SECTION 031000 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT; and DIVISION 1 - GENERAL REQUIREMENTS shall govern the work under this section.

1.02 WORK INCLUDED

A. Provide all labor, materials, necessary equipment, services and included but not limited to all related work to complete the Concrete Formwork work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as "NIC ITEMS".

1.03 QUALITY ASSURANCE

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

1. ACI 117 "Tolerances for Concrete Construction and Materials".

2. ACI 301 "Specifications for Structural Concrete for Buildings"

3. ACI 318 "Building Code Requirements for Reinforced Concrete".

4. ACI 347 "Recommended Practice for Concrete Formwork".

5. All local applicable building codes.

B. Qualifications

1. Formwork Contractor: State licensed contracting firms which have (5) years successful experience in fabrication and erection of formwork systems of similar scope and complexity as required for this project will be acceptable. Contractor shall have sufficient capacity to produce formwork without causing delay in work.

1.04 FORMWORK AND RESHORING DESIGN

A. Formwork

1. Erect in compliance with ACI 117 and ACI 347, including provisions for construction loads and placing equipment to be employed on project.

2. Verify strength and stiffness of in-place building elements to resist required loads and restrict deformations to specified tolerances.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

A. Forms for Exposed Finish Concrete: Unless otherwise indicated, construct formwork for exposed concrete surfaces with plywood, metal, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly-placed concrete restricting bow and deflection to specified tolerances.

1. Use plywood complying with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I, Exterior Grade or better, mill- oiled and edge-sealed, with each piece bearing legible inspection trademark.

2. Where concrete is scheduled to have Smooth Rubbed Finish (Sm Rb-Fn), Use plywood complying with U.S. Product Standard PS-1 "B-B (Medium Density Overlaid Concrete Form, Class I, with each piece bearing legible inspection trademark.

B. Forms for Unexposed Finish Concrete: Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other material.

C. Forms for Textured Finish Concrete: Form textured finish concrete surfaces with units of face design, arrangement and configuration as shown on drawings or as required to match Architect's control sample. Provide form supports to ensure stability of textured form liners.

D. Cylindrical Columns and Supports: Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant adhesive with wax-impregnated exterior for weather and moisture protection. Alternatively, prefabricated fiberglass or steel forms may be used. Provide units with sufficient wall thickness to resist loads imposed by wet concrete and restrict deformation to specified tolerances.

E. Form Ties: Ties that leave plastic tube lined holes through members shall not be permitted.

F. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

G. Forming Accessories: CRD-C572 polyvinyl chloride (PVC)

1. Waterstops: Flat dumbbell type at construction joints and center bulb type at building expansion joints.

2. Chamfers: 1/2" radius on outside corners of all exposed-to-view concrete unless drawings show other size or shape.

3. Drips: 3/8"wide x 1/2" high drip groove placed 3/4" back from edge in cast-in-place exterior soffits.

H. Premolded Expansion Joint: ASTM D994, 1/2" thick.

I. Vapor Retarder: Moisture retarder cover over prepared base material where indicated. Use only materials which are resistant to decay when tested in accordance with ANSI/ASTM E154, as follows:

1. Polyethylene sheet not less than 6 mils thick.

PART 3 - EXECUTION

3.01 FORMS

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

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

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

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

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

F. Chamfer exposed to review corners and edges with 1/2" radius PVC accessories to produce uniform smooth lines and tight edge joints, unless other arrangements are required or permitted by Architect.

G. Form Ties

1. Factory-fabricated, adjustable-length, removable or snapoff metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.

2. Unless otherwise indicated, provide ties so portion remaining within concrete after removal is at least 1 1/2" inside concrete.

3. Unless otherwise shown, provide form ties which will not leave holes large than 1" diameter in concrete surface.

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

I. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt or other debris just before concrete is placed.

3.02 JOINTS

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

B. Provide keyways at least 1-1/2" deep in construction joints in walls, slabs and between walls and footings. Accepted bulkheads designed for this purpose may be used for slabs.

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

D. Waterstops: Provide waterstops in construction joints as indicated. Install waterstops to form continuous diaphragm in each joint. Make provisions to support and protect exposed waterstops during progress of work. Fabricate field joints in waterstops in accordance with manufacturer's printed instructions.

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

1. Joint filler and sealant materials are specified in Division-7 sections of these specifications.

F. Contraction (Control) Joints in Slabs-on-Ground: Construct contraction joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4 inch wide x 1/4 of slab depth, unless otherwise indicated.

G. Form contraction joints by inserting premolded hardboard or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface. After concrete has cured,

remove inserts and clean groove of loose debris.

1. Contraction joints may be formed by saw cuts as soon after slab finishing as possible without dislodging aggregate.

3.03 RE-USE OF FORMS

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

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

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT; and DIVISION 1 - GENERAL REQUIREMENTS shall govern the work under this section.

1.02 WORK INCLUDED

A. Provide all labor, materials, necessary equipment, services and included but not limited to all related work to complete the Concrete Reinforcement work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as "NIC ITEMS".

1.03 QUALITY ASSURANCE

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

1. ACI 117 "Tolerances for Concrete Construction and Materials".
2. ACI 301 "Specifications for Structural Concrete for Buildings"
3. ACI 315 "Details and Detailing of Concrete Reinforcement".
4. ACI 318 "Building Code Requirements for Reinforced Concrete".
5. ACI 439-3R "Mechanical Connection of Reinforcing Bars".
6. AWS D1.4 "Structural Welding Code - Reinforcing Steel".
7. CRSI "Manual of Standard Practice".
8. CRSI "Placing Reinforcing Bars".
9. Wire Reinforcement Institute "Manual Standard Practice".
10. All local applicable building codes.

1.04 REINFORCING SUBMITTALS

A. General: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 showing bar schedules, stirrup spacing, diagrams of bent bars, arrangement of concrete reinforcement and accessories. Include special reinforcement required at openings through concrete structures.

B. Selection of splices: All splices are full tension unless noted otherwise.

1. Splices which are noted on the drawings to be compression splices shall be furnished by one of the following:

   a. Compression lap splices in accord with ACI 315.

   b. Mechanical compression only connectors per ACI 439-3R staggered 1/2 Class "C" lap length and maintaining not less than 1/4 the total tensile capacity of any column face.

   c. Full penetration welds staggered not less than 18 diameters.

2. Splices shown on the drawings to be either .5*Fy or Class "B" may be furnished by one of the following:

   a. Class "B" lap splices.

   b. Class "A" (but not less than compression lap) lap splices staggered not less than one Class "B" lap length, except that this shall not be permitted when shown as class "B" in a location which by design has already accounted for other continuing bars or staggered splices.

   c. Appropriate mechanical connectors per ACI 439-3R to develop at least 125 percent of specified yield strength (fy) of the bar.

   d. Full penetration welds to develop at least 125 percent of specified yield strength (fy) of the bar.

3. Unless otherwise noted in the drawings, all reinforcing shall be spliced to develop the full strength of the bar in either tension or compression. Those splices shall be furnished by one of the following:

   a. Class "B" lap splices.

   b. Full penetration welds to develop at least 125 percent of specified yield strength (fy) of the bar.

   c. Appropriate mechanical connectors per ACI 439-3R to develop at least 125 percent of specified yield strength (fy) of the bar.

4. Total steel at lap splices shall not exceed 8% for columns or shear wall cores containing the spliced bars. Therefore, all the bars may be lapped at one section for up to 4% steel, 1/2 the bars may be lapped for up to 5.3% steel, and only 1/3 the bar may be lapped for up to 6.0% steel. Above 6% steel, other splice choices shall be used. Where staggered lap splices are used, provide a mixture of bars sizes as appropriate where vertical bar size changes on the drawings.

5. Where different size bars are lap spliced, the length of splice may be based on the smaller bar size unless there is a larger quantity of the smaller bar size in which case the splice length shall be based on the larger bar.

6. It shall be the responsibility of the reinforcing detailer to determine the concrete strength at the point of a lap splice, the bar position (top or other), bar spacing, confinement condition based on ties or stirrups or edge condition in order to select the proper lap length.

7. Increase laps for bundled bars in accord with ACI 318, with number based on total bars in group including lapped bars.

C. Detailing of splices: Placing shop drawings shall specifically show all splice lap lengths where they occur. Bar diameter lap tables and references to other charts shall not be considered acceptable.

D. Staggered laps required: Provide staggered laps in any member where necessary to keep space between bars within splice zone at least 1" or 1 bar diameter clear.

E. Detailing of bar placement: For any bar other than those placed at an edge condition, between edge condition and/or openings, or any other location where the bar cannot be shifted longitudinally, a dimension shall be shown from an identifiable building grid, wall, or edge to at least one end of the bar.

F. Congested Areas of Placement: For any conditions which result in bar spacing less than 2 diameters clear or where the placement of bars in one member requires critical templating to permit bar placement in an intersecting member, furnish details of sufficient scale to show clearances, spacing, and arrangements for properly placing those bars.

G. Accessories: Show at least all accessories, supports, chairs, bolsters, and spacers necessary to complete the installation. Where supports are beyond the scope of CRSI detailing standards and custom designed supports are required, provide engineering calculations demonstrating the capacity of the system.

H. Flat Plates: Provide not less than 3 separate drawings of each plate separately showing bottom bars, top bars, and accessories.

I. Welding Submittals: If welding of reinforcing bars is to be included as part of the work, submit a complete welding procedure specification in accord with AWS D1.4, a certified chemical analysis of the steel to be welded, carbon equivalence calculations in accord with a AWS D1.4, and qualification papers for all welders who will be employed on the project. Welders shall have passed a qualification test within a 12 month period prior to the work or furnish a statement from a testing agency acceptable to Architect that they have observed and/or tested that welder's work under similar requirements within the past six months.

1.05 SUBSTITUTIONS

A. Reinforcing Splicing: Splices shown in the drawings shall be considered mandatory for base bid purposes. Alternative methods of providing for splices are available within the constraints of this specification and ACI 318. If alternative splices are desired, the shop

drawing submitted shall clearly indicate the change and include authorization by all other subcontractors involved in the change.

PART 2 - PRODUCTS

2.01 REINFORCING MATERIALS

A. Reinforcing Bars: ANSI/ASTM A615, Grade 60, unless otherwise noted.

B. Epoxy-Coated Reinforcing Bars: ANSI/ASTM A775.

C. Form-Saving Splice Connectors: Flanged devices to permit insertion of threaded reinforcing bars into a previously formed face. Available products include, but are not limited to:

1. "Form Saver"; Lenton.

2. "DB-SAE Splices System"; Richmond.

3. "Rebar Flange Coupler"; Williams.

D. Mechanical Connectors and Splice Devices: Proprietary products suitable for the use intended and listed in ACI 439-3R.

E. Steel Wire: ANSI/ASTM A82, plain, cold-drawn, steel.

F. Fabricated Deformed Steel Bar Mats: ANSI/ASTM A184.

G. Welded Steel Wire Fabric: ANSI/ASTM A185.

H. Deformed Steel Wire: ANSI/ASTM A496.

I. Welded Deformed Steel Wire Fabric: ANSI/ASTM A497.

J. Supports for Reinforcement: Provide supports for reinforcement including bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI Class B or Class A as required acceptable.

1. For slabs-on-grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

2. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs which are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

3. Provide custom supports where required to support top layer of mats and other special conditions not provided for within CRSI standards.

PART 3 - EXECUTION

3.01 PLACING REINFORCEMENT

A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete.

C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

D. When any reinforcing bar is placed projecting either horizontally or vertically from a given element to subsequently lap with other reinforcing bar, verify that the detailed lap length will be achieved. Report any deviation to the Engineer for correction prior to placing concrete in the first element. Bar projections which result in laps shorter than the detailed laps shall be considered rejected, and corrective measures shall be taken at the direction of the engineer with no additional cost to the project.

E. Place reinforcement to obtain at least minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

F. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus 2" and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

G. Provide the Engineer with not less than 48 hours notice prior to commencing any welding of reinforcing bars. Welding of reinforcing bars shall only be permitted under the direct supervision of the Engineer. Welding of crossing reinforcing bars shall not be permitted. Any bars which have unauthorized or unacceptable welds shall be replaced at no additional cost to the project.

END OF SECTION 032000

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All applicable provisions of the Bidding Requirements, Contract Forms, and Conditions of the Contract; and Division 01- General Requirements shall govern the work under this section.

1.2 WORK INCLUDED

A. Provide all labor, materials, necessary equipment, services and included but not limited to all related work to complete the Cast-In-Place Concrete work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as "NIC ITEMS".

1.3 QUALITY ASSURANCE

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

1. ACI 117 "Tolerances for Concrete Construction and Materials".

2. ACI 301 "Specifications for Structural Concrete for Buildings"

3. ACI 302.IR "Guide for Concrete Floor and Slab Construction".

4. ACI 318 "Building Code Requirements for Reinforced Concrete".

5. All local applicable building codes.

1.4 CONCRETE SUBMITTALS

A. Concrete Mixes: Submit mix designs to Architect of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been approved. Submittal shall include:

1. Laboratory Test Reports: Submit signed and sealed laboratory test reports for concrete materials as specified, per Chapter 5 of ACI 318.

2. Material Certificates: When permitted by Architect in lieu of laboratory test reports, submit material certificates, signed by supplier and Contractor, certifying that material item complies with or exceeds specified requirements.

3. Certificates of source and gradation analysis of aggregates to be used.

4. All Concrete mix designs shall include a written description indicating where each particular mix is to be placed within the structure.

1.5 SUBSTITUTIONS

A. Any request for product substitution, including brand of admixture or curing compounds, shall be submitted for review 3 weeks before return is required and shall include product data, laboratory test reports ASTM and industry conformance standards.

B. Concrete Mixes: Where form removal operations dictate achieving higher strengths than that specified to reduce cycle time, all cost associated with these special provisions shall be borne by the contractor. Design mixes intended for high early strength shall be so designated in the mix design submittals.

PART 2 - PRODUCTS

2.1 CONCRETE MATERIALS

A. Acceptable Manufacturers: Trade names listed may be incorporated into the work, subject to compliance with requirements. Other manufacturers shall comply with requirements for "Alternates".

B. Portland Cement

1. ANSI/ASTM C150, Type I, unless otherwise acceptable to Architect.

2. ANSI/ASTM C595, Type IP or ANSI/ASTM C150, Type II; at contractor's option except where required for reduced heat of hydration.

C. Lightweight Aggregates: ANSI/ASTM C330, kept in saturated condition in storage prior to batching for minimum of three days or five days if mix is to be pumped.

D. Water

1. Potable Water.

2. Shaved ice when desired to control temperature for hot-weather placement.

E. Air-Entraining Admixture: ASI/ASTM C260.

1. "MB-AE 10-I"; Master Builders

2. "Darex AEA"; W.R. Grace.

3. "Euco Airmix"; Euclid Chemical Co.

F. Concrete Reinforcement:

1. Reinforcing Steel: ASTM A615, Grade 60.

2. Welded Wire Fabric: ASTM A185.

G. Calcium chloride: Admixtures containing calcium chloride as an active ingredient shall not be permitted.

H. Normal Weight Aggregates: ANSI/ASTM C33, and as herein specified.

I. Water-Reducing Admixture: ANSI/ASTM C494, Type A.

1. "Pozzolith LL-819"; Master Builders.
2. "WRDA-79"; W.R. Grace.
3. "LL-979-W"; Master Builders.

J. Accelerating Admixture: ANSI/ASTM C494, Type C, non-chloride.

1. "Pozzolith 555"; Master Builders.
2. "Daraset"; W.C. Grace.

K. Water-Reducing and Retarding Admixture: ASTM C494, Type D.

1. "Pozzolith 100-XR" Master Builders.
2. "WRDA-79"; W.R. Grace.
3. "Eucon Retarded-75"; Euclid Chemical Co.
4. "LL-961R"; Master Builders.
5. "Daratard-17"; W.R. Grace.
6. "Daratard-HC"; W.R. Grace.

L. Water-Reducing and Accelerating Admixture: ASTM C494, Type E, non-chloride.

1. "Pozzolith LL-800"; Master Builders.
2. "Daraccel"; W.R. Grace.
3. "Accelguard 80"; Euclid Chemical Co.

M. High-Range Water-Reducing Admixture (Job Batched): ASTM C494, Type F.

1. "Pozzolith 400-N"; Master Builders
2. "WRDA-19";W.R. Grace.
3. "Eucon 37"; Euclid Chemical CO.

N. High-Range Water Reducing Retarding Admixture (Plant Batched): ASTM C49 Type G.

1. "Pozzolith 886"; Master Builders.
2. "Daracem-100"; W.R. Grace.
3. "Eucon 537"; Euclid Chemical Co.

O. Corrosion Inhibitor (where applicable): PRODUCT TO BE APPLIED AT ALL BALCONIES, AND OTHER CONCRETE SURFACES EXPOSED TO WEATHER.

1. Manufacturer: Provide DCI or DCI-S concrete admixtures by Grace Construction Products meeting specified requirements. Regional sales offices providing technical support include the following:

a. Florida, Pompano Beach, Tel. (305) 974-6700.

2. Materials: Corrosion Inhibitor Admixture: Provide DCI or DCI-S concrete admixtures by Grace Construction Products complying with the following requirements:

a. Calcium Nitrate by Weight of Solution: 30% plus or minus 2 percent

3. Concrete Mix:

a. Application Rate: [2] gallons per cubic yard of concrete, to inhibit active corrosion.

b. Batching Requirements: DCI concrete shall be placed within one hour of batching. DCI-S placement time shall be standard ACI time.

2.2 RELATED MATERIALS:

A. Acceptable Manufacturers: Trade names listed may be incorporated into the work, subject to compliance with requirements. Other manufacturers shall comply with requirements for "Alternates".

B. Liquid Membrane Curing and Sealing Compound: The compound shall be a clear styrene acrylic type, 30% solids content minimum, and have test data from an independent laboratory indicating a maximum moisture loss of 0.030 grams per sq. cm. when applied at a coverage rate of 300 wq. ft. per gallon. Manufacturer's certification required.

1. "Super Rez Seal"; Euclid Chemical Company.

2. "Mastercure"; Master Builders.

3. "Spartan Cote"; The Burke Co.

C. Polymer Modified Patching Mortar: placed in accord with manufacturer's published recommendations.

1. "Masterpatch 90"; Master Builders.

2. "Thoropatch"; Thoro.

3. "Thin Coat"; Euclid Chemical Co.

4. "Acrylic Patch"; The Burke Co.

D. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 9 Oz. per sq. yd., complying with AASHTO M182, Class 2.

E. Moisture-Retaining Cover: Polyethylene-coated burlap, complying with ANSI/ASTM C171.

F. Dissipating Resin Curing Compound: Dissipating resin based liquid type curing compound complying with ANSI/ASTM C309, Type I. The film must break down in a two to four week period after application.

1. "Kurez DR"; Euclid Chemical Co.
2. "Res-x"; The Burke Company.

G. Epoxy Adhesive: 100% solids, two component material suitable for use on dry or damp surfaces and placed in accord with manufacturer's published recommendations.

1. "Sikadur Hi-Mod"; Sika Chemical Co.
2. "Euco Epoxy"; Euclid Chemical Co.
3. "FS-786"; Master Builders.
4. "Burke 881 LPL Epoxy"; The Burke Co.

2.3 PROPORTIONING AND DESIGN OF MIXES

A. General: Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301 and ACI 318.

1. Strength Prediction: Calculate predicted strength at various ages by statistical analysis for strength of identical mix design using same brand of cement and admixtures, same source of aggregates, same slump, same air content, and similar measures of quality control. Any deviation of above requirements in the production tests included in the statistical analysis shall be stated and justified or adjusted for by the mix design engineer. Where quantities of any ingredients vary from normal production mixes, interpolation of strengths is not acceptable. Analysis shall include ACI 318 equations 4-1 and 4-2 rewritten to solve for F'c instead of F'cr.

2. Chloride Prediction: Calculate predicted total water soluble chloride ion content in mix, expressed as percent of weight of cement, considering statistical analysis of water soluble chloride ion content of all material ingredients in the mixes except if valid statistical data is not available, use tests of sample materials with chloride content multiplied by 2.0 for aggregates and cement, 5.0 for water, and 20.0 for admixtures. Where statistical data is used, the same factors shall be applied to chloride contents as for strength design by ACI 318 equations 4-1 and 4-2. Values used for admixtures may be actual tested values where admixture used is from the same batch as that sampled.

3. If trial batch method is used, use an independent testing facility for preparing and reporting proposed mix designs.

B. Compressive Strength

1. Normal wight concrete

a. 3000 psi at 28-days
b. 4000 psi at 28-days

2. Lightweight concrete, typically:

a. 4000 psi at 28-days.

C. Cement

1. Use one brand of cement in any contiguous area.

D. Aggregate

1. ASTM C33, size # 57 for all members unless other sizes are required or permitted.

2. ASTM C33, size #8 (3/8 "nominal).

a. Clear bar spacings less than 3/4" or 1 bar diameter including zone of splices if any in:
(1) Columns.
(2) Walls.
(3) Bottoms of beams, footings, or mats with multiple layers of bottom bars in one direction.

b. Course grout in filled cell masonry construction.

3. Smaller aggregates than required may be used a contractor's option to aid in pumping, placing, or strength design criteria.

4. Use aggregate from single source in any contiguous area.

5. ASTM C33, size #467 (1 1/2" nominal) may be used in foundation elements where clear bar spacing is not less than 2" or 4 bar diameters including zone of splices (if any).

6. Fine aggregates shall conform to ASTM C33.

E. Durability: Maximum limit water soluble chloride ion in percent of weight of cement shall be indicated in Table 4.5.4 ACI 318.

F. Admixtures: Use in strict compliance with manufacturer's published directions.

1. High-slump (Super-plasticized) concrete produced with ASTM C494 type F (note special field inspection and testing required with type F) or type G, shall be used in the following members:

a. Columns and shearwalls with vertical bar clear spacing less than 1" or 1 1/2 bar diameters including within zone of bar splices.
b. Beam, footing, and met bottoms with multiple layers of bar and clear spacings less than 1" or 1 1/2 bar diameters within zone of splices (if

any).

c. Columns and walls where the height of placement in any lift exceeds 12 times the least dimension (thickness).

d. Course grout in filled cell masonry construction where the height of any lift exceeds 3 feet.

2. High slump concrete may be used in any other members at the contractor's opinion except for sloping surfaces exceeding 6% incline.

3. Use accelerating admixture in concrete slabs placed at ambient temperatures below 40 F.

4. Use air-entraining admixture in all concrete with restricted water/cement ratios and all floor slabs, unless otherwise indicated, except do not add air-entraining admixture to concrete with specified strength exceeding 6000 psi. Air content shall not exceed that upon which the statistical or laboratory test data was based. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within following limits:

a. Concrete subjected to hydraulic pressure : 5% to 6% air.
b. Other concrete: 3% to 6% air.

G. Slump Limits: Shall be as indicated on approved mix designs.

H. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, test results, seasonal weather changes, or other circumstances warrant; at no additional cost to Owner and as accepted by Architect. Comply with all mix design and submittal requirements.

2.4 CONCRETE MIXES

A. Ready-Mix Concrete

1. Comply with requirements of ANSI/ASTM C94, and as herein specified.

a. Addition of water to the batch to adjust slump shall be permitted one time only and then mixed for an additional 30 revolutions. Water added at the jobsite shall be noted on the delivery ticket and on a summary log of concrete delivery.

2. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ANSI/ASTM C94 (90 minutes) may be required.

a. When air temperature is between 90 degrees F and 94 degrees F, reduce mixing and delivery time from 1 1/2 hours to 75 minutes, and when air temperature is above 95 degrees F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 INSTALLATION OF EMBEDDED ITEMS

A. 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.

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

3.2 PREPARATION OF FORM SURFACES

A. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

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

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

3.3 CONCRETE

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

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

C. Placing Concrete:

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

2. Do not use vibrators to transport concrete inside forms.

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

D. Hot Weather Placing

1. When hot weather conditions exist that could impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. Wet forms thoroughly before placing concrete

3. Cool reinforcing with mist spray so that bars are not hot-to-touch when enveloped in concrete.

E. Cold Weather Placing:

1. Protect concrete work from physical damage or reduced strength which could be caused by first actions, or low temperatures, in compliance with ACI 306 and as herein specified.

2. When air temperature have 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.

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

3.4 MONOLITHIC SLAB FINISHES

A. Tolerance for finished Slab Surfaces: in accord with ACI 117 section 2.2 with tolerance class as follows:

1. Class BX (5/16" in 10') for finished interior building areas and any other unscheduled concrete flat work.

2. Bulkhead joints and other defects in all slabs shall be patched and ground smooth to accept scheduled architectural finish. Joints which do not form level slab shall be repaired as noted in Section 3.06.

B. Scratch Finish

1. Apply scratch finish to monolithic slab surfaces that are to receive concrete fill or topping or mortar setting beds for tile, portland cement terrazzo, and other bonded applied cementitious finish flooring material, and as otherwise indicated.

2. Slope surface uniformly to drain where required. After leveling, roughen surface before final set, with stiff brushes, brooms or rakes.

C. Trowel Finish

1. Apply trowel finish to monolithic slab surfaces to be covered with resilient flooring, paint or other thin film finish coating system.

2. After floating, begin first trowel finish operation using power-driven trowel Begin final troweling with surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, uniform in texture and appearance. Grind smooth surface defects which would telegraph through applied floor covering system.

D. Float Finish

1. Apply float finish to monolithic slab surface to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic water proofing, membrane, or sand-bed terrazzo, and as indicated.

2. After leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with driven-powered floats or by hand floating if the area is small. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

E. Non-Slip Broom Finish

1. Apply non-slip broom finish to weather- protected concrete platforms, steps and ramps, and elsewhere as indicated.

2. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.5 FINISH OF FORMED SURFACES

A. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finished work or by other construction, unless otherwise indicated. This is the concrete surface having texture imparted by form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4 inch in height rubbed down or chipped off.

B. Smooth Form Finish: For formed concrete surfaces exposed-to-view, or that are to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, damp proofing, painting or other similar system. This is ascast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of seams. Repair and patch defective areas with fins or other projections completely removed and smoothed.

C. Smooth Rubbed finish: Provide smooth rubbed finish (SmRbd-Fn) to scheduled concrete surfaces, which have received smooth form finish (SmFm-Fn) treatment, not later than one day after form removal.

1. Moisten concrete surface and rub with carborundum brick or other abrasive until

a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.

D. Grout Cleaned Finish: Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment.

1. Combine one part portland cement to 1 1/2 parts fine sand by volume and mix with water to consistency of thick paint. Use of proprietary may be used at Contractor's option. Blend standard portland cement and white portland cement, amounts determined by trail patches, so that final color of dry grout will closely match adjacent surface.

2. Thoroughly wet concrete surfaces and apply grout to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Uniformed Surfaces: At tops of walls, horizontal offsets surfaces occurring adjacent to formed surfaces, strike-off smooth and finished with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.6 CONCRETE CURING AND PROTECTION

A. General

1. Protect unformed surfaces of freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Curing Methods: Perform curing of concrete by curing compound, as herein specified.

1. Provide curing compound to slabs as follows:

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

b. Do not use membrane curing compounds on surfaces which are to be covered with coating material applied directly to concrete, roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to Architect.

c. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover or dissipating resin curing compound, unless otherwise directed.

2. Provide moisture curing by following methods:

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

b. Continuous water-fog spray.

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

3. Provide moisture-cover curing as follows:

a. Cover concrete surface with moisture-retaining cover for curing concrete, placed in widest practicable width with slides and ends laped at least 3" and sealed by waterproofing tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproofing tape.

C. Curing Horizontal Formed Surfaces: Only when specified concrete strength is greater than 5000 psi or relative humidity (at maximum daytime temperature) on the day of stripping and for 7 days thereafter is less than 30%, cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

3.7 MISCELLANEOUS CONCRETE ITEMS

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

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

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

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads and landing and associated items. Cast in safety inserts and accessories as shown on drawings. Screed, tamp, and finish concrete placement.

E. Reinforcement Masonry: Provide concrete grout for reinforced masonry lintels and bond beams where indicated on drawings and as scheduled. Maintain accurate location of reinforcing steel during concrete placement.

3.8 CONCRETE SURFACE REPAIRS

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

1. Cut out honeycomb, rock pockets, voids over 1/4" in any dimension, and holes left by tie rods and bolts, down to solid concrete but, in no case to a depth of less than 1". Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

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

B. Replace or Repair of Unformed Surfaces

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

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

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

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 Architect.

5. Repair defective areas, except random cracks and single holes not exceeding 1" diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean square cuts and expose reinforcing steel with at least 3/4" clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding compound. Mix patching concrete of same materials to provide concrete of same type or class or original concrete. Place, compact and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair isolated random cracks and single holes not over 1" in diameter by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part portland cement to 2 1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 72 hours.

7. Use epoxy-based mortar or non-shrink, non-metallic grout as specified in 03600 Grout for Structural Repairs, where directed by Architect or Engineer.

C. Repair of Formed Surfaces

1. Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surfaces; and stains and other discoloration's that cannot be removed by cleaning. Flush out from tie holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

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

3.9 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. Owner will employ a testing laboratory to perform tests and submit test reports.

B. Contractor shall employ testing laboratory to perform any additional tests required to verify strength at ages other than those specified and modulus of elasticity tests to establish form and reshore removal criteria.

C. Provide testing laboratory with access to site as required to perform tests.

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

END OF SECTION 033000

SECTION 033120 - CONCRETE TESTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. All applicable provisions of the BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT; and DIVISION 1 - GENERAL REQUIREMENTS shall govern the work under this section.

1.02 WORK INCLUDED

A. Provide all labor, materials, necessary equipment, services and included but not limited to all related work to complete the Concrete Testing work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as "NIC ITEMS".

B. Including but not necessarily limited to the following:

1. Testing and evaluation of concrete ingredients.

2. Sampling and Testing of Concrete.

1.03 QUALITY ASSURANCE

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

1. ACI 301 "Specifications for Structural Concrete for Buildings"

2. ACI 318 "Building Code Requirements for Reinforced Concrete".

3. All local applicable building codes.

B. Testing Laboratory Qualification

1. Testing laboratory shall comply with all State and Local requirements.

2. Compression testing machines shall comply with ASTM E4.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.01 SAMPLING FRESH CONCRETE

A. Comply with ASTM C172, except modified for slump to comply with ASTM C94.

B. Slump: ASTM C143, at each sample for strength tests. Perform visual slump evaluation of each load and perform test when questionable.

C. Air Content: ASTM C173, volumetric method for lightweight concrete; one for each set of compressive strength test specimens.

D. Concrete Temperature: Test hourly when air temperature is 80°F and above; and each time a set of compression test specimens is made.

E. Compression Test Specimens: ASTM C31;

1. Number of Cylinders Per Set: One set of 5 standard cylinders for each compressive strength test.

2. Frequency of Sampling: one set for each 50 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 5,000 sq. ft. of slab surface area placed. When frequency of testing will provide less than 5 strength tests for a given class of concrete, take samples from at least 5 randomly selected batches or from each batch if fewer than 5 are used.

3. Point of Sampling: Samples may be taken at the discharge of the truck except when concrete is placed by conveyor or pumping, take samples at point of final placement of concrete within the structure at intervals not exceeding every 150 cubic yards placed. Samples taken at point of final placement may be in place of samples at intervals required above, or all samples may be taken at point of final placement, at option of testing agency.

4. Handling: Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

3.02 COMPRESSIVE STRENGTH TESTS

A. Comply with ASTM C39.

B. Time of tests: 1 specimen tested at 3 days, 1 specimen at 7 days, 1 specimen tested at 28 days, 1 at specified age and 1 reserve.

3.03 REPORTS

A. Reports of compressive strength test shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for all tests.

3.04 ACCEPTANCE

A. When strength of field-cured cylinders is less than 85% of companion laboratory cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

B. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

3.05 ADDITIONAL TESTS

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

END OF SECTION 033120