

SECTION 03 21 00 REINFORCING STEEL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Under this Section, the Contractor shall furnish all labor, materials and equipment for installing all Reinforcing Steel, welded wire fabric and accessories for cast-in-place concrete as shown on the Plans, as specified, and/or directed.

1.02 REFERENCES

- A. Reference to standard specifications for the following organizations is intended to specify minimum standards for quality of materials and performance of workmanship, and for standard test methods.
 - 1. American Society for Testing and Materials (ASTM) Publications, Latest Edition
 - 2. American Concrete Institute (ACI) Standards, Latest Edition
 - 3. American Welding Society (AWS) Publications, Latest Edition
 - 4. American National Standards Institute (ANSI) Publications, Latest Edition
 - 5. Concrete Reinforcing Steel Institute (CRSI) Publications, Latest Edition

1.03 SUBMITTALS

- A. Shop Drawings: Indicate bar sizes, spacings, locations and quantities of reinforcing steel and wire fabric, bending and cutting schedules, and supporting and spacing devices. No work on fabricating or placing steel shall be done until such drawings and schedules have been approved.
- B. Manufacturer's Certificate: Submit certified copies of mill test report of reinforcement materials analysis.
- C. Welder's Certificate: Submit certification from welders employed on the work, verifying AWS qualification within the previous twelve months.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcing steel bars shall be free from defects, kinks, bends, rust, scale or other irregularities. Reinforcing mesh shall be of the electrically welded type, with wires arranged in rectangular or square patterns.
- B. Reinforcing bars shall be deformed billet steel meeting the requirements of ASTM A615 Grade 60.
- C. Steel wire fabric shall meet the requirements of ASTM A185.

- D. Stirrup steel shall be cold drawn steel wire meeting the requirements of ASTM A82.
- E. Epoxy coated reinforcing bars shall be deformed billet steel meeting the requirements of ASTM A775, Grade 60.
- F. Galvanized reinforcing bars shall be deformed billet steel meeting the requirements of ASTM A767, Grade 60.
- G. Accessory materials shall include: tie wire, minimum 16 gage annealed type. Epoxy-coated reinforcing bars shall be tied with plastic-; epoxy-; or nylon-coated tie wire. Chairs, bolsters, bar supports, and spacers shall be sized and shaped for strength and support of reinforcement during concrete placement conditions.

2.02 IDENTIFICATION AND PROTECTION OF BARS AND FABRIC:

- A. Reinforcing steel shall be delivered to the work in strongly tied bundles identified with metal tags corresponding to the bar schedules and diagrams. Identification marks shall show quantity, producing mill, bar size, type of steel and grade mark.
- B. All bars and fabric shall be stored off the ground and shall, at all times, be protected from moisture and be kept free from dirt, oil, or injurious coatings. Epoxy-coated reinforcing bars shall be stored on protective cribbing. If concreting is delayed for any considerable number of days after the reinforcing is placed in position, it shall be protected by covering with canvas or other satisfactory covering, or, if directed, shall be painted with a coat of neat cement grout.
- C. Any bar or fabric having a scaly rust shall be cleaned. Epoxy-coated reinforcing bars that are cut, welded or otherwise damaged shall be repaired with patching material conforming to ASTM A775 and done in accordance with the Material Manufacturer's recommendation. Galvanized reinforcing bars that are cut, welded or otherwise damaged shall be repaired with patching material conforming to ASTM A767 and done in accordance with the Material Manufacturer's recommendation. The Contractor will be required to replace bars exhibiting severely damaged coatings.

PART 3 - EXECUTION

3.01 FABRICATION AND INSTALLATION:

- A. Metal reinforcing shall be properly fabricated in accordance to references specified.
- B. Metal reinforcing shall be properly placed in accordance to CRSI, ACI 301, ACI 318, ACI SP-66, as shown on the approved Shop Drawings and as herein directed.

- C. Bars shall be bent in the shop to the shapes shown or required. Field bending shall be done only with the written approval of the Engineer. Field welding shall not be allowed without direct approval and supervision of the Engineer.
- D. Unless otherwise shown, splices in tension reinforcement shall not be permitted, and splices in compression reinforcement shall be lapped 40 diameters. All bar splices shall be staggered, wherever possible. Locate splices not indicated on drawings, at point of minimum stress. Splice locations must be approved by the Engineer.
- E. Reinforcing shall be securely tied and supported and must not be displaced during concrete placing operations. Epoxy-coated reinforcing bars shall rest on coated wire bar supports, or other acceptable materials. Dowels must be wired in place before concreting begins. All metal shall be kept away from exposed surfaces of concrete.
- F. Conduit in slabs on grade shall be placed in a depression below the slab and the mesh run continuous over conduit. Conduit in slabs on forms shall be above the bottom reinforcing and below the top reinforcing. No conduit is permitted in thin joist slabs.
- G. Cutting of bars to clear openings in walls or slabs is strictly prohibited. Warp bars around such openings.
- H. Provide two #6 diagonal bars at each corner of every rectangular opening in walls, unless otherwise shown on the Plans.
- I. All slabs, unless otherwise shown on the Plans, to be reinforced with not less than WWF 6 x 6 - W2.9 x W2.9 welded wire mesh.
- J. Placing of concrete shall not be scheduled until all of the reinforcing for the section is secured in place and the reinforcing and forms have been approved by the Engineer or his representative. Contractor shall notify the Engineer 24 hours prior to a concrete pour.
- K. Welded wire mesh in slabs is to be placed in the upper third of the depth of the slab. Lap 6" minimum. Fabric shall be straightened as required before placement.
- L. Provide bent bars 6'-0" long of same size and spacing as horizontal bars for all corners of foundation walls, unless otherwise shown on the Plans.
- M. Do not displace or damage vapor barrier.
- N. For footing reinforcement - support bars on small precast concrete blocks; space at intervals as shown on the Plans and within minimum height specified above underside of slab or footing.
- O. Reinforcement shall not be bent after being partially embedded in hardened concrete.

3.02 CONCRETE PROTECTION FOR REINFORCEMENT:

- A. Unless otherwise shown or directed, concrete protection, measured from the surface of the bar, shall be the following:
1. For concrete deposited against the ground, without the use of forms.....3 inches
 2. For formed concrete in contact with the ground2 inches
 3. For slabs and walls contacting water or sewage2 inches
For beams, girders and columns not directly exposed to ground and weather 1-1/2 inches
 4. For formed concrete exposed to the weather2 inches
 5. For slabs and walls, not directly exposed to ground, weather, water or sewage 1 inch
- B. Exposed reinforcing bars intended for bonding with future extensions shall be protected from corrosion by a covering of concrete or other approved material.

3.03 FIELD QUALITY CONTROL

- A. Field inspection will be performed under the provisions of Section 03 30 00 or 03 30 20.

END OF SECTION

SECTION 03 30 00 CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Under this Section, the Contractor shall furnish all labor, materials and equipment for plain and reinforced Cast-In-Place Concrete work including accessory items of work herein described, as shown on the Plans, as specified, and/or directed.

1.02 REFERENCES

- A. Reference to standard specifications for the following organizations is intended to specify minimum standards for quality of materials and performance of workmanship, and for standard test methods.
 - 1. American Society for Testing and Materials (ASTM) Publications, Latest Edition.
 - 2. American Concrete Institute (ACI) Standards, Latest Edition.
 - 3. Standard Specifications - Construction and Materials, New York State Department of Transportation (NYSDOT), Latest Edition, including Addenda thereto.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with ACI 301 and ACI 302.
- B. Acquire cement and aggregate from same source for all work.
- C. Conform to ACI 305R when concreting during hot weather, except as herein modified.
- D. Conform to ACI 306R when concreting during cold weather, except as herein modified.

1.04 SUBMITTALS, SAMPLES AND TESTS

- A. Product Data: Provide data on joint devices, attachment accessories and admixtures.
- B. Concrete:
 - 1. Samples and tests of all materials to be incorporated in the concrete shall be submitted in ample time for testing before delivery. All materials are subject to inspection and testing by a commercial testing laboratory approved by the Engineer at the Owner's expense. All materials are subject to approval by the Engineer prior to their delivery to the site.
 - 2. The Contractor shall obtain from the manufacturer, prior to the actual delivery of the concrete, a statement giving the sources, specific gravities, and sieve analyses of the aggregates and the dry weights of cement and saturated-surface-dry weights of fine and coarse aggregate and

quantities, type and name of admixture (if any) and of water per cubic yard of concrete that will be used in the manufacture of each class of concrete to be provided. This data shall be sent to the Engineer for review and approval.

- a. Aggregates shall be tested for gradation, purity and accelerated soundness. Tests shall comply with ASTM C33, C136, ASTM C40, and ASTM C88. The source of the material shall not be changed without retesting.
- b. Cement shall have representative mill test reports on physical and chemical requirements. All cement stored at job site or at concrete supplier's place for over 60 days shall be tested for compliance with ASTM C150.
- c. Contractor shall submit concrete mix design to be reviewed by the Engineer.
- d. Tests of other materials may be required by the Engineer.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials shown, specified or required to be incorporated in cast-in-place concrete shall be of finest quality, and shall be delivered, stored and handled so as to prevent damage. Damaged or inferior materials will be rejected. Approved brands or sources must be used, without change for the entire project. All materials shall be proportioned to produce a well graded mixture of high density and maximum workability.
- B. Portland Cement shall be a standard brand in compliance with ASTM C150 Type I. Only one brand shall be used for exposed work. Generally, Type I cement shall be used; however, Types II or III may be employed with the approval of the Engineer or if shown, or specified.
- C. Fine Aggregates shall be clean, sharp, natural sand, free from loam, clay, organic impurities or frozen materials and shall conform to ASTM C33 in all respects. Sand shall be tested for impurities in accordance with ASTM C40.
- D. Coarse Aggregates shall consist of strong, clean, crushed limestone or crushed gravel, free from harmful material and meeting all of the requirements of ASTM C33. Coarse aggregate shall also comply with New York State Department of Transportation Material Designation 703-02. Crushed limestone and crushed gravel shall meet the Physical Requirements (Testing) Designation 703-0201 and 703-0202, respectively.
- E. Water used in mixing concrete shall be clean and free from all acid, alkali or organic matter and shall be obtained from a public water supply unless specifically permitted otherwise by the Engineer.
- F. Ready Mix Concrete shall comply with ASTM Specification C94, this Specification, and used subject to the Engineer's approval.

- G. Admixtures, where shown or specified, shall be as follows:
1. Air entraining agent shall be "Daravair" or "Darex AEA" as manufactured by W.R. Grace Co., or Master Builder's "MBVR", or equal meeting the requirements of ASTM C260.
 2. Water reducing agent shall be Sika "Plastiment", Master Builder's "Pozzolith", W.R. Grace's "WRDA", or equal meeting the requirements of ASTM C494.
 3. High range water reducers or superplasticizers shall be Sika "Sikament-FF", W.R. Grace's "Daracem-100" or "WRDA-19", or equal meeting the requirements of ASTM C494.
- H. Bonding Agent, where shown or specified, shall be "Dural 104" bonding compound manufactured by Dural International Corporation, "Sikadur 32 Hi Mod" by Sika Corporation, or equal.
- I. Anchorage Items, where shown or specified, shall be as follows:
1. Inserts for fastening shelf angles shall be malleable iron adjustable wedge type, with bolt and washer, if required, as manufactured by Hohman & Barnard, Inc., Richmond Screw Anchor Co., Inc., or equal.
 2. Threaded inserts for fastening of soffits of concrete beams shall malleable iron, as manufactured by Hohman & Barnard, Inc., Richmond Screw Anchor Co., Inc., or equal.
 3. Ceiling hanger inserts shall be standard type wire as manufactured by Hohman & Barnard, Inc., Heckman Building Products, Inc., or equal.
 4. Masonry anchor slots shall be galvanized sheet metal, felt filled, as manufactured by Hohman & Barnard, Inc., Heckman Building Products, Inc., or equal.
 5. Flashing reglets shall be O'Keefe's Inc., PVC "Watertite Type P", or equal to size and shape shown.
- J. Flexible Sleeve, where shown or specified, shall be of resilient rubber with a flanged, serrated waterstop and shall be cast directly into the walls of the concrete structure as shown on the Contract Documents. Flexible sleeve shall conform to the following physical requirements:

PROPERTY	ASTM TEST REQUIREMENTS		
	METHOD	MIN.	MAX.
Tensile Strength, psi	D412	1500	-
Ultimate Elongation, percent	D412	450	-
Hardness, Type A durometer	D2240	45	55

1. Flexible sleeve must permit a minimum of 10 degrees deflection in all directions. Flexible sleeve shall be "Lockjoint Flexible Manhole Sleeve" as manufactured by Chardon Rubber Company, or equal.

- K. Forms shall be wood, metal, or other approved materials as follows:
1. Plywood shall be Commercial Standard Douglas Fir, moisture resistant, concrete form plywood, at least 5-ply 5/8" thick.
 2. Metal forms shall be as approved, and must produce surfaces equal to those specified for wood forms.
 3. Form oil shall be an approved non-staining mineral oil, such as "Duogaurd II" by W.R. Meadows, or equal.
 4. Form ties shall be of approved design, adjustable length and free of devices that will leave hole or depression larger than 7/8" diameter. When forms are removed no metal shall be left within 1" of finished surface.
- L. Waterstops, where shown or specified, shall be minimum 3/8-inch thick across their entire section, heavy duty, serrated type manufactured from virgin polyvinyl chloride compound, "Model RB6-38H" as manufactured by Vinylex Corporation, or equal. They shall have a tensile strength of minimum 1800 psi and an elongation of minimum 200%.
1. Waterstops shall be open bulb type, 6-inch wide unless otherwise shown or directed by the Engineer. The waterstops shall be supported during concrete placement to prevent dislodgement and to insure that the ends remain at right angles to the joint. Field joints shall be butt welded with an electric iron in accordance with the manufacturer's instructions.
 2. Sample of the waterstops to be used shall be submitted to the Engineer for approval.
- M. Premolded Joint Filler, where shown or specified, shall be premolded, resilient, non-extruding type, 1/2-inch thick unless shown otherwise, full depth of concrete section as manufactured by Celotex Corporation, "Fibre Expansion Joint Filler" by W.R. Meadows, or equal.
1. Sample of the premolded filler proposed to be used shall be submitted to the Engineer for approval.
- N. Joint Sealant, where shown or specified, shall be elastomeric polyurethane sealant material, black in unexposed locations, and grey in exposed locations, and have balanced properties of elongation recovery and tensile strength, and shall be Sonneborn "Sonolastic NP1", Sika "Sikaflex 1A", or equal.
- O. Protective Covering for concrete finish slabs, where shown or specified, shall be "Orange Label Sisalkraft", Polyethylene Film as manufactured by Fortifiber Corp., or equal.
- P. Non-Shrink Grout, where shown or specified, shall be premixed compound consisting of non-metallic aggregate, natural aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days; such as "Masterflow" as manufactured by Master Builders, "SikaGrout 212" as manufactured by Sika, or approved equal.
1. Non-Shrink grout shall be used under structural steel column baseplates and all equipment baseplates. All work shall be done in strict accordance with the manufacturer's recommendations. At the request of the

Engineer, the manufacturer's representative shall be called to the job site for consultation regarding detailed use of the grout.

- Q. Grout for fillets, channels, or other non-structural applications shall consist of one (1) part cement (Portland Cement Type 2) and three (3) parts fine aggregate (sand) with sufficient mixing water for the intended application.
- R. Cementitious Coating Materials, where shown or specified, shall be "Thoroseal" with "Acryle 60" bonding agent, as manufactured by Thoro System Products, "Anchor Masonry Surfer" as manufactured by Anti Hydro Waterproofing Company, or equal.
- S. Curing Compound shall be acrylic based "Kure-N-Seal" as manufactured by Sonneborn, acrylic based "CS-309", or water based "VOCOMP-20" as manufactured by W.R. Meadows, or equal.
- T. Vapor Retarder, where shown or specified, shall be "Moistop" as manufactured by Fortifiber Corp. Vapor Barrier shall be "Premoulded Membrane Vaporseal" as manufactured by W.R. Meadows, or equal.
- U. Perimeter Insulation, where shown or specified, shall be "Styrofoam Square Edge" as manufactured by the Dow Chemical Corporation, "Foamular 250" as manufactured by UC Industries, or equal.
- V. Penetrating Sealer, where shown or specified, shall be two components, 50% solids penetrating epoxy sealer. The penetrating sealer shall be fully compatible with the types of form oil, curing compound and joint sealant used.
 - 1. Concrete surfaces to be treated must be dry, cured for a minimum of 21 days, free from surface accumulations of dust, dirt, oil, debris, concrete curing compounds, bond breakers, or other compounds which would prevent penetration and intimate contact between the concrete surface and the penetrating sealer. Concrete surfaces require preparation per manufacturer's directions prior to sealer installation.
 - 2. Penetrating sealer shall be "Spec-Seal" as manufactured by Conspec, Inc., or equal.
- W. Metal Slab Joints, where shown or specified, shall be keyed type, minimum 18 gauge, galvanized steel by Heckmann Building Products, or equal.
- X. Vapor Barrier: 10 mil (0.5 mm) thick recommended for below grade application.

2.02 CONCRETE MIX DESIGN

- A. The Contractor shall submit concrete mix designs to be reviewed by the Engineer. The mix designs shall be confirmed by making and testing trial mixes for each class of concrete to be incorporated in the work. All testing shall be made by an approved testing laboratory at the expense of the Contractor. Mix designs shall conform to the ACI 301, except as may be modified in the Plans and/or Specifications.

- B. No job concrete shall be poured until the mix design for that concrete has been approved by the Engineer. Once the mix has been approved, it shall not be changed, except when requested by the Engineer, or if requested by the Contractor and approved by the Engineer.
- C. Ready-mixed concrete from an established company will be approved, if conforming to ASTM C94, and to this specification. All concrete shall be batched, mixed, delivered to the site, and shall conform to these requirements and be controlled in a manner to assure uniform concrete for the quality specified.
- D. Water/cement ratios of all mixes shall be determined from w/c curve plotted from tests of the cement and aggregates used on the job. If necessary to increase the water content of the mix due to field conditions, sufficient cement must be added to maintain the design water/cement ratio. Accelerating or retarding admixtures may be permitted by the Engineer if requested by the Contractor to compensate for adverse weather conditions.
1. The various classes of concrete shall be designated as follows:

MAXIMUM PERMISSIBLE WATER-CEMENT RATIOS FOR CONCRETE (WHEN STRENGTH DATA FROM TRIAL BATCHES OR FIELD EXPERIENCE ARE NOT AVAILABLE) Maximum permissible water-cement ratio					
CLASS	MIN. 28-DAY COMPRESSIVE STRENGTH IN PSI*	NON-AIR-ENTRAINED CONCRETE		AIR-ENTRAINED CONCRETE	
		ABSOLUTE RATIO BY WEIGHT	US GAL. PER 94-LB. BAG OF CEMENT	ABSOLUTE RATIO BY WEIGHT	US GAL. PER 94-LB. BAG OF CEMENT
A	5,000	**	**	**	**
B	4,000	0.44	5.0	0.35	4.0
C	3,000	0.58	6.6	0.46	5.2
D	2,500	0.67	7.6	0.54	6.1
E	2,000	0.71	8.0	-	-
*28-day strength. With most materials, water/cement ratios shown will provide average strengths greater than indicated in Section 5.4 of ACI 318R as being required. **For strength above 4,500 psi (non-air-entrained concrete) and 4,000 psi (air-entrained concrete) proportions shall be established by methods of Section 5.3 of ACI 318R.					

Unless otherwise specified, all concrete shall be Class "B", non-air-entrained except exposed concrete which shall be air-entrained. When foundation walls or grade beams are exposed to weather above grade, the entire wall shall be considered exposed concrete.

2. Maximum size aggregates shall be used as follows unless otherwise designated by the Engineer.

1-1/2"	general work
3/4"	thin sections; heavy reinforcing
3/4"	columns, beams and slabs
Over 1-1/2"	massive structures, with approval
3/8"	floor toppings

3. Slump - Maximum:

Reinforced concrete – general	4"
Reinforced concrete - thin walls, columns	5"
Non-reinforced concrete	3"
Pavements, including sidewalks	3"
Heavy mass concrete	3"

4. Air Content: Use an approved air entraining admixture. The entrained content shall be controlled between 4% - 6%. See Plans for concrete work requiring air entrainment.
 - a. For mixes containing coarse aggregate with a top size of 3/4" or smaller and for exposed concrete subject to frost and salt action, air contents shall be increased to the range of 5% - 7%.

5. Should the Contractor feel it advantageous to employ concrete additives to improve workmanship or facilitate his work, he shall obtain the approval of the Engineer prior to his use of additives.
6. Use of accelerating admixtures in cold weather will not relax cold weather placement requirements.

2.03 STORAGE OF MATERIALS

- A. Portland cement shall be stored in a weather-tight structure. No cement that has taken a warehouse set shall be used and any stored over sixty (60) days shall be rejected unless tested for soundness and setting time under ASTM C150. Such tests shall be at the Contractor's expense.

- B. Fine and coarse aggregates shall be kept separated and free from deleterious substances. All topsoil shall be removed from the storage area. Materials shall be stockpiled in layers to prevent segregation; however, re-mixing may be required if gradation is not maintained. Care shall be taken not to inter-mix materials in the area with the aggregates.

- C. Any materials that have deteriorated or become contaminated will be rejected for use in the concrete and must be promptly disposed of by the Contractor.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Before each pour, forms and reinforcing shall be inspected and approved by the Engineer. The Contractor shall give at least 24 hours' notice before such an inspection is required. No pour shall be started until the Engineer has given approval. No concreting may be done in the absence of the Engineer without written permission of the Engineer.
- B. Concrete Batch Ticket:
1. The Contractor shall require the manufacturer of the concrete to furnish to the Engineer with each batch of concrete before unloading at the site, a delivery ticket on which is printed, stamped, or written, information concerning said concrete as follows:
 - Name of ready-mix batch plant
 - Serial number of ticket
 - Date
 - Truck number
 - Name of purchaser
 - Specific designation of job (name and location)
 - Designation of the concrete by compressive strength
 - Amount of concrete in cubic yards
 - Time loaded or of first mixing of cement and aggregates
 - Reading of revolution counter at the first addition of water
 - Type and brand, and amount of cement
 - Type and brand, and amount of admixtures
 - Total water added by producer (and W/C ratio)
 - Water added at job site (upon approval of the Engineer)
 - Maximum size of aggregate
 - Weights of fine and coarse aggregate
 - Ingredients certified as being previously approved
 - Signature or initials of ready-mix representative
- C. Concrete Testing:
1. The Owner shall employ an approved commercial testing laboratory at its own expense to provide field sampling, testing and inspection of all concrete. Continuous inspection by the approved testing laboratory shall be provided during all concrete pours. The Contractor shall maintain a record set of plans at the site showing date and amount of each pour, test results and temperature. If any portion of the work shows low test results, the Engineer may require batch plant inspection, additional testing, load tests, cored samples, and/or replacement of the faulty work, etc., at the Contractor's expense.
 2. The Owner, through its approved testing laboratory, shall make all laboratory or field tests as required and shall furnish all necessary equipment. The Owner, through its approved testing laboratory, shall transport all test cylinders from the site to the laboratory.

3. Field concrete inspection: The Owner, through its approved testing laboratory, shall provide a competent field concrete inspector whose minimum duties shall be as follows:
 - a. Check each truck on arrival to make sure that the concrete is not retempered.
 - b. Make necessary slump tests for uniformity control.
 - c. Make air tests and yield tests as required.
 - d. Make any and all test cylinders as may be required in the Specifications.
 - e. Notify the Engineers and/or his representative if any test results vary from the specified limits.
4. Tests:
 - a. Concrete shall be tested by an approved testing laboratory as follows:
 - Standard 6" x 12" compression cylinders shall be in compliance with ASTM C39 in sets of four and shall be moist cured. Break 2 at 7 days, and 2 at 28 days. One set shall be made for approval of each mix design, one set for first pour of 50 cubic yards or less, and one set for each additional pour of 50 cubic yards. If less than 50 cubic yards are placed in one day, one set shall be made for each day's pour.
 - All test cylinders shall be cast, moist cured and broken under laboratory conditions in accordance with the ASTM C31 and ASTM C39. All four cylinders of a test shall be taken from the middle third of a single load. Each cylinder shall be properly labeled with an identifying mark, the mix proportions, air content, amount of water, slump, and the location in the structure where the concrete was placed. Test reports shall include all this information. Distribute copies of reports as requested by the Engineer. Should any results be questionable, the Engineer shall be notified immediately so that corrective measures can be taken. Any test cylinder which has broken and fails to meet requirements shall be preserved for inspection by the Engineer.

D. Records:

1. Maintain records of concrete placement. Record date, location, quantity, air temperature and test samples taken.

3.02 BATCHING AND MIXING

- A. All Batching and Mixing shall conform to the following and the ACI 304, "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete".
- B. Aggregates and bulk cement shall be measured to within 1% by weight. Cement in standard sacks need not be weighed. Water shall be measured by volume or by weight to within 1/2%. Aggregate weights shall be corrected for moisture content. Admixtures shall be added through appropriate dispensing equipment to an accuracy of 3%.

- C. The complete plant assembly shall be approved by the Engineer and shall conform to the following requirements:
 - 1. Provide ready adjustment of aggregate weights for varying moisture contents.
 - 2. Provide means of accurately controlling and easily checking water-cement ratio.
 - 3. Provide accurate control of all materials with positive shut-off.
 - 4. Facilities shall be provided for prompt removal of excess materials in hoppers.
 - 5. Each specified size of aggregate shall be measured separately with a separate beam scale.
 - 6. Bulk cement shall be dropped through canvas drop chutes or telescopic flexible hose tremie.
- D. Concrete mixers or mixer trucks shall not be loaded to more than the rated capacity of the truck.
- E. All concrete shall be mixed not less than 60 revolutions in the drum of a modern power mixer, at the rated speed of rotation. Mix not less than an additional 30 revolutions after the addition of any further water to the mix.
- F. Do not add raw materials to the drum until all of the preceding batch has been discharged. For transit mixers, the wash water shall be discharged and not used as part of the mix water for the next batch.
- G. Transit-mixed concrete shall be transported to the job site unmixed and only after arrival at the job site shall mixing begin. All concrete shall be unloaded from the mixer within 45 minutes after completion of mixing. All concrete still remaining in the truck shall be rejected.
- H. The total time interval from the time the cement makes contact with the aggregate to the complete unloading from the mixer shall not exceed 90 minutes, unless such time is extended by the Engineer. The time may be reduced in hot weather or under unusual conditions, if unsatisfactory results are obtained.

3.03 FORMWORK

- A. The Contractor shall design and construct suitable and adequate formwork in conformance with ACI 347R. All shoring shall be properly braced to safely withstand all vertical, moving and lateral forces during the construction period. Responsibility for adequacy and safety rests with the Contractor. Materials shall be as stated in Paragraph 2.1.
- B. General requirements for all forms shall be as follows:
 - 1. Forms shall be constructed of wood, plywood, or steel.
 - a. All forms shall be set true to line, plumb, and properly braced so as to maintain the desired position and shape during and after pouring concrete. Forms shall be sufficiently tight to prevent leakage.

- b. All joints between sheets shall be backed up to assure that both sheets are in the same plane. Edges of abutting sheets shall be straight and true and shall be forced tightly together to minimize fins. Quality of form contact surfaces shall be subject to Engineer's approval.
- c. Form ties shall be designed for the specific wall thickness required, and after removal of the external portion, no metal shall remain closer than one inch (1") from the surface. Ties to be left in place shall be equipped with washers or other approved devices to prevent seepage of moisture along the tie. The removable portion shall be oil or grease coated.
- d. Immediately following the removal of forms, the projecting ties shall be removed and all holes filled with grout flush with the wall. Care shall be taken to use the same brand of cement and same mix proportions used in the wall to prevent color differences.
- e. Forms for walls and columns shall be provided with removable cleanout panels, to allow removal of chips and debris. All plywood forms must be new when first used on this job, but may be reused if kept in good condition. All forms shall be swept or flushed clean of shavings, debris, and other loose material. Loose earth and rock shall be scraped from footing trenches before pouring concrete.
- f. Provide 3/4" chamfer strips, unless noted otherwise on the drawings, at all exposed corners of columns, beams and walls where later finish is not to be applied.
- g. All forms and shores for floor and roof slabs and beams shall be "crowned" or "cambered" 1/4" for each 12 feet of span to eliminate dead load deflection. All forms shall be oiled with a non-staining mineral form oil before placing reinforcing.
- h. Build into forms all hangers, anchors, bolts, inserts, sleeves, etc., required to be set as part of this work, place and secure in exact position.

C. Form removal shall be as follows:

- 1. It shall be the Contractor's responsibility to determine the time at which forms may be removed without endangering the structure, subject to the following limitations, unless documentation is provided to modify these requirements:

Footing forms - 24 hours minimum; continue curing as specified.

Wall forms - 2 days minimum for ten (10) feet high. Add one (1) day for each additional five (5) feet of height; continue curing as specified.

Superstructure slabs, beams and columns shall not be stripped until the concrete attains at least 75% of its design strength as proven by test cylinders, and until a minimum of 14 days has elapsed.

Reshoring - immediately after stripping, fully reshore all slabs which are to be used to support shores for upper slabs. All forms for upper floor pours must be supported by shoring to at least two levels of full strength concrete.

3.04 JOINTS FOR CONCRETE

- A. Joints for concrete shall include all expansion joints, construction joints and contraction joints.
- B. All joints shall be constructed at locations shown on the drawings, or as directed by the Engineer. Additional joints may be constructed by the Contractor subject to the approval of the Engineer.
- C. Expansion Joints:
 - 1. Expansion joints shall be constructed where shown and as directed. Reinforcement, corner protection angles or other fixed items embedded or bonded into concrete shall not be run continuously through expansion joints. Reinforcement shall be discontinued 2 inches from the joint face. A slightly rounded edging shall be provided to finish neatly all edges around expansion joints.
 - 2. Preformed expansion joint filler material, sealant and waterstops, where shown on the drawings, shall be as specified in Paragraph 2.1.
- D. Construction Joints:
 - 1. The location of construction joints shall be chosen by the Contractor and shall be subject to the Engineer's approval except where specifically located on the Plans.
 - 2. Horizontal construction joints in walls will not be permitted, except with the approval of the Engineer. In order to minimize shrinkage, long continuous walls shall not be poured at one time. No more than 50 feet in horizontal direction shall be poured without a construction joint, unless prior approval is obtained from the Engineer.
 - 3. Reinforcing shall be discontinuous through a construction joint, unless otherwise noted on drawings. As shown or specified on the drawings, additional No. 3 reinforcing bars spaced at 12-inches on center shall be placed horizontally in each construction joint at the center of the section. These bars shall be 4-feet long and shall extend 2-feet on each side of the joint. Reinforcement projecting through joint shall be kept clean.
 - 4. As indicated on the drawings, all construction joints shall be provided with a keyway and a PVC waterstop as specified in Paragraph 2.1. The joint surface of the concrete previously placed shall be cleaned of all foreign matter and laitance by means of sandblasting with steam and sharp sand, or by other approved methods, until coarse aggregate is exposed. The concrete surface shall be saturated for a period of 6 hours and excess water then removed.
 - 5. The new concrete shall be preceded by about 1/2-inch of soft mortar of the same proportions as that in the concrete. When accessible, this shall be scrubbed into the surface of the joint with wire brooms. When waterproofing is required, the entire joint shall be parged with a grout of

approved mixture as recommended by the manufacturer of the waterproofing admixture, or one composed of one part integral waterproofing, three parts water and sufficient Portland Cement to form a thick, creamy mixture. This grout shall be fresh when followed by the new concrete. In column forms and deep narrow forms, the concrete placement shall be started with an oversanded mix with 5/8-inch maximum aggregate, and extra sack of cement per cubic yard, and a 5-inch slump. This mix shall be placed maximum 2 inches deep on the construction joint. A mortar layer shall not be used.

6. As indicated on drawings, a metal keyed floor slab joint may be used in lieu of above method.

E. Contraction (Control) Joints:

1. Contraction joints shall be located as shown on the drawings or as directed. Reinforcement through the joint shall be continuous as shown on the drawings and/or as directed by the Engineer.
2. Sawcut contraction joints (Type "A") shall be made by cutting the concrete surface and filling with the sealant material as specified under paragraph 2.1. Cutting shall be done after the surface is firm enough not to be damaged by the cutting blade. Time of cutting shall be approved by the Engineer.
3. Formed contraction joints (Type "B") shall be made by tooling with a 1/4-inch radius edging tool and filled with the sealant material as specified under paragraph 2.1.
4. Premolded Contraction Joints (Type "C") shall be "Kold-Seal Zipper Strip" by Vinylex or "Zip Cap Control Joint" by Greenstreak Products, or equal.
5. As indicated on drawings, a metal keyed floor slab joint may be used in lieu of above method.

3.05 INSERTS AND SLEEVES

- A. The Contractor shall cooperate with all other Contractors in permitting the placing of all necessary sleeves, conduit, or inserts for hangers for their trades. The Contractor shall notify the trades of all pours in ample time for the responsible Contractor to place all embedded items, sleeves, slots, holes or chases.
- B. Accurately set all slots, chases, anchor bolts, opening, etc. All inserts for hanging mechanical equipment shall be provided and set by the Contractor for the trade involved. All sleeves for piping passing through floors and walls shall be provided by the Contractor for the trade involved and set by the General Contractor.
- C. All conduit which must be placed in concrete slabs shall be installed after, and above the bottom reinforcing, but before, and under the top reinforcing. Where conduit cross-overs are necessary, they shall be located so that reinforcing is not displaced from its specified position.
- D. All anchor bolts for the structural steel shall be carefully set as shown on the fabricator's approved anchor bolt plan.

- E. If, in the judgement of the Engineer, embedded items are located or grouped in a manner that will weaken the structure, the Contractor shall take the necessary corrective steps.
- F. All inserts and sleeves where the outside diameter is greater than the spacing between the reinforcing steel, the reinforcing bars shall be warped around such inserts and sleeves. Unless shown otherwise on the drawings, provide, as a minimum, two #4 diagonal bars per face at 90 degrees to each other all around the inserts and sleeves.
- G. Where openings are left in new concrete or are made in existing concrete for the insertion of wall castings, pipes or other fixtures, the space around these fixtures shall be made watertight by completely filling with a non-shrinking concrete containing an admixture of "SikaSet-C", "Anti-Hydro" Concrete Waterproofing Agent, or equal.

3.06 CONVEYING AND PLACING CONCRETE

- A. The placing or depositing of all concrete shall be done in accordance with ACI 304, and as modified herein.
- B. Preparation Prior to Placing Concrete:
 - 1. Prepare previously placed concrete surfaces by cleaning with steel brush and applying bonding agent in accordance with manufacturer's instructions.
 - 2. In locations where new concrete is dowelled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
 - 3. Before placing concrete, all debris, water, snow and ice shall be removed from places to be occupied by concrete. Wood forms shall be wetted except in freezing weather or oiled, and the reinforcement cleaned of ice or other coatings.
- C. Conveying, transporting, and placing shall be done as rapidly as practicable and without segregation, loss of ingredients, and without unnecessary rehandling. The tempering of concrete will not be permitted.
- D. Concrete shall be deposited as nearly as practical to its final position to avoid segregation due to rehandling or flowing. The concreting shall be carried on at such a rate that the concrete is at all times plastic and workable and flows readily into the spaces between the reinforcing bars. No concrete that has partially hardened or been contaminated by foreign material shall be deposited on the work, nor shall retempered concrete be used. Once the concreting is started, it shall be carried on as a continuous operation until the placing of the panel or section is completed. All concrete shall be compacted by suitable means during the placing operation, and thoroughly worked around reinforcement and embedded fixtures and into corners of the forms. Tremies shall be used for deep forms, and concrete shall not be dropped more than 6'-0".

- E. Vibrating:
 - 1. During and immediately after depositing, all concrete shall be thoroughly compacted by vibrating the concrete internally with mechanical vibrating equipment. Care must be taken not to over-vibrate the concrete. Maintain spare vibrator(s) at the site for use in the event of breakdowns.
 - 2. Spade and work the coarse aggregate away from forms, and work concrete around reinforcement to avoid air pockets, voids, and honeycombed sections. Hand spading slabs will be required in addition to mechanical vibration.
- F. During concreting, check shoring frequently with level. Strengthen or adjust shoring as required. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.
- G. Placing of concrete in supported elements shall not be started until the concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours.
- H. Screed all work to level surfaces at the proper elevations. Rake surfaces to provide bond for floor finishes where specified.
- I. No concrete shall be deposited under water without written permission of the Engineer and then only in accordance with his directions. Proper tremie equipment and techniques must be used, should the need arise.
- J. The Contractor shall have available at all times, sufficient approved materials such that, when started, concrete shall be continuous operation until placement of panel or section is complete. Should placing of concrete be suspended or unavoidably interrupted once a pour has been started, provide bulkheads and keyways at formed surface at which to stop pour.
- K. All laitance shall be removed from previous pours before additional concrete is placed.
- L. Place concrete continuously between predetermined expansion, control and construction joints.

3.07 PROTECTION AND CURING

- A. All concrete shall be protected against injury by sun, rain, freezing, mechanical damage, or premature drying. All concrete shall be maintained above 50°F in a moist or wet condition for at least the first 7 days after placement.
- B. On vertical surfaces keep forms on, or cover with burlap blankets, kept wet. When forms are exposed to the sun, minimize moisture loss by keeping the forms wet until they can be removed safely.
 - 1. For the preservation of moisture, apply one of the following procedures to concrete not in contact with forms, immediately after completion of placement and finishing:
 - a. continuous sprinkling
 - b. application of absorptive mats or fabric kept continuously wet

- c. application of waterproof sheet materials as specified in Part 2, herein
 - d. application of the curing agent specified in Part 2, herein
- C. On horizontal surfaces and floors to receive later finishes, cover with wet burlap, wet sand, or curing paper and keep saturated. Cement finish floors shall be covered with protective covering material with lapped and sealed edges after the concrete has set sufficiently to carry worker's weight. Covering shall remain in place until floor is cleaned. Weight covering with planks as required to hold it in place.
- D. Cold weather protection shall conform to A.C.I. 306R, except as modified herein.
 - 1. Prior to pouring, it shall be the Contractor's responsibility to keep the forms free from snow, ice, mud or debris at all times, by means of covers, enclosures, live steam or heating below the forms, as necessary. Use of torches, open flames, salts, straw, hay or chemical is prohibited.
 - 2. When air temperature is 40°F, or less, use only heated concrete, delivered to the forms at temperatures between 65°F and 85°F. All portions of freshly poured concrete shall be continually maintained at a temperature of not less than 50°F for seven days. Specified temperature shall be maintained by heated enclosures, insulating blankets, insulated forms, or whatever approved methods are required to attain the specified result.
 - 3. Concrete shall not be poured on frozen soil. After pouring, protect against freezing and heaving of subgrade. Any frozen concrete will be rejected and removed at the Contractor's expense. Accelerating admixtures shall not be accepted in lieu of winter protection.
- E. Hot weather protection shall conform to ACI 305R, except as modified herein.
 - 1. During warm dry weather special care and precautions should be taken to prevent premature setting which may cause shrinkage and surface checking. No concrete shall be placed at temperatures above 90°F without approval of the Engineer.
- F. No water (except curing spray) shall be allowed to come in contact with the concrete or masonry surface for a minimum of 24 hours. Should the rising water place a stress on the concrete, proper bracing shall be provided. Loading shall not occur without prior approval by the Engineer, and proper safety precautions shall be the responsibility of the Contractor.
- G. Curing compound may be used as specified in Paragraph 2.1 provided discoloration does not occur and application is in accordance with manufacturer's direction and is compatible with concrete finish.

3.08 FOOTINGS AND MATS

- A. Hand trim excavation to required levels.
- B. Where shown on the drawings provide concrete mud mat to the thickness indicated.

- C. Support reinforcing on bricks or precast blocks, or where mud mat is used, on chairs or bolsters, 3" clear of soil.
- D. Columns and wall dowels shall be positioned, supported and tied in place before concrete is poured. Footing bottoms shall be inspected and approved by the Engineer before placing mud mat or footings.

3.09 SUPPORTED SLABS ON FORMS

- A. Forms shall be built to required dimensions and camber as specified above. Reinforcing shall be located as shown on approved placing plans. Support bars at specified heights with bolsters, chairs, etc., so that reinforcing will not be moved from the specified position during placing of concrete.
- B. Refer to Article 3.5 for installation of conduits.

3.10 SLABS ON GROUND

- A. Subgrade and base to be prepared as specified in Contract Documents.
- B. Form depressed ribs under partitions as required by sloping gravel, or provide permanent side forms to retain gravel.
- C. Trench subgrade for electric conduit as detailed on Plans. All reinforcing shall be above electric conduit.
- D. Place slabs of thickness shown on Plans, vibrate, screed, float level, and finish as specified below.

3.11 CONCRETE FINISHES - FORMED SURFACES

- A. After the forms are removed, all concrete surfaces shall be inspected, and any poor joints, voids, stone pockets or other defective areas noted by the Engineer shall be repaired immediately at the Contractor's expense by cutting away the unsound area to a minimum depth of 1 inch, and refilling with mortar mixed using the same brand of cement as the original pour. Edges of the patch shall be square with the face, with feather-edging prohibited. Obtain approval of corrective action prior to repair.
- B. Care shall be taken to saturate the patched area and holes shall be filled in 1/2-inch layers with a delay for an initial set to take place before the succeeding layer is applied. If, in the opinion of the Engineer, improper consolidation is too extensive, or if the structure appears weakened by the voids, complete removal of the concrete in question may be required. Patches shall be kept moist for a minimum of three days.
- C. Rubbed finishes shall be as follows:
 - 1. Type A: Surfaces shall be rubbed until all marks are obliterated and a uniformly smooth finish is obtained.
 - 2. Type B: Surfaces shall be rubbed until they are uniformly smooth, but the complete obliteration of all marks is not required.

3. Type C: All fins, burrs and projections shall be removed, any honey-comb or tie-holes shall be filled and patched.
- D. The type of finish to be used shall be as scheduled or as noted on the Plans. Where the type of finish is not shown or scheduled, exposed faces shall be given a Type B finish and unexposed faces shall be given Type C finish.
- E. Rubbing shall begin as soon as practicable after removal of forms and shall be expedited to completion as rapidly as practicable.
- F. Surfaces shall be rubbed with carborundum and water until all fins, bubbles, hollows and other defects are removed. Grout or mortar shall not be used in the rubbing process, and plastering of surfaces will not be permitted. Power tools shall be used for rubbing with hand work limited to inaccessible corners or very small areas.

3.12 FLOOR AND SLAB FINISHING

- A. Finished floors and slabs shall be level to within 1/8" of finish floor elevation in ten feet. If this variation occurs, it must not be abrupt, but must taper so that the 1/8" variation takes place in not under 4 feet. Areas with drains shall have the surfaces sloped uniformly and true to the effect that no surface ponding occurs. If required by the Engineer, replace, grind or furnish underlayment to correct the variation, at the Contractor's expense. All floors and slabs shall be cured and protected as specified.
- B. Troweled Finish: Provide a floated finish, followed by a power troweling and then a hand troweling thoroughly consolidating the surface. Provide a finished surface essentially free from trowel marks and uniform in texture and appearance.
1. Where exposed concrete finish is specified, provide a steel troweled finish.
2. Under quarry tile and ceramic tile screed to accurate lines and levels as required to receive these materials. Floors receiving tile are to be steel troweled finished and are indicated on the Plans.
- C. Float Finish: A float finish shall be applied to all exterior concrete and those areas not intended for occupancy, such as culvert inverts, bottoms of manholes and catch basins, pads, etc.
- D. Broom Finish: Provide a floated finish. While the surface is still plastic, provide a textured finish by drawing a fiber bustle broom uniformly over the surface in one direction only. Provide "medium" texturing unless noted otherwise on the Contract Drawings. Sidewalks, walkways, or exterior ramps shall be given a broom finish, perpendicular to traffic, sufficient to leave marks without appreciable disturbance of the surface.
- E. Dusting with dry cement or cement sand mixtures, to hasten drying, is prohibited. Dry time shall be controlled by controlling the water content and slump of the concrete when placed.

3.13 BONDING

- A. For the bonding of new and old concrete, such provisions shall be made by means of steps, dovetails, bonding agents as specified in Paragraph 2.1, or other devices as shown, or directed.
- B. When placing of concrete is suspended or unavoidably interrupted, all necessary grooves for bonding future work shall be made before the concrete has attained its initial set. When the work is resumed, concrete previously placed shall be roughened, cleaned of all foreign material and laitance by means of sandblasting with steam and sharp sand or other approved methods, until coarse aggregate is exposed, and thoroughly wetted and slushed with mortar containing the same proportion of cement and fine aggregate as used in the concrete to be placed. Follow manufacturer's preparation recommendations when using a bonding agent.

3.14 MISCELLANEOUS CONCRETE WORK

- A. Pour all sump pits, canopies, copings and provide all other miscellaneous concrete and cement work shown on the drawings. All such concrete shall be reinforced as shown. Provide all cement filled stair treads as detailed. Place bottoms and walls of pits and trenches monolithically or provide waterstops and keys.
- B. Concrete Walks: Provide 4 inches thick minimum. Provide contraction joints spaced every 5 linear feet, unless otherwise indicated. Cut contraction joints 3/4-inch deep with a jointing tool after the surface has been finished. Provide 1/2-inch thick transverse expansion joints at changes in direction, where sidewalk abuts curb, steps, rigid pavement, or other similar structures. Provide a transverse slope of 1/4-inch per foot, and limit variation in cross section to 1/4-inch in 5 feet unless otherwise indicated.
- C. Curbs and Gutters: Provide contraction joints spaced every 10 feet maximum, unless otherwise indicated. Cut contraction joints 3/4-inch deep with a jointing tool after the surface has been finished. Provide expansion joints 1/2-inch thick and spaced every 100 feet maximum, unless otherwise indicated. Provide a broom finish.
- D. Equipment Bases: Unless otherwise shown, all equipment shall be erected on bases of Class "B" concrete. Thickness shall be as noted on the Plans, but at no time shall it measure less than 1 inch.
- E. Concrete Stairs, Steps and Platforms: Stairs, steps and platforms shall be formed to required profiles shown on the Plans. Place reinforcing as required. Finish of stairs and steps shall be monolithic. Where shown on Plans, provide for nosings. Exterior stairs, steps and platforms shall have a non-slip finish. Before final troweling, embed abrasive grits, as specified in Paragraph 2.1, in the surface.

3.15 CEMENTITIOUS COATING

- A. Cementitious Coating shall be applied to all exposed exterior and interior Cast-In-Place Concrete surfaces except concrete floors and walking surfaces in accordance with the schedule shown on the Plans, or otherwise directed.
- B. The surfaces to be coated shall be clean, free of all laitance, dirt, grease, curing compound, form treatments, efflorescence, paint and other foreign matter. All formed tie-rod holes and honeycombed areas shall be patched flush with the surrounding area using mortar as recommended by cementitious coating manufacturer.
- C. All areas scheduled to be coated will receive two coats of cementitious coating as specified in Paragraph 2.1, applied at a minimum rate of 2 pounds per square yard per coat. The first coat shall be allowed to set before the second coat is applied. Sufficient materials shall be applied to fully seal all pores and voids. All coatings shall be done strictly in accordance with the manufacturer's recommendations.

END OF SECTION