# PART 1 - GENERAL

## 1.1 SUMMARY

A. Section Includes
   1. Design and construction of formwork for concrete.
   2. Setting in forms, all anchor bolts, metal inserts, sleeves, etc., embedded in concrete, including coordination with work specified in other Sections in order to locate embedded items accurately.
   3. Miscellaneous concrete work, including but not limited to areaways, cast-in-place valve boxes, pits, splash blocks, equipment bases, and other items as shown or required to complete all Work.

## 1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Division 3 Section 032000 “Concrete Reinforcement” for furnishing and placing reinforcing for cast-in-place concrete.

B. Division 3 Section 033000 “Cast-In-Place Concrete” for furnishing, placing, finishing, and curing of cast-in-place concrete, Placing of embedded anchor bolts and inserts, and plates, screeds for slabs, and screeds for insulating concrete.

C. Division 5 Section “Metal Floor and Roof Decking” for metal decking.

## 1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings showing form pattern layouts of all exterior and interior concrete dimensioned to precisely locate grooves, form panel jointing, and similar features. Review and approval will not include form strength and adequacy.
   1. Indicate on Shop Drawings location of embedded items coordinated with work specified in other Sections.
   2. Indicate on Shop Drawings locations of smooth formwork for exposed concrete and rough formwork for concealed concrete.

B. Record Document: Keep an accurate record of the dates of removal of forms, form shores and reshores, and furnish copies to the University’s Representative.

C. Shoring and re-shoring Plans and Calculations: Contractor shall submit shoring/re-shoring plans, calculations, and sequence for the structural slabs to the University’s Representative. The submittal shall be used to verify the coordination of the shoring layout with the final structural slab layout (i.e., edge of slabs, concrete beams, depressions, etc.) and to verify the shoring/re-shoring layout and loads are in general conformance with the slab design and specification requirements.

D. General: Comply with Division 1 section “Shop Drawings, Product Data and Samples.”

## 1.4 QUALITY ASSURANCE

A. Construct forms according to ACI 347 "Recommended Practice for Concrete Formwork", and conforming to tolerances specified in ACI 301, "Specifications for Structural Concrete

for Buildings", as applicable, unless exceeded by Applicable Code Requirements or otherwise indicated or specified.

B. Prior to construction of formwork for concrete beams and slabs above grade, Contractor shall conduct a meeting at the site to determine and define all cambers required for the project. The University's Representative, Architect, Structural Engineer of record, Contractor and Contractor's formwork installer shall be in attendance at this meeting.

C. General: Comply with Division 1 Section "Quality Control."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials for forms in timely manner to ensure uninterrupted progress.

B. Store materials by methods that prevent damage and permit ready access for inspection and identification.

C. General: Comply with Division 1 section "Material and Equipment."

PART 2 - PRODUCTS

2.1 MATERIALS

A. Form lumber: WCLIB "Construction" grade or better, WWPA No. 1 or better, or equal.

B. Form plywood: Use HDO for all exposed concrete, whether painted, sacked, or left untreated. Use BBX for all non-exposed surfaces where indicated acceptable or as approved by University's Representative.

C. Tube forms: Burke "Smooth Tube", Sonoco "Seamless Sonotubes", Alton Building Products "Sleek Seamless Standard Wall", or equal, type leaving no marks in concrete, 1-piece lengths for full required heights.

D. Form ties: High strength taper ties or other type bolt through ties, for complete removal.

E. Form coating: Non-staining clear coating free from oil, silicone, wax, not grain-raising, "Formshield" by A.C. Horn, Inc., "Release" by Burke Concrete Accessories, or "Cast-Off" by Sonneborn Building Products, or equal. Where form liners are used, Furnish and install form coatings recommended by form liner manufacturer.

F. Form liner: Rigid or resilient type by L.M. Scofield, Labrado Forms, Symons, Greenstreak, or equal, types shown or directed, matching approved Sample.

PART 3 - EXECUTION

3.1 WORKMANSHIP

A. Rigidly construct forms to prevent mortar leakage, sagging, displacement or bulging between studs. Use clean, sound, approved form material, coated with specified materials only, not oil. Furnish and install backing on all plywood joints.

B Sides of all footings and grade beams shall be formed, unless permission is obtained to place concrete directly against earth. Remove formwork prior to backfilling operations. Where permission is granted to cast concrete against earth, the footing or grade beam dimensions shall be increased 3” on each side of foundation.

3.2 FORM ERECTION AND REMOVAL

A. Conform to ACI 301 and ACI 347 except as exceeded by the requirements of Code, regulatory agencies, or herein.

B. Construction: For architectural concrete forms coat forms with the coating CS390, as manufactured by Master Builders, Inc., or equal. For non-Architectural concrete forms, use Rheofinish 211 water-based form release agent, as manufactured by Master Builders, Inc., or equal. All substitutions must be environmentally safe, and will be subject to the approval of the University’s Representative. Construct forms to exact shapes, sizes, lines, and dimensions required to obtain level, plumb, and straight surfaces. Provide openings, offsets, keys, reglets, anchorages, recesses, moldings, chamfers, blocking, screeds, drips, bulkheads, and all other required features. Make forms easily removable without hammering or prying against concrete. Space forms apart with metal spreaders. Construct forms to accurate alignment, location and grades, and provide against sagging, leakage of concrete mortar, or displacement occurring during and after placing of concrete. Coordinate installation of inserts and anchors in forms according to Shop Drawings and requirements for work of other sections.

C. Camber: Place suitable jacks, wedges, or similar means to induce camber and to correct settlement in forms before and during concrete placing. Camber shall be as determined in pre-installation meeting specified above. In general, formwork shall be capable of accommodating camber of 1/4" per 10' of span plus 1/2".

D. Corners and Angles: Furnish and install 1/2" by 1/2" beveled chamfer strips for all exposed concrete corners and angles unless otherwise indicated. Form concealed concrete corners and angles square unless otherwise indicated.

E. Reglets and Rebates and Embedded Items: Form required reglets and rebates to receive frames, flashing, and other equipment. Obtain required dimensions, details, and precise positions for work and embedded items specified in other sections, coordinate locations within formwork, and form concrete accordingly.

F. Form Joints: Fill joints to produce smooth surfaces, intersections, and arrises. Use polymer foam or equivalent fillers at joints and where forms abut or overlap existing concrete to prevent leakage of mortar.

G. Recesses, Drips, and Profiles: Furnish and install smooth milled wood or preformed rubber or plastic shapes of types shown and required.

H. Cleanouts and Cleaning: Provide temporary openings in all wall forms and other vertical forms for cleaning and inspection. Clean forms and surfaces to receive concrete prior to placing.

I. Re-Use: Clean and recondition form material before re-use.

J. Form Removal: Do not remove concrete forms until concrete attains sufficient strength to support its own weight and all superimposed loads as determine by testing field cured concrete cylinders, but not sooner than specified in ACI 347, paragraph 3.6.2.3. Load supporting forms may be removed when concrete has attained 75 percent of required 28-day compressive strength, but no sooner than 7 days provided construction is reshored. Shoring at cantilever slabs shall remain in place for a minimum of 14 days and until the concrete has obtained its compressive strength.
   1. Reshore structural members as specified below because of design requirements or construction conditions to permit successive construction.
   2. Remove formwork progressively so unbalanced loads are not imposed on the structure.
   3. Avoid damage concrete surfaces during form removal.
   4. Store reusable forms for exposed architectural concrete to prevent damage to contact surfaces.
   5. Remove formwork in same sequence as concrete placement to achieve similar concrete surface coloration.

K. Reshoring:
   1. Minimum reshoring shall consist of not less than half the full required shoring added under last placed floor over which full shoring is to be placed for the next floor above. Leave reshoring in place for at least 7 days after the floor above is placed, but in no case remove reshoring until next concrete placing has attained a compressive strength equal to 75% of that required for the 28 day age as determined by control test cylinders specified hereinafter.
   2. Record: Maintain a form and shoring removal record.
   3. Contractor shall submit shoring/reshoring plans, calculations, and sequence to the University's Representative for review and approval. The submittal shall be used to verify the coordination of the shoring layout with the final structural slab layout (i.e., edge of slabs, concrete beams, depressions, etc.) and to verify the shoring/re-shoring layout and loads are in general conformance with the slab design and specification requirements.

L. Shoring for Tributary Loads: Set temporary shoring for structural steel beams supporting cast-in-place concrete slabs. Such shoring is not required where beams are partially or totally encased with concrete or for steel beams supporting concrete or masonry walls resting on the beams.

## 3.3 FORMWORK TOLERANCES

A. Deflection: Limit deflection of forming surfaces from concrete pressure to a minimum of L/240.

B. Finish Lines: Position formwork to maintain hardened concrete finish lines within following permissible deviations.
   1. Variation from Plumb:

| | |
|---|---|
| In 10'-0" | 1/4 inch |
| In any story or 20'-0" | 3/8 inch |
| In 40'-0" or more | 3/4 inch |

   2. Variation from Level or Grades Indicated

| | | |
|---|---|---|
| | In 10'-0" | 1/4 inch |
| | In any bay or 20'-0" maximum | 3/8 inch |
| | In 40'-0" or more | 3/4 inch |
| 3. | Cross-Sectional Dimensions | |
| | Minus | 1/4 inch |
| | Plus | 1/2 inch |

C. Building Lines: Variation of linear building lines from established position in plan and related position of columns, walls and partitions:
   1. In any bay or 10'-0" maximum 1/2 inch
   2. In 40'-0" or more 1 inch

D. Slab Openings: Variations in size and location of sleeves and slab openings shall not exceed 1/4 inch.

3.4 SURVEY AND ADJUSTMENT

A. Check forms before and during placement of concrete, using an instrument, and make corrections as work proceeds.

3.5 EMBEDDED PIPING AND ROUGH HARDWARE

A. Where work of other sections require openings for passage of pipes, conduits, ducts, and other inserts in the concrete, obtain all dimensions and other information. All necessary pipe sleeves, anchors, or other required inserts shall be accurately installed as part of the work of other sections, according to following requirements.

B. Pipes: Pipes other than PVC conduits are not permitted in structural concrete except where specifically approved by the University's Representative.

C. Sleeves: Pipe sleeves may pass through slabs or walls if not exposed to rusting or other deterioration and are of uncoated or galvanized iron or steel. Furnish and install sleeves of diameter large enough to pass any hub or coupling on pipe, including any insulation. Submit all sleeve locations to the University's Representative for review prior to installation.

D. Conduits: Conduits larger than 1-1/2-inch diameter shall not be embedded in structural concrete except where specifically approved by the University's Representative. Space embedded conduits at a minimum of 6 diameters on centers. Conduits shall be placed in the middle third of the slab thickness and a minimum of four feet from the face of the column. Conduits shall not displace or interrupt reinforcing bars or impair the strength of the structure.
   1. Clusters of Conduits:
      a. Clusters of conduits embedded in a concrete slab shall not exceed 6 conduits per cluster and each conduit per cluster shall be individually spaced as per the above requirements. Conduit clusters exceeding this requirement shall be reviewed and approved by the University's Representative prior to the installation of the conduits.
      b. If more than one conduit cluster is required in a specific area of the slab, routing and spacing of the clusters shall be reviewed and approved by the University's Representative prior to the installation of the conduits.

3.6 FIELD QUALITY CONTROL

A. Inspection: Obtain inspection and approval of forms before placing structural concrete.

3.7 WASTE MANAGEMENT

A. Collect recyclable cutoffs or scrap, if any, and place in designated area for recycling, in accordance with the Waste Management Plan.

END OF SECTION