placement schedule and submit for review prior to start of concrete placement operations.
- D. Delivery Tickets: Furnish copies of delivery tickets for each load of concrete delivered to the site. Provide items of information to the Engineer as specified under ASTM C94, Certification.
- E. Submit proposed mix design for review and acceptance prior to commencement of work. Mix design criteria shall conform to Chapter 19 of the IBC.

PART 2 PRODUCTS

2.1 CONCRETE MATERIALS

- A. Cement: ASTM C150, normal – Type II gray color (maximum 0.60 percent).
- B. Fine and Coarse Aggregates: ASTM C33

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1. Fine Aggregate: clean, sharp natural sand free from loam, clay, lumps or other deleterious material.
 2. Coarse Aggregate: clean, uncoated, processed aggregate of crushed stone or washed gravel containing no clay, mud, loam, or foreign matter. Use of pit or bank run gravel is not permitted. Maximum aggregate size shall be in accordance with ACI 301.
- C. Water: Clean, potable and not detrimental to concrete. Water containing 2-percent of more common salt shall not be used.

2.2 ADMIXTURES

- A. Air Entrainment: ASTM C260
- B. Chemical Admixture: ASTM C494, water-reducing, retarding, and accelerating (except calcium chloride).
- C. Calcium chloride shall not be used.
- D. FLYASH: ASTM C618

2.3 NON-SHRINK GROUT

- A. Non-shrink grout in accordance with ASTM C230, ASTM C1107.
- B. Non-shrink grout shall consist of a hydraulic cementitious system; specially graded and composed of processed natural fine aggregate and additives as required. The material shall meet all of the following requirements:
 1. Non-metallic.
 2. Free of gas-producing or releasing agents.
 3. Free of oxidizing catalysts.
 4. Free of inorganic accelerators, including chlorides.

2.4 MORTAR

- A. Mortar for build-up at various surfaces shall be composed of approximately 1 part Type II Portland cement, 1-1/2 parts sand, an amount of air-entraining admixture per sack of cement to produce an air content of 9% by volume and sufficient

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water to make a stiff, workable mix. Sand, cement, water and air-entraining admixture shall be as specified for concrete.

2.5 WATERSTOPS

- A. Waterstops embedded in concrete shall be polyvinyl chloride plastic (PVC) meeting the following minimum requirements:

Specific Gravity	1.3	ASTM D792
Tensile Strength	1,800 psi	ASTM D412
Elongation	300%	ASTM D412
Shore A Durometer	50	ASTM D2240
Low Temp. Brittleness	at 35°F	ASTM D746
Stiffness in Flexure	1,200 psi	ASTM D747

- B. No reclaimed PVC will be allowed.
- C. Waterstop sizes and shapes shall be Multi-Rib with Center Bulb Style as shown on the drawings. Splice all joints with a heat-sealing method without lapping. Support waterstop by wiring to reinforcing. Hold securely in place during concreting operation.

2.6 CONCRETE MIX

- A. General: Mix concrete in accordance with ASTM C94 and ACI 304R.
- B. Provide concrete as indicated on the drawings of the following characteristics:
1. Compressive Strength (28 days) for cast-in-place concrete: 4000 psi minimum unless otherwise noted.
 2. Slump : 4 inches maximum.
- C. Use accelerating admixtures in cold weather only when reviewed and accepted by the Engineer. Use of admixtures will not relax cold weather placement requirements. Do not use calcium chloride.
- D. Use set-retarding admixtures during hot weather only when reviewed and accepted by the Engineer.
- E. Add air entraining agent to concrete mix for all exposed exterior structural concrete work to attain 5.0 plus or minus 1 percent entrained air.
- F. Use water-reducing admixtures as reviewed and accepted by the Engineer.

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- G. Where tinted concrete is being produced the coloring agent shall be added in the mixer by weight along with the aggregate, cement and water while the mixer is operating at mixing speed. Mixing with the color shall take place for a minimum of 10 minutes or for at least 100 revolutions.

2.7 EPOXY BONDING AGENT

- A. Two component epoxy resin adhesive (ASTM C881):
- B. Manufacturers or approved equivalent:

"Sikadur Hi-Mod" by Sika Chemical Corp.
"Euco Epoxy #463" by Euclid Chemical Co.
"Epobond" by L & M Construction Chemicals, Inc.
"Sonobond" by Sonneborn.

2.8 CONCRETE GLUE

- A. Manufacturers or approved equivalent:

"Weldcrete" by Larsen Products Corp.
"Flex-Con" by Euclid Chemical Corp.
"Daraweld C" by A.C. Horn (formerly W.R. Grace Co.)
"Sonocrete" by Sonneborn
"Everbond" by L&M Construction Chemicals, Inc.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify anchors, seats, plates, reinforcement, and other items to be cast into concrete are accurately placed, held securely, and will not cause hardship in placing concrete.

3.2 PLACING CONCRETE

- A. Notify the Engineer a minimum of 48 hours prior to commencement of concreting operations.
- B. Place concrete in accordance with ACI 301.
- C. Placing Concrete into Forms
 - 1. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists

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of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

2. Remove temporary spreaders in forms when concrete being placed has reached the elevation of such spreaders.
3. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, and tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and project conditions. Vibration of forms and reinforcing will not be permitted.
4. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6 inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary for consolidation around reinforcement and other embedded items without causing segregation of the mix. Generally, this will be from 5 to 15 seconds in accordance with ACI 301.
5. Concrete shall not be dropped more than three (3) feet. This is to avoid material segregation.

D. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed. When concrete in place has sufficiently set up (at least 24 hours), alternate section shall be placed. All joints between sections shall be keyed. The edges of all sections shall be tooled with a minimum radius-edging tool.
2. Slope all exterior concrete slabs and interior slabs with floor drains in a manner to prevent the collection of water.
3. Consolidate concrete during placing operations using vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
4. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free from humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

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5. Maintain reinforcing steel in the proper position continuously during concrete placement operations.
- E. Hot Weather Placement.
1. Concrete to be placed when anticipated 24-hour range will exceed 89°F, shall conform to ACI 305R.
 2. Contractor shall submit a hot weather plan to the Engineer for acceptance, prior to commencement of any work.
- F. Cold Weather Placement:
1. Do not place concrete against frozen earth or ice or against forms and reinforcement with frost or ice present.
 2. When air temperature is expected to fall below 40°F during placement, or within seven (7) days thereafter, the Contractor shall place and cure concrete in accordance with ACI 306R.
 3. No less than seven (7) days prior to proposed cold weather concreting, the Contractor shall submit a cold weather-concreting plan to the Engineer for review and approval.
 4. Frozen concrete shall be immediately removed upon direction of the Engineer and replaced with new work at no additional expense to Owner
- G. Ensure reinforcement, inserts, embedded parts, and formed joints are not disturbed during concrete placement.
- H. Place control joints prior to initial set.
- I. Excessive honeycomb or embedded debris in concrete is not acceptable.

3.3 FINISH OF SLABS

- A. Screed all slabs.
- B. Trowel by hand or machine to hard, dense surface, free from trowel marks. Do not take measures to absorb wet spots, rather wait until surfaces are dry enough for proper troweling. Chemical dryers not permitted.
- C. Exterior slabs shall receive a light broom finish.

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3.4 FINISH OF FORMED SURFACES

A. Rough Form Finish - Surfaces Not In Contact With Water

1. This includes formed concrete surfaces not exposed to view in the finish work or covered by other construction, unless otherwise shown or specified.
2. Provide as-cast rough form finish.
3. Standard rough form finish shall be the concrete surface having the texture imparted by the form-facing material used with tie holes and defective areas repaired and patched and all fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Sumps, Headtank and Surfaces Exposed to View

1. This includes surfaces that hold water, but are never in direct contact with fish, and concrete surfaces that are visible, but not in contact with water.
2. Grind all interior walls with a rotary grinder to expose all air pockets, voids, and other imperfections to create a smooth wall surface. Fill all voids as required with cement mortar fill.
3. Exterior walls exposed to view shall be finished per number 2, above, to a depth of one foot below grade.

C. Water Contact Surfaces

1. This includes all concrete water contacting surfaces that may come in contact with fish being reared or held.
2. Grind all interior walls with rotary grinder to expose all air pockets, voids, and other imperfections to create a smooth wall surface. Fill all voids as required with cement mortar fill.
3. Clean wall or floor surfaces and apply mixture of similarly colored cement (mix white and gray mortar or gray mortar and pigment to match existing color as appropriate) and concrete glue with metal trowel to a plaster like consistency. Trowel surfaces to uniform finish free of runs and drips. Surfaces should be damp prior to application of mixture. Provide skim coat, provide proper curing time, apply uniform finish coat. Final surface shall be finished "glass smooth", by rubbing with carborundum stones.

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3.5 DEFECTIVE CONCRETE AND REPAIR OF CONCRETE

- A. Modify or replace concrete not conforming to required levels and lines, details and elevations.
- B. Repair or replace concrete not properly placed or of the specified type.
- C. All concrete shall be inspected and all poor joints, rough sections, cracks, and honeycombed areas shall be repaired by cutting back to solid concrete. Apply cement mortar fill after coating surface with epoxy bonding agent.
- D. Fill all tie holes and small imperfections with cement mortar fill.

3.6 FIELD QUALITY CONTROL

- A. Field Laboratory Testing:
 - 1. The Contractor shall give the Engineer 48 hours' advance notice of concrete sampling and field-testing. Samples shall be secured in - accordance with ASTM C172. Field tests shall include the making of strength test cylinders in accordance with ASTM C31, the measurement of slump in accordance with ASTM C143, and the measurement of air content in accordance with ASTM C231. The number of tests for strength, slump, and air content will be determined by the Engineer; however, not less than one strength test (four cylinders) shall be performed for each 25 cubic yards of concrete or fraction thereof.
 - 2. Laboratory testing of concrete cylinders for strength requirements shall be performed in accordance with ASTM C39. Test cylinders shall be field cured and protected for the first 24-hour period by the laboratory in accordance with ASTM C31. Cylinders shall then be delivered to the laboratory immediately. Analysis of strength data for test cylinders shall be determined in accordance with ACI 214. A 7-day compressive strength test will be considered as an indication only of the concrete's ability to meet the 28-day strength requirements. Concrete represented by those test cylinders failing to meet the 28-day strength requirements will be classified as "Rejected."
 - 3. Any concrete that is classified as being "Rejected" shall be removed as a complete section and shall be replaced with new concrete and -reinforcing steel. Prior to removal, if the Contractor desires further testing of rejected concrete, the Contractor may request test cores be taken and tested. If test cores meet the specified strength requirements, rejected concrete will be reclassified as acceptable. Test core drilling shall be performed in accordance with ASTM C42 from any part of the work as determined by the

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Engineer. At the Engineer's option, either the Contractor's laboratory or another laboratory selected by the Engineer shall perform the test core drilling and testing. In either case, all costs associated with test core drilling and testing shall be paid by the Contractor.

4. Written test reports shall be prepared by the laboratory for each test. Test reports shall be stamped in red as "conforming" or "Non- Conforming" with the Specifications. Test reports shall be signed by the laboratory's authorized representative. All reports shall be consecutively numbered. The laboratory shall send an original of all reports to onsite job office; with an additional copy provided by the laboratory to the Engineer.

B. Admixture. Segregation Test: Test each truck prior to use on job.

1. Segregation Test Objective: Concrete with 5- to 9-inch slump must stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
3. Reject concrete if mortar or moisture separates and flows out of mix.

C. Cold Weather Placement Tests:

1. During cold weather concreting, cast cylinders for field curing as follows. Use method that will produce greater number of specimens:
 - a. Six extra test cylinders from the last 100 cubic yards of concrete.
 - b. Minimum three specimens for each 2 hours of placing time or for each 100 cubic yards.
2. These specimens shall be in addition to those cast for lab testing.
3. Protect test cylinders from the weather until they can be placed under same protection provided for the concrete of the structure that they represent.
4. Keep field test cylinders in same protective environment as the parts of the structure they represent to determine if specified strength has been obtained.
5. Test cylinders in accordance with applicable sections of ASTM C31-90a and C39-86.
6. Use test results to determine specified strength gain prior to falsework removal or for prestressing.

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D. Tolerances:

1. Walls: Measure and inspect walls for compliance with tolerances specified in SECTION 03100.
2. Slab Finish Tolerances and Slope Tolerances:
 - a. Floor flatness measurements will be made the day after floor is finished and before shoring is removed, to eliminate effects of shrinkage, curing, and deflection.
 - b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
 - c. Compliance with designated limits in four of five consecutive measurements is satisfactory unless defective conditions are observed.

E. Water Leakage Tests:

1. Purpose: Determine integrity and watertightness of finished concrete surfaces.
2. All Water-Holding Structures:
 - a. Perform leakage tests after concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength.
 - b. Perform leakage test before backfill, brick facing, or other work that will cover concrete wall surfaces is begun.
 - c. Install all temporary bulkheads, cofferdams, and pipe blind flanges, and close all valves. Inspect each to see that it provides a complete seal.
 - d. Fill with water to test level shown, or maximum liquid level if no test level is given. Maintain this level for 72 hours prior to the start of the test to allow water absorption, structural deflection, and temperature to stabilize.
 - e. Measure evaporation and precipitation by floating a partially filled, transparent, calibrated, open top container.
 - f. Measure the water surface at two points 180 degrees apart, when possible where attachments such as ladders exist, at 24-hour intervals. Using, a sharp pointed hook gauge and fixed metal measure capable of reading to 1/100 of an inch. Continue the test for a period of time sufficient to produce at least 1/2-inch drop in the water surface based on

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the assumption that leakage would occur at the maximum allowable rate specified or for 72 hours whichever is the lesser time.

3. Acceptance Criteria
 - a. Volume loss shall not exceed 0.075 percent of contained liquid volume in a 24-hour period, correcting for evaporation, precipitation, and settlement.
 - b. No damp spots or seepage visible on exterior surfaces. A damp spot is defined as sufficient moisture to be transferred to a dry hand upon touching.
4. Repairs When Test Fails: Dewater the structure; epoxy inject leaking cracks with crack repair epoxy, patch areas of damp spots previously recorded, and repeat water leakage test in its entirety at no additional cost to Owner until the structure successfully passes the test.

3.7 SUPPLIER SERVICES

- A. Provide the following representative at the site for installation assistance, inspection and certification of proper installation for concrete ingredients, mix design, mixing and placement.
 1. Batch Plant Representative:
 - a. Observe how concrete mixes are performing.
 - b. Be present during first placement of each type of concrete mix.
 - c. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout the Project.
 - d. Establish control limits on concrete mix designs.
 2. Admixture Manufacturer's Representative:
 - a. Demonstrate special features, product performance, product mixing, testing, and placement or installation for each type of admixture.
 - b. Observe how concrete mixes are performing.
 - c. Be present during the first placement of each type of concrete mix.

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- d. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout the Project, including instructions for redosing
 - e. Provide equipment for control of concrete redosing, for air entrainment or superplasticizer at the site to maintain proper slump and air content if so needed.
3. Bonding Agent Manufacturer's Representative: Demonstrate product performance, product mixing, and placement.

3.8 PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury in accordance with IBC.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete. See SECTION 03370.

END OF SECTION

SECTION 03370

CONCRETE CURING

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. Work includes furnishing all labor, materials and equipment necessary for curing of concrete materials as specified herein and as shown on the Drawings.

1.2 REFERENCES

- A. This section references the latest edition of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ACI 301	Specifications for Structural Concrete for Buildings.
ACI 306	Recommended Practice for Cold Weather Curing.
ACI 308	Recommended Practice for Curing Concrete.
ASTM C309	Liquid Membrane-Forming Compounds for Curing Concrete.
ASTM D2103	Polyethylene Film and Sheeting.

1.3 SUBMITTALS

- A. Submit product information for review and acceptance in accordance with the requirements of SECTION 01340.

1.4 QUALITY ASSURANCE

- A. Conform to requirements of ACI 301.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Water: Clean, potable and not detrimental to concrete.

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- B. Absorptive Mat: Burlap-polyethylene, 8 oz/sq.yd. bonded to prevent separation during use.
- C. Concrete curing compound shall be of a standard and uniform quality ready for use as shipped by the manufacturer. Verify curing compound compatibility with required concrete surface finishes as specified in SECTION 03300 and as noted on the Drawings. The curing compound shall conform to Federal Specification TT-C-800A(1) and shall be clear and no discoloring.
- D. Polyethylene Film: ASTM D2103, 6 mil thick, opaque color.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify concrete surfaces are ready for curing.
- B. Start initial curing (membrane curing compound) as soon as free water has disappeared from concrete surface after placing and finishing. Keep continuously moist for not less than 72 hours. (Moisture loss=(0.030 gm/cm²/72 hours max.).
- C. Begin final curing (absorptive mat or polyethylene film) immediately following initial curing. Continue final curing for at least seven days.

3.2 MEMBRANE CURING COMPOUND

- A. Apply immediately after finishing of slabs and after removal of forms on walls, etc. in accordance with manufacturer's instructions.
- B. Surfaces that have their forms removed after concrete has reached two-thirds of its design strength by test will not have to have curing compound applied.

3.3 ABSORPTIVE MAT

- A. Saturate burlap side of burlap-polyethylene mat. Place over slab areas, burlap side down, lap edges and ends 12 inches. Maintain in place for seven days.

3.4 POLYETHYLENE FILM

- A. Spread polyethylene film over slab areas. Lap edges and ends 3 inches and seal with pressure sensitive polyester tape.
- B. Maintain in place with plywood sheets for seven days.

END OF SECTION

SECTION 03400

PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.1 DESCRIPTION OF WORK

- A. This section specifies furnishing all labor, material and equipment as specified herein and shown on the Drawings for furnishing and installing precast concrete structures.

1.2 REFERENCES

- A. This section references the latest edition of the following documents. They are a part of this section as specified and modified. In a case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

<u>Reference</u>	<u>Title</u>
ACI 301	Specifications for Structural Concrete for Buildings
ACI 315	Manual of Standard Practice for Detailing Reinforced Concrete Structures
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 347	Recommended Practice for Concrete Formwork
ACI 350	Code Requirements for Environmental Engineering Concrete Structures
ACI 525	Minimum Requirements for Thin-Section Precast Concrete Construction
ASTM A615	Deformed and Plain Billet-Steel Bar for Concrete Reinforcing Steel Institute Manual of Standard Practice
ASTM C33	Concrete Aggregate
ASTM C494	Chemical Admixtures for Concrete
ASTM C150	Portland Cement
ASTM C260	Air-Entraining Admixtures for Concrete
AWS D12.1	Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction

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1.3 QUALITY ASSURANCE

A. Manufacture, transportation and installation shall be by a company specializing in providing precast products and services normally associated with precast concrete construction.

1. Standards

- a. ACI 318 Building Code Requirements for Reinforced Concrete.
- b. AWS D12.1 Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction.
- c. Sampling and testing shall be in accordance with the manufacturer's standard procedure, subject to approval by the Engineer.

1.4 SUBMITTALS

- A. Submit shop drawings in accordance with the requirements of SECTION 01340.
- B. Shop drawings shall be complete and shall include a layout plan; connection and anchorage details; size and location of reinforcing steel and inserts; and member identification marks. These identification marks shall appear on the manufactured units to facilitate correct field placement.
- C. The manufacturer shall be responsible to check the shop drawings and to insure their conformance with the overall structure dimensions, and to resolve any conflicts prior to delivery.

1.5 DELIVERY AND HANDLING

- A. Care shall be used in transporting precast concrete structures to the job site. Members shall be handled in such a manner as to prevent excessive stresses, spalling and undesirable cracking.
- B. Handle by means of lifting inserts.

PART 2 PRODUCTS

2.1 PRECAST CONCRETE STRUCTURES

A. General

1. Precast structures shall consist of precast concrete designed to conform with the dimensions, design loads and accessories shown on the Drawings, and

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the requirements of these Specifications. In addition, the precast structure designer shall familiarize himself/herself with the recommendations of the soils report for this project, to ascertain site soil conditions and soil loadings. All vault penetrations, framing attachments and finishes are detailed on the Drawings, and in these specifications.

B. Precast Concrete Manholes

1. Precast concrete manhole sections shall conform to the requirements of ASTM C478. Cement shall be ASTM C150, Type II. Minimum wall thickness for nonreinforced sections shall be 6 inches. Minimum wall thickness for reinforced sections shall be 4 inches. Joints shall be tongue and groove with rubber gaskets conforming to ASTM C443, Section 5.
2. Precast sumps for the intakes shall be manufactured from Reinforced Concrete Pipe and conform to ASTM C-76. The pipe shall be capable of withstanding the earth and hydrostatic loads indicated on the drawings. All sections with an inside diameter of 9 ft. and greater shall be Class III pipe. All joints shall conform to ASTM C-443, for rubber gasket joints. Openings and special top finishes shall be factory made to the sizes and shapes as indicated on the drawings. Contractor provide shop drawings.

C. Access Steps

1. All access steps shall conform to the requirements of ASTM C478-80, paragraph 12 and current OSHA standards. Steps shall be injection molded copolymer polypropylene that encapsulates a 1/2-inch diameter, grade 60 steel reinforcing rod as manufactured by M.A. Industries, Peachtree City, Georgia, or equivalent. As an alternative, the Contractor may install stainless steel (Type 304) steps, 3/4-inch in diameter, 12 inches wide with a 3-inch rise in each step. Steps shall be spaced at 12" O.C.

D. Access Lids

1. Access lids shall be concrete with a cast-iron frame and cover and rated for H20 truck loads, unless otherwise shown on Drawings.

2.2 MATERIALS FOR PRECAST CONCRETE STRUCTURES

A. All material shall be outlined in ACI 318 and AISC Manual of Steel Construction, conforming to latest ASTM specifications.

1. Portland Cement. ASTM C 150, Type II.
2. Admixtures

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- a. Total air content admixture shall be used meeting ASTM C 260 to achieve a total air content of 4 to 7 percent for 1 1/2 inch aggregate, 5 to 9 percent for 3/4 inch and 7 to 10 percent for 3/8 inch.
 - b. Water reducing admixtures shall meet ASTM C 494.
 - c. Fly ash shall not exceed 15 percent of the total quantity of cementitious materials and be Class C conforming to ASTM C 618.
3. Compressive Strength. 4500 psi minimum at 28 days.
4. Aggregates. ASTM C 33.
- a. All aggregates, fine and coarse, shall be free of all deleterious substances which cause reactivity with oxidized hydrogen sulfide. Both sizes of aggregates shall be graded to produce a homogeneous concrete mix.
5. Reinforcing Steel
- a. Reinforcing bars. ASTM A 615, Grade 60.
 - b. Welded wire fabric. ASTM A 185.
 - c. All reinforcing steel shall be of the size and in the location as shown on the shop drawings. Sufficiently tie reinforcing to withstand any displacement during the concrete placement operation.

PART 3 EXECUTION

3.1 INSPECTION

- A. Verify lines, levels, and measurement before proceeding with form work.
- B. Verify anchors, guides, floor framing, pipe penetrations, and risers and lids are accurately placed to be true, plumb and level, held securely and perform as intended.

3.2 INSTALLATION

- A. Inspect the bearing surfaces assuring that they are smooth and level prior to the structure installations.
- B. Installation procedure shall be specified by the vault manufacturer, and shall take into account the size of excavation required for vault installation.
- C. The Contractor shall coordinate with the precast product manufacturer the installation of all bolt-on items, and any items that penetrate walls or roofs.

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- D. All manhole sections shall be set plumb and true. Sections of various heights shall be used as required to bring the ring and cover to final grade.
- E. All lifting holes in precast structure shall be filled with mortar.

3.3 REPAIR

- A. Patch damage occurring during installation as deemed necessary with the epoxy bonding agent specified for concrete.
- B. Cut off lifting devices and grout if the devices interfere with the floor slab placement.

END OF SECTION