SECTION 03 10 00

CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section covers design, construction, treatment of formwork to confine and shape concrete to the required dimensions, and formwork accessories.

B. Related Sections:

1. 01 33 00 – Submittal Procedures

2. 01 45 00 – Structural Testing, Inspection, and Quality Assurance

3. 03 20 00 – Concrete Reinforcing

4. 03 30 00 – Cast-in-Place Concrete

1.3 REFERENCE STANDARDS

A. The latest versions of the publications listed below form a part of this Specification; comply with provisions of these publications except as otherwise shown or specified.

1. ACI 117 Standard Specification for Tolerances for Concrete

2. ACI 301 Standard Specifications for Structural Concrete, including other standards referred to in ACI 301, such as ASTM, etc.

1.4 SUBMITTALS

A. Formwork Shop Drawings: Submit the following in accordance with Section 01 33 00, "Submittal Procedures":

1. Formwork shop drawings sealed by a professional Engineer licensed in the state where the Work will be done.

2. Calculations for formwork, reshoring, and backshoring sealed by a professional Engineer licensed in the state where the Work will be done.

3. Exposed Concrete Surfaces: Show the general construction of forms including jointing, formed joints or reveals, form tie locations, and pattern of form placement, and other items that affect the exposed concrete visually.

4. Formwork Facing Materials: Data on form facing materials proposed for smooth-form finish.

B. Product Data: Include specifications and installation instructions for proprietary materials and items as required, including formwork release agents, form liners, manufactured form systems, form ties, and accessories.

C. Construction and Contraction Joints: Submit the location of construction and contraction joints proposed if different from those indicated in the Contract Documents.

D. Testing for Formwork Removal: Data on method for determining strength of concrete for removal of formwork when a method other than field-cured cylinders is proposed.

E. Formwork Removal Plans: Detail plans for formwork removal operations when removal of forms at concrete strengths lower than that specified is proposed.

F. Reshoring and Backshoring Plans: When reshoring or backshoring is required or permitted, submit procedures and plans of operations, before use, sealed by a professional Engineer licensed in the state where Work will be performed.

G. Slab Survey Information: In accordance with Article 1.5-F of this Section. Survey results shall be submitted to the Architect/Engineer within 24 hours.

1.5 QUALITY ASSURANCE

A. Design and construction of concrete formwork is the responsibility of the Contractor. Design and construct formwork to furnish only those lines and shapes indicated on drawings, unless otherwise approved by Architect. Construct formwork for erection in satisfactory sequence and removal without damage to the resulting concrete surface.

B. Allowable Tolerances: Variations from plumb and designated building lines shall not exceed the tolerances specified in ACI 117.

C. Inspections: Refer to Section 01 45 00, "Structural Testing, Inspection, and Quality Assurance," for inspection requirements performed by Owner’s Testing Agency.

D. Embedded Items: Where items, such as embedded plates, reglets, anchors, fastenings, conduit, piping and other items are supplied by other trades and specified elsewhere in the Contract Documents, coordinate and obtain approval of their placement in the forms prior to placing any concrete.

E. Forms for Reuse: Where applicable, construct and erect forms for reuse; withdraw all projecting nails and other objects from contact surfaces before reusing; clean and completely recondition all forms prior to reuse. Obtain approval for form reuse from Owner's Inspector; formwork with patches and repairs affecting the appearance of concrete surfaces will not be allowed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Form-Facing Materials: Materials for form faces in contact with concrete shall meet the following requirements unless otherwise specified in the Contract Documents.

1. Rough Form Finish: No form-facing material is specified.

2. Smooth Form Finish: Use plywood, tempered concrete form-grade hardboard, metal, plastic, paper, or other acceptable materials capable of producing the desired finish. Form-facing materials shall produce a smooth, uniform texture on the concrete. Do not use form-facing materials with raised grain, torn surfaces, worn edges, patches, dents, or other defects that will impair the texture of concrete surfaces. Set the facing materials in an orderly and symmetrical arrangement, and keep the number of seams to a practical minimum.

B. Formwork Accessories: Use commercially manufactured formwork accessories that are partially or wholly embedded in concrete, including ties and hangers. Do not use non-fabricated wire form ties. Where noted in the Contract Documents, use form ties with integral water barrier plates in walls.

C. Formwork Release Agents: Use commercially manufactured formwork release agents that will prevent formwork absorption of moisture, prevent bond with concrete, and not stain the concrete surfaces.

D. Expansion Joint Filler: Premolded expansion joint filler shall conform to ASTM D994, ASTM D1751, or ASTM D1752.

E. Other Embedded Items: Use waterstops, sleeves, inserts, anchors, reglets, dovetail anchor slots, and other embedded items of the material and design indicated in the Contract Documents.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design and engineering of formwork shall be the responsibility of the Contractor.

B. Design formwork, shores, reshores, and backshores to carry all loads transmitted to them and to comply with the requirements of the applicable building code. Design formwork to withstand the pressure resulting from placement and vibration of concrete and to maintain specified tolerances.

C. Do not use earth cuts as forms for vertical or sloping surfaces unless required or permitted by Contract Documents.

D. Maximum deflection of facing materials reflected on concrete surfaces exposed to public view shall be L/240 of the span between structural members of the formwork.

E. Formed Construction: Locate and form construction joints that least impair the strength of the structure. Unless otherwise specified or permitted, locate and detail formed construction joints to the following requirements:

1. Locate construction joints within the middle third of the spans of slabs, beams, and girders. When a beam intersects a girder at this point, offset the joint in the girder a distance equal to or greater than twice the width of the beam.

2. Locate joints in walls and columns at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs.

3. Make joints perpendicular to the main reinforcement.

4. Provide keyways as indicated in the Contract Documents.

2.3 FABRICATION AND MANUFACTURE

A. Formwork shall be tight to prevent loss of mortar from concrete.

B. Place 3/4-inch minimum chamfer strips in the corners of formwork to produce beveled edges on permanently exposed surfaces unless otherwise specified. Do not bevel re-entrant corners or edges of formed joints of concrete unless specified in the Contract Documents.

C. Provide temporary openings at the base of column and wall formwork and at other points where necessary to facilitate cleaning and inspection. Arrange such openings in sides of forms where concrete surfaces will be concealed by other materials or construction. Clean and inspect immediately before concrete is placed.

D. Fabricate form ties so ends or end fasteners can be removed with minimum spalling at the faces of concrete.

E. Locate waterstops in joints where indicated in the Contract Documents. Use pieces of pre-molded waterstop with a maximum practical length to hold the number of end joints to a minimum. Make joints in waterstops in accordance with the manufacturer's recommendations.

PART 3 - EXECUTION

3.1 CONSTRUCTION AND ERECTION OF FORMWORK

A. At construction joints, lap contact surface of the form sheathing for flush surfaces exposed to view over the hardened concrete in the previous placement by 1 inch minimum. Ensure formwork is held firmly against hardened concrete to prevent offsets or loss of mortar at construction joints and to maintain a true surface.

B. Construct formwork so concrete surfaces conform to the tolerance limits of ACI 117.

C. Provide positive means of adjustment (wedges or jacks) for shores and struts. Make adjustments in the formwork prior to concrete placement. Fasten form wedges in place after final adjustment of forms. Brace formwork securely against lateral deflection and lateral instability.

D. Camber formwork to compensate for anticipated formwork deflections. Set formwork and intermediate screed strips for slabs accurately to produce designated elevations and contours of the finished surface. Ensure that edge forms and screed strips are

sufficiently strong to support vibration screeds or roller pipe screeds when the finish specified requires the use of such equipment.

E. When formwork is cambered, set screeds to a like camber to maintain required concrete thickness.

F. Anchor formwork to shores, supporting surfaces, or members to prevent upward or lateral movements of the formwork system during concrete placement.

G. Construct formwork for wall openings to facilitate removal and to counteract swelling of wood formwork.

H. Place sleeves, inserts, anchors, and embedded items required for adjoining work or form support of adjoining work before concrete placement.

I. Position and support expansion joint materials, waterstops, and other embedded items to prevent displacement. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.

J. Clean surfaces of formwork and embedded materials of mortar, grout, and foreign materials before concrete is placed.

K. Cover surfaces of formwork with an acceptable material that will prevent bond with the concrete. A field-applied formwork release agent or a factory-applied liner may be used. If a formwork release agent is used, apply following these guidelines:

1. Apply to the surfaces of the formwork in accordance with the manufacturer's recommendations before placing reinforcing steel.

2. Do not allow formwork release agent to puddle in the forms.

3. Do not allow formwork release agent to make contact with reinforcing steel or hardened concrete against which fresh concrete is to be placed.

3.2 REMOVAL OF FORMWORK

A. When finishing is required, remove forms as soon as removal operations will not damage concrete.

B. Remove top forms on sloping surfaces of concrete as soon as removal will not allow concrete to sag. Perform needed repairs or required treatments at once, and follow immediately with specified curing.

C. Loosen wood formwork for wall openings when this can be accomplished without causing damage to the concrete.

D. Leave formwork and shoring in place to support the weight of concrete in beams, slabs, and in-place structural members until concrete has reached the specified compressive strength. If a lower compressive strength is proposed for removal of formwork and shoring, submit detailed plans for review and acceptance. When shores and other vertical supports are arranged to allow the form-facing material to be removed without loosening or disturbing the shores and supports, the facing material may be removed at an earlier age.

E. Construct formwork to permit easy removal.

3.3 RESHORING AND BACKSHORING

A. While reshoring and backshoring is under way, do not permit any construction load on new construction.

B. During reshoring and backshoring, do not allow concrete in beam, slab, column, or any structural member to be loaded with combined dead and construction loads in excess of the design loads indicated in the Contract Documents at the specified concrete compressive strength.

C. Place reshores and backshores in sequence with stripping operations.

D. Tighten reshores and backshores to carry the required loads without overstressing the concrete members. Leave them in place until required tests indicate the concrete compressive strength has attained the minimum value specified.

E. For floors supporting shores under newly placed concrete, either leave the original supporting shores in place or install reshores and backshores. The shoring system and the supporting slabs shall have capacities sufficient to resist the anticipated loads. Locate reshores and backshores directly under a shore position.

F. Extend reshoring or backshoring over a sufficient number of stories to distribute the weight of newly placed concrete, forms, and construction live loads such that the design loads of the floors supporting the shores, reshores, or backshores are not exceeded.

3.4 STRENGTH OF CONCRETE REQUIRED FOR REMOVAL OF FORMWORK

A. Vertical formwork not supporting the weight of concrete may be removed 24 hours after concrete placement, provided the concrete is hard enough to not be damaged and curing and protection operations are continued.

B. Formwork Supporting Weight of Concrete

1. Leave in place at least 7 days after concrete placement and until concrete design compressive strength is attained, or until sufficient prestressing has been applied to carry dead loads and construction loads.

2. After the concrete has been in place at least 3 days and has reached 75% of required design compressive strength, reshoring will be permitted, provided concrete does not remain unsupported more than 4 hours.

C. When removal of formwork or reshoring is based on concrete reaching a specified compressive strength, concrete will be presumed to have reached this strength when test cylinders, field cured the same as the concrete they represent, have reached the compressive strength specified for removal of formwork and/or reshoring. Mold cylinders in accordance with ASTM C31, and cure them under the same conditions for moisture and temperature as used for the concrete they represent. Test cylinders in accordance with ASTM C39.

D. Alternatively, one of the following methods for evaluating concrete strength for formwork removal may be used, provided sufficient data is submitted, using project

materials, to demonstrate correlation of measurements on the structure with the compressive strength of laboratory-cured molded cylinders or drilled cores. Submit correlation data on the proposed alternative method for determining strength to the Architect/Engineer.

1. Tests of cast-in-place cylinders in accordance with ASTM C873 (limited to slabs with concrete depths from 5 to 12 inches)

2. Penetration resistance in accordance with ASTM C803

3. Pullout strength in accordance with ASTM C900

4. Acceptable maturity-factor procedure in accordance with ASTM C1074

5. Break-off number of concrete in accordance with ASTM C1150

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section covers materials, fabrication, placement, and tolerances of reinforcement and reinforcement accessories.

B. Related Sections:

1. 01 33 00 – Submittal Procedures
2. 01 45 00 – Structural Testing, Inspection, and Quality Assurance
3. 03 10 00 – Concrete Forming and Accessories
4. 03 30 00 – Cast-in-Place Concrete
5. 04 20 00 – Unit Masonry

1.3 REFERENCE STANDARDS

A. The latest versions of the publications listed below form a part of this specification; comply with provisions of these publications except as otherwise shown or specified.

1. ACI 117 Standard Specification for Tolerances for Concrete
2. ACI 301 Standard Specifications for Structural Concrete, including other standards referred to in ACI 301, such as ASTM, AWS, etc.
3. CRSI MSP Manual of Standard Practice

1.4 SUBMITTALS

A. General: Submit the following data and drawings for review and acceptance before fabrication and execution in accordance with Section 01 33 00, "Submittal Procedures."

B. Placing Drawings: Submit placing drawings showing fabrication dimensions and locations for placement of reinforcement and reinforcement supports. Indicate splicing, laps, details of reinforcing, and accessories.

1. Show embedded plates, bolts, etc., for purposes of checking for potential interferences.

2. Indicate locations of construction joints in the concrete construction.

C. Mechanical Splices: Submit the types of mechanical splices proposed for use. Include the latest ICC-ES Reports for threaded or sleeve-type splices to verify compliance with specified requirements.

D. Headed Bars or Terminators: Submit the types of headed bars or terminators proposed for use. Include the latest ICC-ES reports to verify compliance with the specified requirements.

E. Product Data: Include specifications and installation instructions for all proprietary materials and reinforcement accessories.

F. Welding Procedures and Qualifications: Submit description of reinforcement weld locations, welding procedures, and welder qualifications when welding is permitted.

G. Mill Certificates: Submit mill certificates for all reinforcing steel for information and record only.

1.5 QUALITY ASSURANCE

A. Allowable Tolerances: Fabrication and placement tolerances shall be in accordance with ACI 117.

B. Welder Qualifications: Welders shall be qualified in the last six months in accordance with the American Welding Society, AWS D1.4. Welding procedures qualified by others and welders qualified by another employer may be acceptable as permitted by AWS D1.4. If re-qualification is required, the cost of these qualification tests shall be borne by the Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Bundles of reinforcing bars shall be tagged showing quantity, grade, size, and suitable identification to allow checking, sorting, and placing. Identification of steel shall be maintained after bundles are broken.

1. Bundles of flat sheets and rolls of welded wire fabric shall be tagged showing quantity, style designation, width, and length.

B. Reinforcing steel shall be stored off the ground in a manner that will prevent bending and be protected from earth, oil, or any other material that might impair bond to concrete.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Reinforcing Bars: ASTM A615, Grade 60, deformed, unless otherwise indicated on drawings.

B. Reinforcing Bars for Welding and Reinforcing Bars Specified as "Special Ductile Quality": ASTM A706, Grade 60, deformed. ASTM A615, Grade 60 reinforcement may be used in lieu of ASTM 706 if the following conditions apply:

1. The actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 psi.

2. The ratio of the actual ultimate tensile strength to the actual tensile yield strength is not less than 1.25.

C. Column Spirals (where noted): Plain, cold-drawn wire conforming to ASTM A82 or hot-rolled rods for spirals conforming to ASTM A615.

D. Welded Wire Fabric: ASTM A185 or ASTM A497; mesh and wire sizes as noted on Structural drawings. When used in slabs, provide flat sheets, not rolls.

E. Bar Supports: In accordance with CRSI Manual of Standard Practice; types and sizes as required for the conditions of the installation.

1. For exposed to view concrete surfaces where legs of supports are in contact with forms, provide supports with legs that are hot-dipped, galvanized, plastic protected, or stainless steel, in accordance with CRSI Class 1 or Class 2 (Types A or B).

2. Provide precast concrete blocks not less than 4 inches square when supporting reinforcing steel on ground. Precast concrete blocks shall have a compressive strength equal to that of surrounding concrete.

F. Tie Wire: No. 16-gage minimum, annealed black wire.

G. Threaded Splices: See General Notes on Structural Drawings.

H. Headed Bars or Terminators: See General Notes on Structural Drawings.

I. Steel Stud Assemblies or Studrails: ASTM 1044; Size, length, and assembly configuration as noted on the Structural Drawings.

2.2 FABRICATION

A. Reinforcement: Bend reinforcement cold. Fabricate and detail to shapes and dimensions shown on drawings in accordance with CRSI Manual of Standard Practice and with fabricating tolerances in accordance with ACI 117.

B. Welding: Welding or tacking of reinforcing bars is not permitted unless specifically indicated in the Contract Documents. When welding of reinforcement is indicated and required, provide welds in accordance with AWS D1.4.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: When concrete is placed, reinforcement shall be free of materials deleterious to bond. Reinforcement with rust, mill scale, or a combination of both will be considered satisfactory provided the minimum nominal dimensions, nominal weight, and the minimum average height of deformation of a hand-wire-brushed test specimen are not less than the applicable ASTM specification requirements.

B. Reinforcement: Place, support, and fasten reinforcement as indicated in the Contract Documents. Do not exceed the placing tolerances specified in ACI 117 before concrete is placed. When necessary to move reinforcement beyond the specified placing tolerances to avoid interference with other reinforcement or embedded items, submit the resulting arrangement of reinforcement for acceptance.

C. Cover: Allowable concrete cover for reinforcement is indicated in the project drawings. Tolerances on concrete cover shall meet the requirements of ACI 117.

D. Tie Wires: After cutting tie wires, turn wires to the inside of section and bend so that concrete placement will not force ends to exposed concrete surfaces.

E. Welded Wire Fabric: Place, support, and fasten welded wire fabric as indicated in the Contract Documents. Do not exceed the placing tolerances specified in ACI 117 before concrete is placed.

1. Slabs on Grade: Extend welded wire fabric to within 2 inches of the concrete edge. Lap edges and ends of fabric sheets a minimum of one mesh spacing plus 2 inches, not less than 6 inches. Support welded wire fabric during placing of concrete to ensure required position in the slab. Do not place welded wire fabric on grade and subsequently raise into position in concrete.

2. Slabs on Steel Deck: Extend welded wire fabric to within 2 inches of the concrete edge. Lap edges and ends of fabric sheets a minimum of one mesh spacing plus 2 inches, not less than 6 inches. Support welded wire fabric during placing of concrete to ensure required position in the slab. Do not place welded wire fabric on deck and subsequently raise into position in concrete.

F. Splicing: Make splices as indicated in the project drawings. Lapped bars shall be placed in contact and securely tied, or spaced transversely apart to permit the embedment of the entire surface of each bar in concrete. Lapped bars shall not be spaced farther apart than 1/5 the required length of lap, and not to exceed 6 inches.

1. Mechanical Splices: Mechanical splices for reinforcement not shown on the project drawings shall be submitted for review and accepted prior to use. Mechanical splices shall be in accordance with the recommendations of the manufacturer of the mechanical splicing device.

G. Reinforcement shall not be field bent or straightened except when specifically permitted.

H. Reinforcement shall not be cut in the field except when specifically permitted.

3.2 DEFECTIVE WORK

A. General: The following reinforcing steel work will be considered defective and shall be removed and replaced by the Contractor at no additional cost to the Owner:

1. Bars with kinks or bends not shown on drawings.

2. Bars injured due to bending or straightening.

3. Bars heated for bending.

4. Reinforcement not placed in accordance with the drawings and/or specifications.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Features:

1. Cast-in-place structural concrete
2. Concrete mix design
3. Concrete placement procedures
4. Concrete finishing
5. Concrete curing
6. Repair of surface defects

B. Related Sections:

1. 01 33 00 – Submittal Procedures
2. 01 45 00 – Structural Testing, Inspection, and Quality Assurance
3. 03 10 00 – Concrete Forming and Accessories
4. 03 20 00 – Concrete Reinforcing

1.3 REFERENCE STANDARDS

A. The latest versions of the publications listed below form a part of this specification; comply with provisions of these publications except as otherwise shown or specified.

1.	ACI 117	Standard Specification for Tolerances for Concrete
2.	ACI 301	Standard Specifications for Structural Concrete, including other standards referred to in ACI 301, such as ASTM, etc.
3.	ACI 305.1	Standard Specification for Hot Weather Concreting
4.	ACI 306.1	Standard Specification for Cold Weather Concreting
5.	ACI 308.1	Standard Specification for Curing Concrete

6. ASTM C1116-03 Standard Specification for Fiber-Reinforced Concrete

1.4 SUBMITTALS

A. General: Make submittals in accordance with Section 01 33 00, "Submittal Procedures."

B. Concrete Mix Design Proportions: Submit concrete mixture proportions and characteristics. Submit the concrete mix design to the local building officials where required. Do not begin concrete production until concrete mix designs have been reviewed and approved. Mix designs shall include proportions of all ingredients, including admixtures added at time of batching or at job site. Include the following:

1. Specify the locations for each mix design.

2. Specify the method used to determine proposed concrete mix design. Include field test records or trial mix test data used to establish the average compressive strength of the concrete mixture.

3. For aggregates, submit types, pit or quarry locations, producers' names, gradings, specific gravities, certification, and evidence not more than 90 days old demonstrating compliance with this specification. Aggregate weights shall be based upon saturated surface dry conditions. Include concrete mix gradation of fine and coarse aggregates.

4. For admixtures, submit types, brand names, producers, manufacturer's technical data, and certification data.

5. Submit the cement type and certification, fly ash type and certification, water/cementitious materials ratio, and source of water supply.

6. Submit the slump.

7. Submit the air content of freshly mixed concrete.

8. Submit the concrete compressive strength at 7, 28, and 56 days. The 56-day strength is required only when specified in the Concrete Mix Specification Table in the General Notes.

9. Submit the chloride ion content of concrete.

10. For fibrous reinforcing, submit the type, fiber length, dosage rate, and dosage procedures.

C. Curing Methods: Submit written methods, procedures, and products for curing of all concrete.

D. Repair Methods: Submit the proposed methods of repair, along with repair material specification, manufacturer's data on the proposed patching material, and the proposed preparation and application procedure.

E. Construction Joints: Submit information for acceptance of proposed location and treatment of construction joints proposed but not indicated on the Construction Documents.

F. Qualification of Finishers: Submit qualifications of the finishing contractor and the finishers who will perform the Work.

G. Matching Sample Finish: When required by Contract Documents, submit sample finish.

H. Exposed-Aggregate Surface: When an exposed-aggregate surface is specified and a chemical retarder is proposed, submit specification and manufacturer's data for the retarder and the proposed method of use.

I. Records: Retain records of all concrete poured, including exact mix proportions, slumps, test strength, date, time, location of the placement, weather conditions at time of placement, and the source of concrete. Submit copy to Owner's Representative and Building Official.

1.5 QUALITY ASSURANCE

A. The Contractor is responsible for correcting Work that does not conform to the specified requirements, including strength, tolerances, and finishes. The Contractor shall submit the proposed solution for review and approval.

B. Unless otherwise noted, maintain the allowable tolerances in ACI 117.

C. Maintain records verifying materials used are of the specified and accepted types and sizes and are in conformance with the Contract Documents.

D. Special Inspection and Testing: Concrete work is subject to special inspection and testing as specified; notify the Testing Agency at least 48 hours before inspection is required.

E. Single Source Responsibility: Provide materials for concrete work made or produced from a single source of supply; no mixing of brands or types of cement will be allowed; no substitution of aggregate type or size from those approved will be permitted.

F. Concrete Contractor Qualifications: An experienced concrete contractor who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

G. Concrete Producer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C94. Producer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.

H. Pre-Construction Conference: At least 30 days prior to start of concrete work, the Contractor shall hold a meeting to review the finish appearance requirements, reveal locations, joint spacings, concrete design mixes, requirements for submittals, construction procedures, schedules for testing, inspection, and certifications.

1. Notify attendees 10 days prior to the scheduled date of the meeting.

2. Required in attendance:

a. Contractor and Subcontractors
b. Testing Laboratory representative
c. Concrete subcontractor
d. Ready-mix producer
e. Architect
f. Engineer
g. All subcontractors with work to be installed in or affected by concrete work
h. Building official or appointed representative

1.6 DELIVERY, STORAGE, AND HANDLING

A. Cementitious Materials: Store cementitious materials in dry, weather-tight buildings, bins, or silos that will exclude contaminants.

B. Aggregates: Store and handle aggregate in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates to drain freely. Do not use aggregates that contain frozen lumps.

C. Admixtures: Protect stored admixtures against contamination, evaporation, or damage. Protect liquid admixtures from freezing and from temperature changes that will adversely affect their characteristics. Store and handle products in a manner to retain original quality. Do not use products stored beyond the manufacturer's recommended shelf life.

D. Delivery of Materials: Deliver site applied materials, such as joint and curing materials, in original factory packaging and unopened containers and protect from damage and contamination.

E. Place concrete within the time limits specified. Concrete shall possess the specified characteristics in the freshly mixed state at the point of placing.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: Portland cement shall conform to ASTM C150, Type I or Type II.

1. The cement shall be of the same brand and type and from the same plant of manufacture as the cement used in the concrete represented by the submitted field test records or used in the trial mixtures.

2. For architectural concrete, use one brand of cement throughout project, unless otherwise acceptable to the Architect.

3. Type III cement may be used for cold weather construction.

B. Aggregate: Aggregates and aggregate grading requirements shall conform to ASTM C33. Aggregates shall be free from any substance that may be deleteriously reactive with the alkalis in the cement in an amount sufficient to cause excessive expansion of the concrete. Aggregates used in concrete shall be obtained from same sources and have the same size ranges as the aggregates used in the concrete represented by submitted historical data or used in trial mixtures.

C. Fly Ash: Pozzolanic mineral admixture conforming to ASTM C618, Class F. Maximum loss on ignition to be 1%. Use fly ash from one single source for the whole project. When fly ash is used, the maximum amount shall be 30% by weight of the total cementitious materials, unless otherwise noted in the Construction Documents.

D. Admixtures: The use of admixtures shall be the responsibility of the Contractor. When more than one admixture is used in the mix, furnish satisfactory evidence to the Architect that the admixtures to be used are compatible in combination with the cement and aggregates. Provide only one brand of each type of admixture. Admixtures shall be free of calcium chloride and thiocyanate (not more than 0.05% chloride ions). The following types of admixtures are approved:

1. Air-Entrainment Admixture: Master Builders "MB-AE, Micro-Air or MB-VR," W. R. Grace & Co. "Daravair or Darex Series," Sika "Sika Air" or approved equal conforming to ASTM C260.

2. Water-Reducing Admixture (Low Range): Master Builders "Pozzolith Series," W. R. Grace & Co. "WRDA, Mira, or ADVA Series," Sika "Plastocrete 161," or approved equal conforming to ASTM C494, Type A.

3. Water-Reducing Admixture (High Range): Master Builders "Rheobuild 1000 of Glenium Series," W. R. Grace & Co. "Daracem, Mira, or ADVA Series," Sika "Viscocrete 2100," or approved equal conforming to ASTM C494, Type F.

4. Retarding Admixture: Master Builders "Pozzolith Series or Delvo Series," W. R. Grace & Co. "Daratard Series or Recover," Sika "Plastiment ES" or approved equal conforming to ASTM C494, Type B.

5. Accelerating Admixture: Master Builders "Pozzolith NC 534 or Pozzutec 20+," W. R. Grace & Co. "Daraset Series, DCI, PolarSet, or Lubricon NCA", Sika "SikaSet NC", or approved equal conforming to ASTM C494, Type C.

6. Shrinkage Reducing Admixture: Master Builders "Tetraguard AS20," W.R. Grace & Co. "Eclipse Floor 200 (interior – non-air entrainable) or Eclipse 4500 (exterior – air entrainalble)", Sika "Sika Control 40", or approved equal conforming to ASTM C494, Type S.

7. Corrosion Inhibiting Admixture: Master Builders "Rheocrete CNI or Rheocrete 222+," W. R. Grace & Co. "DCI or DCI-S", Sika "Sika CNl", or approved equal conforming to ASTM C494, Type S. Calcium Nitrite based with solids content of 30 +/- 2%. Dosage rate varies between 2 and 4 gallons/cubic yards. Contact manufacturer's representative for corrosion-protection guidance based on chloride exposure level.

E. Water: Water shall be in conformance with ASTM C94.

2.2 RELATED MATERIALS

A. Dissipating Resin Curing Materials: Liquid type membrane-forming curing compound complying with ASTM C309, Type I. Curing compound must be of a type that does not inhibit subsequent moist curing operations. The film shall chemically break down in a 6- to 8-week period and shall not affect adhesion of coverings or membranes. Acceptable products are Dayton Superior "Burke Aqua Resin Cure or Day-Chem Rez Cure (J-11-W)," Euclid Chemical Co. "Kurez DR," or approved equal.

B. Cure and Seal Combination Materials (Exposed Interior Concrete Slabs, including Garage Slabs): Use curing and sealing compounds that conform to ASTM C309 (Types 1 and 1D, Class B) or ASTM C1315. Acceptable products are Master Builders "Acryseal or Kure-N-Seal," Euclid Chemical Co. "Rez-Seal," or approved equal. Cure and seal material for use in parking garages must resist de-icing chemicals.

C. Moisture Retaining Cover: Use waterproof sheet materials that conform to ASTM C171.

D. High Density Insulation Fillers: Extruded polystyrene foam insulation complying with ASTM D6817 as noted in the Construction Documents. Where no type is indicated use ASTM D6817 EPS22.

E. Commercial Bonding Grout and Repair Materials: Use products in accordance with manufacturer's recommendations. Products include, but are not limited to, the following:

1. Portland-cement mortar modified with a latex acrylic, non-re-emulsifiable bonding agent conforming to ASTM C1059 Type II. Acceptable products include Euclid Chemical Co. "Flex-Con," Dayton Superior "Day-Chem Ad Bond (J-40)," or approved equal.

2. Epoxy mortars and epoxy compounds that are moisture-insensitive during application and after curing and that embody an epoxy binder conforming to ASTM C881. The type, grade, and class shall be appropriate for the application as specified in ASTM C881.

3. Shrinkage-compensating or nonshrink Portland cement grout conforming to ASTM C1107. Acceptable products include Master Builders "Masterflow 713 Grout," Dayton Superior "Sure-Grip High Performance Grout," Burke "Non-Ferrous Non-Shrink Grout," or approved equal.

4. Packaged, dry concrete repair materials conforming to ASTM C928. Acceptable products include Master Builders "Emaco T415," Dayton Superior "HD-50," Burke "Fast Patch 928," or approved equal.

2.3 PROPORTIONING AND DESIGN REQUIREMENTS OF CONCRETE MIXES

A. Prepare design mixes for each type and strength of concrete by Field Experience Method or, if not available, by Laboratory Trial Batch Methods as specified in ACI 301. Mix proportions shall produce consistent and workable concrete that can be worked readily into forms and around reinforcement without segregation or excessive bleeding.

1. Field Experience Method: If field test data is available, in accordance with ACI 301, submit for acceptance the mixture proportions along with the field test data.

2. Trial Batch Method: Use an independent, qualified Testing Facility for preparing and reporting proposed mix designs. All expenses connected with such testing and submittals shall be borne by the Contractor.

B. Concrete Mixes: Provide concrete mixes conforming to the requirements as indicated in the Structural Drawing General Notes.

1. Strength Requirements: Compressive strength requirements are indicated on drawings and are based on cylinder tests at indicated age. Concrete made with high-early strength cement shall have a 7-day strength equal to the specified 28-day strength for concrete made with Type III Portland cement.

2. Cement Content for Slabs: Not less than those indicated in ACI 301.

3. Water/Cementitious Material Ratio: Not to exceed limits indicated on the Structural Drawings.

4. Air Entrainment: Use air-entraining admixture in exterior exposed concrete as indicated on the Structural Drawings.

5. Slump: The Contractor shall determine slump. Each concrete mix submitted shall have the slump specified. Slump tolerances shall meet the requirements of ACI 117.

6. Admixtures: Concrete may contain admixtures, such as water reducers, superplasticizers, or set retarding agents to provide special properties to the concrete. When admixtures are specified or required for workability for particular parts of the Work, use the types specified.

7. Chloride Ion: Maximum water soluble chloride ion concentrations in hardened concrete at ages 28 to 42 days contributed from the ingredients, including water, aggregates, cementitious materials and admixtures, shall not exceed a maximum, by weight of cement, of 0.06% for prestressed concrete and 0.30% for other concrete.

C. Adjustment to Concrete Mixes: Mix design adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, at no additional cost to the Owner. New field data, data from new trial mixtures, or evidence that indicates that the change will not adversely affect the relevant properties of the concrete shall be submitted for acceptance before use.

PART 3 - EXECUTION

3.1 PREPARATION

A. Do not place concrete until the Architect approves all required submittals.

B. Remove snow, ice, frost, water, and other foreign materials from form surfaces, reinforcement, and embedded items against which concrete will be placed.

C. Place concrete on properly prepared and unfrozen sub-grade or forms and only in dewatered excavations and forms.

D. Do not allow mud or foreign materials into the concrete during placement operations.

E. When the ambient temperature necessitates the use of cold or hot weather concreting, make provisions in advance of concrete placement.

F. Do not begin placing concrete when the sun, heat, wind, or limitations of facilities furnished by the Contractor prevent proper consolidation, finishing and curing.

G. Do not begin placing concrete while rain, sleet, or snow is falling unless adequate protection is provided. Do not allow rainwater to increase mixing water or to damage the surface of the concrete.

3.2 JOINTS

A. Construction Joints: Locate construction joints as indicated on the structural drawings or as approved by the Architect. Remove laitance and thoroughly clean and dampen construction joints prior to placement of fresh concrete.

B. Bonded Construction Joints: Coat concrete joined with new concrete, including topping, with a concrete bonding compound. Mix and apply in strict accordance with manufacturer's recommendations for the conditions of the application. Concrete surfaces to which other concrete is to be bonded shall be roughened in an approved manner that will expose sound aggregate uniformly without damaging the concrete; remove all laitance and loose particles.

C. Control Joints in Slabs-on-Ground: Construct control joints in slabs-on-ground to form panels of patterns as approved. Use inserts 1/4 inch wide by 1/3 of slab depth. Where saw-cut joints are required or permitted, start cutting as soon as concrete has hardened sufficiently to prevent dislodgment of aggregates. Saw a continuous slot to the depth indicated on the drawings. Complete sawing within the timeframe indicated on the drawings. The aspect ratio of the slab panels should be a maximum of 1.5:1. "L" and "T" shaped panels should be avoided. If an alternative method, timing, or depth is proposed for saw cutting, submit detailed procedure plans for review and acceptance.

3.3 INSTALLATION OF EMBEDDED ITEMS

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

1. Embedded items include, but are not limited to, expansion joints, joint fillers, waterstops, anchor bolts, embedded plates, dovetail anchor slots, etc.

2. Items shall be free of oil, loose scale, rust, etc.

3. Fill voids in sleeves, inserts, and anchor slots temporarily with readily removable material to prevent the entry of concrete into the voids.

4. Do not embed aluminum in concrete, except where the aluminum is protected from direct contact from the concrete.

3.4 INSTALLATION OF HIGH DENSITY INSULATION FILLER

A. Insulation Fillers: Lay high density insulation in areas as indicated on drawings. Use boards of maximum thickness to achieve full insulation depth as indicated. If required, apply adhesive to layers of insulation to prevent movement during concrete

placement. After boards have been installed, protect until concrete topping is prepared and placed.

3.5 CONCRETE DELIVERY

A. Ready-Mix Concrete: Comply with requirements of ASTM C94 and as herein specified.

1. Elapsed time from start of batching at plant to completed discharge at job site shall not exceed 90 minutes or more than 300 revolutions, whichever comes first after introducing mixing water.

2. When air temperature is between 85°F and 90°F, reduce mixing and delivery time from 90 minutes to 75 minutes. When air temperature is above 90°F, reduce mixing and delivery time to 60 minutes.

3. The concrete temperature shall be monitored in the truck. A rise in temperature of 5°F within 10 minutes or less indicates concrete setting has started before discharge and the load shall be rejected.

4. Ready-Mix Concrete: Provide certificate signed by authorized official of supplier with each load of concrete, stating the following:

a. Time truck left plant
b. Mix of concrete
c. Amount of water and cement in mix
d. Amount and type of admixtures
e. Time truck is unloaded at site
f. Additional water amount allowed at the project site

5. A truck without batch tickets will be rejected.

B. Control of Mixing Water: Water may be added once to increase the slump of the concrete within the first 15 minutes after the truck arrives at the job-site, provided the following requirements are adhered to:

1. The specified slump and maximum allowable water/cement ratio is not exceeded.

2. The Independent Testing Agency is present to monitor the amount of water added to compare with the amount of water added at the plant. Testing Agency shall keep written record of the amount of water added at the job-site to each truckload delivered.

3. The drum shall be turned an additional 30 revolutions, or more if necessary, until the added water is uniformly mixed into the concrete.

4. Water shall not be added to the batch after the taking of test cylinders, unless new test cylinders are taken at the expense of the Contractor.

5. Do not add water to concrete after adding high-range water-reducing admixtures to mix.

C. Admixtures: Add admixtures within an accuracy of 3%. Where two or more admixtures are used in the same batch, they shall be added separately and must be compatible. Approved admixtures must be added at the appropriate time in strict compliance with manufacturer's directions. Concrete that shows evidence of total collapse or segregation caused by the use of admixtures shall be removed from the site.

3.6 CONCRETE PLACEMENT

A. Pre-Placement Inspection: Before concrete placement operation begins, perform the following procedures:

1. Inspect and complete formwork installation and all reinforcing, and embed items. Notify other crafts to permit installation of their work.

2. Ensure that the reinforcing will be maintained in the proper position during concrete placement operations.

3. Moisten wood forms immediately before placing concrete where form coatings are not used.

4. At topping slabs, thoroughly saturate base slab just prior to placing topping, but do not leave pools of water.

5. Verify all dimensions and elevations.

B. Conveying: Methods of conveying concrete is the responsibility of the Contractor. Convey concrete from mixer to the place of final deposit rapidly by methods that prevent segregation or loss of ingredients and that will ensure the required quality of concrete. Do not use aluminum pipes or chutes. Use acceptable conveying equipment of a size and design that will prevent cold joints from occurring. Clean conveying equipment before each placement.

1. Provide runways or other means for wheeled equipment to convey concrete to deposit points. Do not run wheeled equipment used to deposit concrete over reinforcement; do not support runways on reinforcement.

2. Belt Conveyors: Use belt conveyors that are horizontal or at a slope that will not cause excessive segregation or loss of ingredients. Protect concrete to minimize drying and effects of temperature rise. Use an acceptable discharge baffle or hopper at the discharge end to prevent segregation. Do not allow mortar to adhere to the return length of the belt.

3. Chutes: Use metal or metal-lined chutes having rounded bottoms and a slope between 1:2 and 1:3 (vertical:horizontal). Chutes more than 20 feet long and those not meeting slope requirements may be used, provided they discharge into a hopper prior to distributing into the forms.

4. Pumping or Pneumatic Conveying: Use pumping conveying equipment that permits placement rates that avoid cold joints and prevent segregation in discharge of pumped concrete. In addition:

a. Pipeline shall be steel pipe or heavy-duty flexible hose.

b. Inside diameter of the pipe shall be at least three times the maximum size of the coarse aggregate.
c. Distance to be pumped shall not exceed the limits recommended by the pump manufacturer.
d. Provide continuous supply of concrete to the pump.
e. When pumping is completed, the concrete remaining in the pipeline shall be ejected without contaminating the concrete in place.

5. Cleaning: Do not discharge rinse water into forms or areas to receive concrete.

C. Depositing: Deposit concrete continuously in one layer, or in multiple layers if the fresh concrete is deposited on in-place concrete that is still plastic. Do not deposit fresh concrete on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joint as specified. Deposit concrete as near to its final location as practicable to avoid segregation. In addition:

1. There shall be no vertical drop greater than 3 feet, except where suitable equipment is provided to prevent segregation and where specifically authorized.

2. Do not use concrete that has surface-dried or partially hardened or that contains foreign material.

3. Place concrete for beams, girders, brackets, column capitals, haunches, and drop panels at the same time as concrete for slabs.

D. Consolidating: Consolidate concrete by vibration. Thoroughly work concrete around reinforcement and embedded items and into corners of forms, eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness.

1. Workers shall be experienced in use of the vibrators.

2. Vibrators shall have a frequency of not less than 8,000 vibrations per minute, and the head diameter and amplitude shall be appropriate for the concrete mix being placed. A spare vibrator shall be kept at the job site during all concrete placing operations.

3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniform spacing over the area of placement; distance between insertions shall be approximately 1-1/2 times the radius of action of the vibrator so that the area being vibrated will overlap the adjacent just vibrated area by a few inches. Do not place vibrators within 2-1/2 inches of form face.

4. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set; if there is a delay of more than 15 minutes, vibrate previous lift prior to placing the new concrete. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix. Withdraw vibrators slowly.

5. Consolidation of slabs shall be obtained with vibrating screeds, rolling pipe screeds, or internal vibrators.

E. Re-tamping of concrete that has taken its initial set is not allowed.

F. Cold Weather Placing: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306.1 and as specified herein.

1. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50°F and not more than 80°F at point of placement.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.

3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators.

G. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305.1 and as specified herein. Loss of slump, flash set, or cold joints due to temperature of concrete as placed are not acceptable.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90°F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing.

2. When temperature of steel reinforcement, embedments, or forms is greater than 120°F, fog steel reinforcement, embedments, and forms with water immediately before placing concrete. Remove standing water before placing concrete.

3. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

4. Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, if approved by the Architect.

3.7 FINISHES FOR FORMED SURFACES

A. General: After removal of forms, give each formed surface one or more of the finishes described below. When Contract Documents do not specify a finish, finish surfaces as required by Unspecified Finishes.

B. When the finish is required by the Contract Documents to match a sample panel furnished by the Contractor, reproduce the sample finish on an area at least 100 square feet in a location designated by the Architect. Obtain acceptance before proceeding with that finish in the specified locations.

C. As-Cast Finishes: Coordinate finishes of all "as-cast" concrete finishes with construction of formwork. Produce as-cast form finishes in accordance with the following requirements:

1. Rough-Form Finish: Patch tie holes and defects. Chip or rub off fins exceeding 1/2 inch in height. Leave surfaces with the texture imparted by the forms.

2. Smooth-Form Finish: Patch tie holes and defects. Remove fins exceeding 1/8 inch in height. Leave surfaces with the texture imparted by the forms.

3. Architectural Finish: Patch tie holes and defects, and remove fins. Produce architectural finishes as specified in the Contract Documents.

D. Rubbed Finishes: Remove forms as early as permitted, and produce one of the following finishes on concrete specified to have a smooth form finish:

1. Smooth-Rubbed Finish: Patch tie holes and defects, and remove fins. Produce finish on newly hardened concrete no later than the day following formwork removal. Wet the surface and rub it with carborundum brick or other abrasive until uniform color and texture are produced. Use no cement grout other than the cement paste drawn from the concrete itself by the rubbing process.

2. Grout-Cleaned Finish: Patch tie holes and defects, and remove fins. Begin cleaning operations after contiguous surfaces to be cleaned are completed and accessible. Do not clean surfaces as work progresses. Wet the surface and apply grout consisting of 1 part Portland cement and 1-1/2 parts fine sand with enough water to produce the consistency of thick paint. Add white cement as needed to match color of surrounding concrete. Scrub grout into voids, and remove excess grout. When grout whitens, rub the surface. Keep the surface damp for 36 hours afterward.

3. Cork-Floated Finish: Patch tie holes and defects, and remove fins. Wet the surface and apply stiff grout of 1 part Portland cement and 1 part fine sand, filling voids. Add white cement as needed to match color of surrounding concrete. Use enough water to produce a stiff consistency. Compress grout into voids by grinding the surface with a slow-speed grinder. Produce the final finish with cork float, using a swirling motion.

E. Sandblast Finish: After removal of forms and while concrete is still "green," apply a light abrasive blast finish to exposed-to-view surfaces to match approved sample. Perform abrasive blasting in a continuous operation, utilizing same work crew to maintain continuity of finish on each surface. Use wet sandblasting operations. Use same type and grading of abrasives as that used on approved sample. Continually wash off abraded mortar from sandblasted areas to prevent staining.

F. Unspecified Finishes: When a specific finish is not specified in Contract Documents for a concrete surface, apply the following finishes:

1. Rough-form finish on concrete surfaces not exposed to public view.

2. Smooth-form finish on concrete surfaces exposed to public view.

G. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent surfaces, unless otherwise indicated.

3.8 FINISHES FOR UNFORMED SURFACES

A. General: Finish slab surfaces in accordance with one of the finishes noted below, as designated in the Contract Documents. Finish all joints and edges with proper tools as approved.

B. Placement: Place concrete at a rate that allows spreading, straightedging, and darbying or bull floating before bleed water appears. Screed all slabs, topping fills to true levels and slopes. Work surfaces as required to produce specified finish. Do no finishing in areas where water has accumulated; drain and re-screed. In no case use a sprinkling of cement and sand to absorb moisture.

C. Tolerances: Measure floor slabs for suspended floors and slabs-on-grade to verify compliance with the tolerance requirements of ASTM E 1155 and ACI 117. Measure floor finish tolerances within 72 hours after slab finishing and before removal of supporting formwork or shoring.

D. Scratch Finish: Place, consolidate, strike off, and level concrete, eliminating high spots and low spots. Roughen the surface with stiff brushes or rakes before the final set. Produce a finish that will meet Moderately flat (Ff flatness = 25) requirements of ACI 117.

E. Float Finish: Place, consolidate, strike off, and level concrete, eliminating high spots and low spots. Do not work concrete further until it is ready for floating. Begin floating with a hand float, a bladed power float equipped with float shoes, or a powered disk float when the bleed water sheen has disappeared and the surface has stiffened sufficiently to permit the operation. Produce a finish that will meet Moderately flat (Ff flatness = 25) requirements of ACI 117, then refloat the slab immediately to a uniform texture.

F. Light Steel Troweled Finish: Float concrete surface, then power trowel the surface. Hand trowel the surface smooth and free of trowel marks. Continue hand troweling until all "shine" has disappeared from surface; no final troweling is required. Tolerance for concrete floors shall be Moderately flat (Ff flatness = 25) in accordance with ACI 117.

G. Full Steel Trowel Finish: Float concrete surface, then power trowel the surface. Hand trowel the surface smooth and free of trowel marks. Continue hand troweling until a ringing sound is produced as the floor is troweled. Finished surface shall be free of trowel marks, uniform in texture and appearance. Tolerance for concrete floors shall be Moderately flat (Ff flatness = 25) in accordance with ACI 117.

H. Broom or Belt Finish: Immediately after concrete has received a floated finish, give the concrete surface a coarse transverse scored texture by drawing a broom or burlap belt across the surface. Degree of texture shall be as approved by the Architect. Tolerance for concrete floors shall be Moderately flat (Ff flatness = 25) in accordance with ACI 117.

I. Raked Finish: Immediately after concrete has received a floated finish, draw closely spaced rake across surface with ribs perpendicular to traffic flow. Notify Architect at time of finishing so that they may be present to approve the final degree of texture required. Tolerance for concrete floors shall be Moderately flat (Ff flatness = 25) tolerance in accordance with ACI 117.

J. Dry-Shake Finish: Blend metallic or mineral aggregate specified in Contract Documents with Portland cement in the proportions recommended by the aggregate manufacturer, or use bagged, premixed material specified in Contract Documents as recommended by the aggregate manufacturer.

1. Float-finish the concrete surface.

2. Apply approximately 2/3 of the blended material required for coverage to the surface by a method that ensures even coverage without segregation. Float-finish the surface after application of the first dry-shake.

3. Apply the remaining dry-shake material at right angles to the first application and in locations necessary to provide the specified minimum thickness. Begin final floating and finishing immediately after application of the dry-shake.

4. After selected material is embedded by the two floatings, complete operation with a broomed, floated, or troweled finish, as specified in the Contract Documents.

K. Exposed-Aggregate Finish: Immediately after surface of the concrete has been leveled to meet the Moderately flat (Ff flatness = 25) tolerance requirements of ACI 117 and the bleed water sheen has disappeared, spread aggregate of the color and size specified in Contract Documents uniformly over the surface to provide complete coverage to a depth of one stone.

1. Tamp the aggregate lightly to embed aggregate in the surface. Float the surface until the embedded stone is fully coated with mortar and the surface has been finished to meet the Moderately flat (Ff flatness = 25) tolerance requirements of ACI 117.

2. After the matrix has hardened sufficiently to prevent dislodgment of the aggregate, apply water carefully and brush the surface with a fine-bristled brush to expose the aggregate without dislodging it.

3. An acceptable chemical retarder sprayed on freshly floated concrete surface may be used to extend the working time for the exposure of aggregate.

L. Non-specified Finish: When the type of finish is not specified in Contract Documents, use one of the following appropriate finishes and accompanying tolerances.

1. Scratched Finish: For surfaces intended to receive bonded cementitious mixtures.

2. Floated Finish: For walks, drives, steps, ramps, and for surfaces intended to receive waterproofing, roofing, insulation, or sand-bed terrazzo.

3. Full Steel Troweled Finish: For floors intended as walking surfaces, floors in manufacturing, storage, and warehousing areas, or for reception of floor coverings.

3.9 CONCRETE CURING AND PROTECTION

A. General: Cure concrete in accordance with the Curing Methods noted below for a minimum of 7 days after placement. Cure high-early strength concrete for a

minimum of 3 days after placement. Alternatively, moisture retention measures may be terminated when any of the following criteria are met:

1. Tests made on at least two cylinders kept adjacent to the structure and cured by the same methods as the structure indicate 70% of f'c, as determined in accordance with ASTM C39, has been attained.

2. The compressive strength of laboratory-cured cylinders, representative of the in-place concrete, exceeds 85% f'c, provided the temperature of the in-place concrete has been maintained at 50°F or higher during curing.

3. Strength of concrete reaches f'c as determined by accepted nondestructive test methods.

B. Additional Curing Periods: When the 7-day compression test cylinders, representative of parts of a structure already placed, indicate that the 28-day strengths may be less than 85 percent of the design strengths, give those parts of the structure additional curing.

C. Protection: Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

1. Protect concrete during the curing period such that the concrete temperature does not fall below requirements of ACI 306.1. The concrete shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and to ensure the necessary strength development for structural safety.

2. Maintain protection in such a manner that the maximum decrease in temperature measured at the surface of the concrete in a 24-hour period shall not exceed the following:

   a. 50°F for sections less than 12 inches in the least dimension.
   b. 40°F for sections from 12 to 36 inches in the least dimension.
   c. 30°F for sections 36 to 72 inches in the least dimension.
   d. 20°F for sections greater than 72 inches in the least dimension.

3. Measure and record concrete temperature using a method acceptable to the Architect/Engineer. When the surface temperature of the concrete is within 20°F of the ambient temperature, protection measures may be removed.

D. Curing Unformed Concrete Surfaces: Apply one of the Curing Methods after completion of placement and finishing of concrete surfaces not in contact with forms.

E. Curing Formed Concrete Surfaces: Keep absorbent wood forms wet until they are removed. After formwork removal, cure concrete by one the Curing Methods.

F. Curing Methods: After placing and finishing, use one or more of the following methods to preserve moisture in concrete. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing, or as soon as marring of the concrete will not occur. When one of the curing procedures is used initially, the curing procedure may be replaced by one of the other procedures when concrete is 1 day old, provided the concrete is not permitted to become surface-dry at any time. Avoid rapid drying at end of final curing period.

1. Ponding, continuous fogging, or continuous sprinkling.

2. Application of mats or fabric kept continuously wet.

3. Continuous application of steam (under 150°F).

4. Application of sheet materials conforming to ASTM C171.

5. Application of a curing compound conforming to ASTM C309 or C1315.

    a. Apply the compound in accordance with manufacturer's recommendation as soon as water sheen has disappeared from the concrete surface and after finishing operations.
    b. For rough surfaces, apply curing compound in two applications at right angles to each other.
    c. Do not use curing compound on any surface where concrete or other material will be bonded unless the curing compound will not prevent bond or unless measures are to be taken to completely remove the curing compound from areas to receive bonded applications.
    d. Curing compound may be used on concrete that is to receive resilient flooring, carpet, sand cushion terrazzo, and wood flooring, unless otherwise required by finish treatment manufacturer. Provide written certification from the finish floor treatment manufacturer as previously specified.
    e. The Contractor shall be responsible for removing any traces of the dissipating curing compound that remains on the substrate prior to applying subsequent floor finish. This shall include, but is not limited to, removing the curing compound using power scrubbers and industrial strength detergents and using fresh water to remove the detergents. Comply with any additional instructions and recommendations of the manufacturer whose products are to be applied directly over concrete slab.

6. Application of other accepted moisture-retaining method.

3.10 CONCRETE SURFACE REPAIRS

A. General: All surface defects shall be reported to the Architect. Remove and replace concrete having defective surfaces if defects cannot be repaired to the satisfaction of the Architect.

B. Repair of Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins, stains, and other discolorations that cannot be removed by cleaning.

1. Repair concealed formed surfaces that contain defects that affect the durability of concrete.

2. Repair tie holes and surface defects immediately after formwork removal. Where the concrete surface will be textured by sandblasting or bush-hammering, repair surface defects before texturing.

C. Repair of Unformed Surfaces: Surface defects include crazing, cracks in excess of 0.01 inch wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

1. Repair finished unformed surfaces that contain defects that affect durability of concrete.

2. Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope.

3. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days. Depth or removal shall not exceed 1/4 inch without scanning the effected area to verify required concrete cover will be maintained over reinforcing, post-tensioning tendons, or other embedment.

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

D. Repair of Tie Holes: Plug tie holes except where stainless steel ties, non-corroding ties, or acceptably coated ties are used. When Portland cement patching mortar is used for plugging, clean and dampen tie holes before applying the mortar. When other materials are used, apply them in accordance with manufacturer's recommendations.

E. Repair of Surface Defects: Outline honeycombed or otherwise defective concrete with a 1/2- to 3/4-inch-deep saw cut and remove such concrete down to sound concrete. When chipping is necessary, leave chipped edges perpendicular to the surface or slightly undercut. Do not feather edges. Dampen the area to be patched, plus 6 inches around the patch area perimeter. Prepare bonding grout and thoroughly brush grout into the surface. When the bond coat begins to lose water sheen, apply patching mortar and thoroughly consolidate mortar into place. Strike off mortar, leaving the patch slightly higher than the surrounding surface to permit initial shrinkage. Leave the patch undisturbed for 1 hour before finishing. Keep the patch damp for 7 days.

F. Removal of Stains: Remove stains, rust, efflorescence, and surface deposits considered objectionable by the Architect by acceptable methods.

G. Site-Mixed Repair Materials:

1. Bonding Grout: Mix approximately 1 part cement and 1 part fine sand with water to the consistency of thick cream.

2. Repair Mortar: Mix repair mortar using the same materials as concrete to be patched with no coarse aggregate. Do not use more than 1 part cement to 2-1/2 parts sand by damp loose volume.

   a. For repairs in exposed concrete, make a trial batch and check color compatibility of repair material with surrounding concrete. Blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match color surrounding.
   b. Use repair mortar at a stiff consistency with no more mixing water than is necessary for handling and placing. Mix repair mortar and manipulate the mortar frequently with a trowel without adding water.

H. Commercial Repair Products: Acceptable commercial repair products other than site-mixed repair materials may be used for repair, as specified in Part 2. Use repair products in accordance with manufacturer's recommendations.

3.11 MISCELLANEOUS CONCRETE ITEMS

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

B. Equipment Bases and Foundations: Form bases for the mounting of equipment shown on drawings. Coordinate sizes and requirements for bases with trade requiring same; make bases a minimum of 4 inches high, unless otherwise noted on drawings, and finish to match adjacent floor finish. Set anchor bolts for machines and equipment to correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.

C. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landings and associated items. Screed, tamp, and finish concrete surfaces with light broom finish.

D. Cast-in-Place Aisle Steps, Walls, and Over-Framing within Seating Bowl: Provide forming and finish to match requirements of precast concrete.

3.12 SPECIAL CONCRETE FINISH REQUIREMENTS

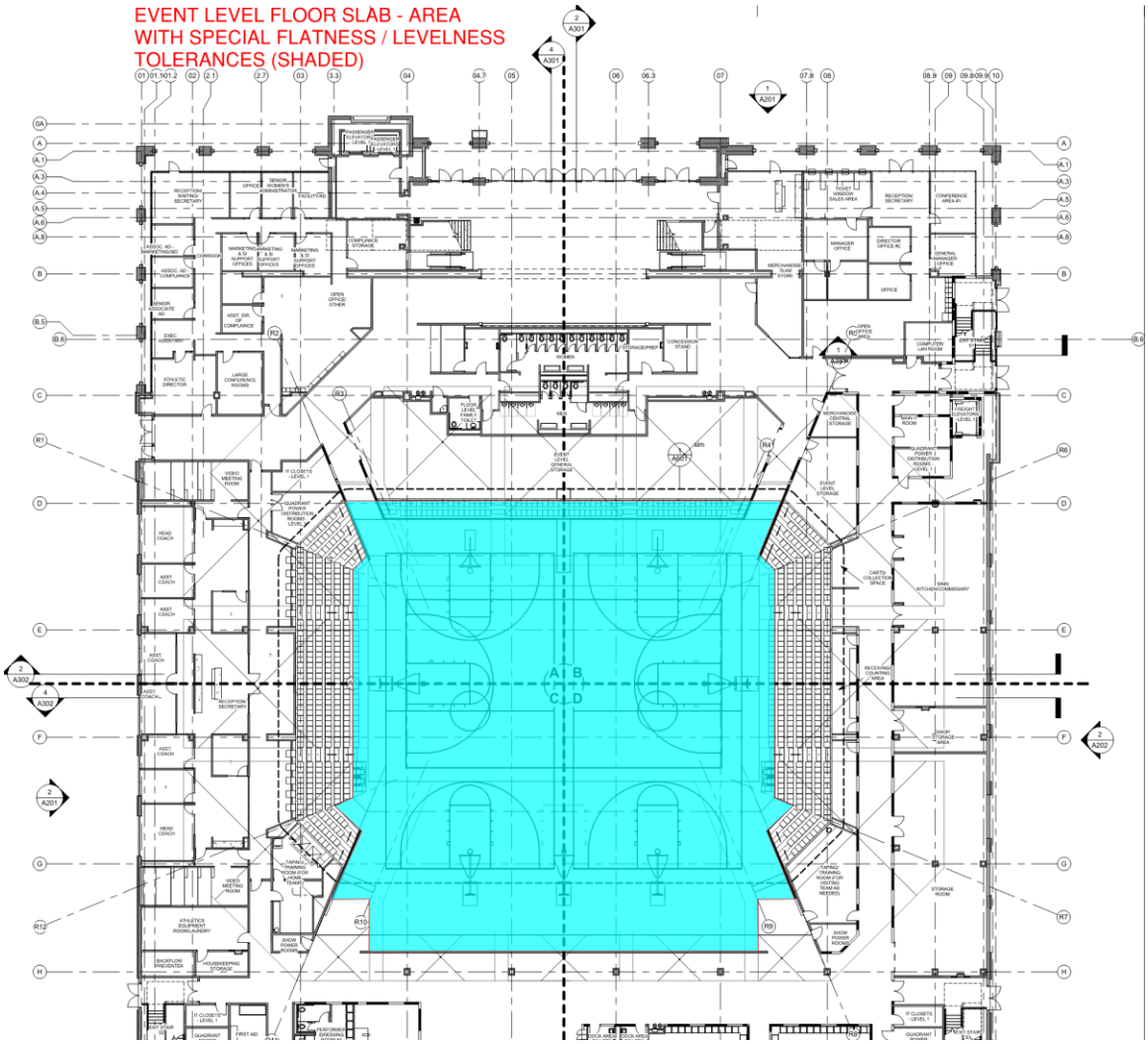
A. Slab on Grade Supporting Telescopic Seating: Provide suitable floor finish to accommodate operating / sliding systems such as telescopic seating and high density sliding filing systems. The minimum requirements for finish and extents shall be directly below said system. Finish requirements shall satisfy tolerances for flatness and levelness to achieve the following:

1. Specified overall value for flatness to achieve a “Super Flat” floor with FF = 60 minimum and FL= 40 minimum.

2. See attached Exhibit A for extent of special finish.

END OF SECTION

EXHIBIT A – Refer to A101



SECTION 03 30 01

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

The provisions of the "Standard Specifications for Public Works Construction" shall apply except as modified herein.

1.2 SCOPE:

Work included: Provide all cast-in-place concrete, complete in place, as indicated on the drawings, specified herein, and needed for a complete and proper installation.

1.3 QUALITY ASSURANCE:

Qualifications of Installers:

Throughout the progress of installation of the work of this Section, provide at least one person who shall be thoroughly familiar with the specified requirements, completely trained and experienced in the necessary skills, and who shall be present at the site and shall direct all work performed under this Section.

Use adequate number of skilled workers to ensure installation in strict accordance with the approved design.

PART 2 - MATERIALS

2.1 GENERAL:

All materials shall conform to Section 201 of Standard Specifications.

A. Portland Cement: Section 201-1.2.1, Type I or II, low alkali. Only one brand of cement shall be used.

B. Aggregates: Conform to Section 201-1.2.2.

C. Water shall be clean and free from deleterious materials.

D. Curing compound: "Clear Seal" as manufactured by A.C. Horn, "Burke Cure Seal" as manufactured by Burke Concrete Accessories, Inc.

E. Form lumber shall be Douglas Fir, construction grade or better.

F. Expansion joint material: Shall be ASTM Standard D1751-61 "Flexcell" as manufactured by Celotex Corporation or approved equivalent.

PART 3 - EXECUTION

3.1 GENERAL:

All materials shall conform to Section 302.6 of Standard Specifications except as modified herein.

3.2 CONCRETE MIX:

A. The Contractor shall supply and pay all costs for concrete mix designs.

B. In no case shall concrete contain less than 5 sacks of cement per cubic yard, and a maximum of 7 gallons of water per sack of cement.

C. Concrete mixes shall be proportioned by the using of 1-inch maximum size aggregate.

D. Concrete shall develop an ultimate compressive strength at 28 days of 2000 P.S.I.

E. The maximum slump for slab on grade shall be 4".

3.3 TESTS AND INSPECTION:

A. The quality and quantity of materials used in the concrete shall be controlled at the batch plant by a Weighmaster.

B. Contractor shall deliver two copies of each load ticket to the University Representative.

3.4 FORMWORK:

Form shall be substantial, unyielding, true to line and grade, and shall conform to the dimensions indicated on the drawings.

3.5 TRANSPORTATION AND PLACING CONCRETE:

Responsibility for proper placing, compacting and finishing rests with the Contractor. Finished work showing voids and separation of aggregates will not be accepted.

3.6 SLAB FINISH:

A. Exterior slabs shall have a medium broom finish unless otherwise noted on the plans. The finish must be true to line and grade.

B. Concrete walks shall have 1/4" thick expansion joints at a maximum spacing of 20 feet, and cold joint at maximum intervals of 10 feet o.c.

C. All exterior flatwork shall drain positively away from buildings, whether indicated or not on the drawings.

1. Any condition which may result in water standing or flowing adjacent to buildings shall be brought to the attention of the Landscape Architect before placing concrete.

2. Maximum allowable tolerance for level slab shall be a variation of l/8" from a 10'0" straight edge.

D. Graffittied concrete surfaces will not be accepted. The contractor shall provide watchmen as required to insure a graffitti-free surface. Patching of concrete surfaces will not be permitted. Whole sections must be removed and replaced.

3.7 CURING CONCRETE:

All concrete surfaces shall be kept continuously wet for a period of not less than 36 hours by ponding, soaking or spraying. Following this 36 hour period, the concrete shall be protected from loss of moisture by an approved liquid curing compound.

3.8 LIQUID HARDENER:

Liquid hardener shall be applied to all floors as soon as practicable per the manufacturer's approved installation instructions. A second coat of liquid hardener shall be applied after the work of the other construction trades is completed and surfaces have been thoroughly cleaned and are completely dry.

END OF SECTION