DIVISION 3 - CONCRETE

03100 - CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SUMMARY

A. The work under this Section includes all materials, labor, accessories equipment and related services necessary for furnishing and erecting forms for cast-in-place structural frame concrete work as shown on Drawings and Specified herein.

B. Related Work Specified in Other Sections:
   1. Concrete Reinforcement: Section 03200.
   2. Cast-in-Place Concrete: Section 03310.

1.02 APPLICABLE SPECIFICATIONS AND CODES

A. American Concrete Institute (ACI):
   1. ACI 318 "Building Code Requirements for Reinforced Concrete".
   2. ACI 301 "Specifications for Structural Concrete for Buildings".
   3. ACI 347 "Recommended Practice for Concrete Formwork".
   4. ACI 117 “Standard Tolerances”.

B. ASTM D 5295 “Standard guide for Preparation of Concrete Surfaces for Adhered (Bonded) Membrane Waterproofing Systems”.

1.03 SUBMITTALS

A. Comply with all submittal requirements of Section 01352 - LEED Requirements as applicable to work of this Section.

B. Formwork Placement Drawings: Submit, for Architect’s information only, and for other Governmental Agencies as requested, schematic formwork placement drawings showing preshoring, shoring and reshoring with sequential outline describing stripping times and reshoring placement. Include descriptive literature for formwork materials. Any formwork used must not invalidate warranty of the waterproofing systems specified for this project. Submit reshoring procedure for Architect's review.

C. Manufacturers' Data: Submit manufacturers' data and installation instructions for materials used including form coating, ties, accessories and manufactured form systems if used. Furnish data stating that form release agent will not stain the concrete surfaces and will not adversely affect the bond of subsequently applied finishes and is compatible with the waterproofing system materials.

D. Samples: Submit samples of form ties and spreaders.

PART 2 - PRODUCTS
2.01 FORM MATERIALS

A. Formwork:

1. For unexposed surfaces and rough work, use Exterior Type Douglas Fir, Grade B-B, (concrete form) Plywood, conforming to NBS PS-1, minimum ¾ in. thick, or undressed lumber, No. 2 common or better. Before reusing forms, withdraw nails and thoroughly clean surfaces to be in contact with concrete.

2. For exposed surfaces not otherwise specified use Special exterior Type Douglas Fir, Grade A-B plywood, conforming to NBS PS-1, minimum ¾ in. thick and constructed so that finished concrete will be straight, smooth, dense, free from honeycombs, bulges, or depressions. Keep joints between plywood sections to a minimum and make tight and strongly backed so that adjoining edges remain flush and true. Unsightly joint marks will not be permitted. Cover joints on exposed surfaces with smooth-faced vinyl tape.

3. For Cylindrical Columns and Supports use metal, fiberglass-reinforced plastic, or paper or fiber tubes. Provide paper or fiber tubes of laminated piles with water-resistant adhesive and wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist wet concrete loads without deformation.

B. Form ties shall be factory-fabricated, adjustable-length, removable or snap-off metal form ties, designed to prevent form deflection and spalling concrete surfaces upon removal. Portion of form-ties remaining within concrete after removal of exterior parts shall be at least 1-1/2" from the outer surface of concrete. Form ties used will leave a maximum hole of 1" diameter in concrete surface.

C. Form coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect the concrete surfaces and impair subsequent treatment of concrete surfaces requiring bond or adhesion, impede the wetting of surfaces to be cured with water or curing compounds. Apply in compliance with manufacturers' instructions.

PART 3 - EXECUTION

3.01 DESIGN OF FORMWORK

A. Design formwork, shoring and bracing to sustain construction and wind loads and maintain concrete lines and levels within tolerances specified. Formwork types are labeled according to concrete surface finishes. The Drawings and Section 03300, “Cast-in-Place Concrete”, indicate where the various finishes are required. Design forms to permit easy removal. Make the forms completely rigid and strong enough to withstand without leakage the high hydraulic pressures, which result from rapid filling and heavy high-frequency vibration. Deflection of each formwork component shall be limited to 1/360 of the component span due to hydraulic pressure of concrete. Formwork drawings shall bear the seal of a professional engineer registered in the State of New Jersey.

B. Carry vertical and lateral loads to ground by formwork system and in-place construction that has attained adequate strength for that purpose.

C. Construct formwork so that concrete members and structures are of correct size, shape, alignment, elevation and position.

D. Design forms and false work to include assumed values of live load, dead load, weight of moving equipment operated on formwork, concrete mix, height of concrete drop, vibrator frequency,
ambient temperature, foundation pressures, stresses, lateral stability, and other factors pertinent to safety of structure during construction.

E. Provide shore and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof.

F. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

G. Support form facing materials by structural members spaced sufficiently close to prevent objectionable deflection.

H. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities, and within allowable tolerances.

I. Provide camber in formwork as required for anticipated deflections due to weight and pressures of fresh concrete and construction loads. In addition, provide camber as indicated on the Structural Drawings.

J. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.

3.02 EARTH FORMS

A. Side forms of footings may be omitted and concrete placed directly against excavation only when requested by the Contractor and accepted by the Architect. When omission of forms is accepted, provide additional concrete 1" on each side of the minimum design profiles and dimensions shown.

B. Examine the substrate and conditions under which work of this Section is to be performed, and correct unsatisfactory conditions which would prevent proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

3.03 FORMWORK TOLERANCES, STRUCTURAL CONCRETE

A. Survey and Adjustment: Measure forms before and during concreting, make appropriate corrections.

B. Camber: Position forms to maintain hardened concrete within specified tolerances measured from camber lines. Maintain plus or minus 1/8 in. until reshoring is removed.

C. Finish Lines: Maintain hardened concrete finish lines within the following permissible deviations prior to removal of formwork and shores.

D. Variation from Plumb:
   1. In 10 ft.: 1/4 in.
   2. In Any Story or 20 ft.: 3/8 in.
   3. In 40 ft. or More: 3/4 in.

E. Variation from Level or Grades Indicated:
   1. In 10 ft. 1/4 in.
2. In Any Bay or 20 ft.: 3/8 in.
3. In 40 ft. or More: 3/4 in.

F. Cross-Sectional Dimensions: 1/4 in., + ½ in.

G. Building Lines: Variation of the linear building lines from established position in plan and related position of columns, and walls.
1. In Any Bay or 20 ft. Maximum: ½ in.
2. In 40 ft. or More: 3/4 in. maximum.

H. Slab Openings: Variations in the sizes and locations of sleeves and slab openings shall not exceed 1/4 in.

3.04 FORM CONSTRUCTION

A. Construct forms complying with ACI 347, to the exact sizes, shapes, lines, and dimensions shown, and as required to obtain accurate alignment, location, grades, level, and plumb work in finished structures.

B. Provide for openings, offsets, sinkages, keyways, recesses, moldings, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features required. Use selected material to obtain required finishes.

C. Forms for openings, and construction which accommodates installation by other trades whose materials and products must be fabricated before the opportunity exists to verify the measurements of adjacent construction which affects such installations, shall be accurately sized and located as dimensioned on the Drawings. In the event that deviation from the Drawing dimensions results in problems in the field, the Contractor shall be responsible for resolution of the conditions as approved by the Architect, without additional expense to the Owner.

3.05 FORM FABRICATION

A. 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 the 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 assure ease of removal.

B. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Brace temporary closures and set tightly to temporary openings on forms in as inconspicuous locations as possible, consistent with design requirements. Form intersecting planes to provide true, clean cut corners.

3.06 FALSE WORK

A. Erect false work and support, brace and maintain it to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place construction. Construct false work so that adjustments can be made for take-up and settlement.
B. Provide wedges, jacks, or camber strips to facilitate vertical adjustments. Carefully inspect false work and formwork during and after concrete placement operations to determine abnormal deflection or signs of failure; make necessary adjustments to produce Work of required dimensions.

3.07 INSPECTION

A. Examine the areas and conditions where concrete formwork is to be installed and notify the Architect of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected by the Contractor in a manner acceptable to the Architect.

3.08 FORM COATINGS

A. Coat form contact surfaces with form-coating compound before reinforcement is placed. Do not allow excess form coating material to accumulate in the forms or to come into contact with surfaces which will be bonded to fresh concrete. Apply in compliance with manufacturer's instructions. All coatings must be compatible with the waterproofing systems.

3.09 INSTALLATION OF EMBEDDED ITEMS

A. General: Set and build into the 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 the items to be attached thereto.

B. Edge Forms and Screeds Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in the finished slab surface.

3.10 SHORES AND SUPPORTS

A. Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified. Submit a shore removal and reshoring schedule and drawings, all signed and sealed by a professional engineer licensed in the State of New Jersey, for the Architect's review before proceeding with this work. Do not proceed until schedule and drawings have been reviewed.

3.11 REMOVAL OF FORMS

A. Forms shall be removed in accordance with requirements of the ACI 318 Code unless otherwise herein modified without damage to concrete and in a manner to insure complete safety of the structure. Leave shoring in place until concrete member will safely support its own weight plus any live loads that may be placed upon it.

B. Correct all damages due to removal of the forms.

C. Whenever formwork is removed during the curing period, the exposed concrete shall be cured by one of the methods specified under "Curing" in Section 03310.

D. All wood formwork, including that used in void spaces, pockets and other similar places shall be removed.

E. Form tie holes shall be filled as per approved samples submitted to the Architect.

F. Where supports for the first tier of formwork rest upon compressible material, particular care must be exercised to prevent settlement of these supports by utilizing plankings or other spreading
devices. In no event shall frozen ground or soft ground be utilized directly as the supporting medium. Shores shall be carefully watched by experienced workmen during concreting operations in order to adjust for settlement or distortion should it occur.

\[ \text{Column forms, beam side forms and wall forms shall not be stripped until the concrete affected has been in place for the following minimum periods of time which shall be applicable only providing bottom forms, shores, etc., remain undisturbed during this phase:} \]

1. Twenty-four hours after concrete is poured when the average air temperature is
   a. \( 50^\circ \text{F.} \) or higher for walls and columns.
   b. \( 60^\circ \text{F.} \) or higher for other members.

2. Forty-eight hours after concrete is poured when the average air temperature is below the above numbers.

\[ \text{Forms for slab panels, slab bands, and other bottom surfaces of non post-tensioned reinforced concrete shall not be stripped until the concrete affected has been in place for the following minimum periods of time: For concrete made with Type I cement:} \]

1. Forty-eight hours when the average air temperature is \( 65^\circ \text{F.} \) or higher.

2. Sixty-six hours when the average air temperature is below \( 65^\circ \text{F.} \).

\[ \text{Forms for slabs and other bottom surfaces of concrete shall not be removed, reshored or in any way displaced until the concrete affected has been in place for the following minimum periods of time: Whenever form slab panels are to be removed between 24 and 72 hours, after casting of concrete, provide additional field cured test cylinders for each day's concreting to be used as a check of the concrete strength. The number of cylinders required will be determined by the Architect. A minimum of 2 cylinders is required for one compressive strength test. Provide an independent testing laboratory test the cylinders at no additional cost to the Owne.} \]

\[ \text{Forms and shores shall be left in place for longer periods than the above-listed minimums when required, due to weather conditions, due to lack of adequate artificial heat and protection, due to construction loads and/or the condition of the concrete and whenever it is directed by the Architect.} \]

\[ \text{The average temperature, for the period from the time of pouring to the time of stripping, shall be defined as the average of the local weather bureau maximum temperature during the day and minimum temperature for the night or the morning immediately following, whichever is lower. The average for more than one day shall be the average of the daily values as computed above. If artificial heat and protection is provided for the concrete, the average temperature of the air directly above the concrete in question at a point midway between representatives heaters shall be used as the average temperature for determining proper stripping time.} \]

\[ \text{Consider the time interval for stripping forms from the start of the concrete pour to the start of stripping providing:} \]

1. Stripping is started at the first section poured and continues in the same sequence as concrete was placed.
2. The rate of stripping is such that no member is stripped more than six hours earlier than it would have been if stripping were timed from the start of placing concrete for that member.

M. Upon removal of forms, the Architect and Inspecting Agency shall be notified by the Contractor in order that an inspection of the newly stripped surfaces may be made prior to patching.

N. Freshly stripped surfaces shall not be pointed up or touched in any manner before having reviewed by the Architect and Inspecting Agency.

O. Shores and Posts:

1. Proper shoring shall be provided under the forms for concrete work to support all construction loads and reshoring shall be provided for all floors and roof slabs before stripping. Supports for forms shall consist of wood or steel posts of a size and spacing as required to support the weight of the forms, concrete and construction live load.

2. Shores shall be designed by a professional engineer licensed in the State of New Jersey.

P. Reshores:

1. Install reshores for slabs and bottom surfaces of concrete for at least three floors immediately below the one being placed.

2. Use a maximum spacing of reshoring in each direction of eight feet.

3. Locate reshores under the center of beams and slab bands and under slabs along a line midway between supports and at all other required points.

4. Reshores shall not be removed until the concrete has attained its specified 28 day strength. Where construction loads occur reshoring shall remain in place throughout the work as required to prevent overstressing as per ACI 318, latest edition.

5. Proper attention shall be given to the removal of reshores so that excessive loads are not transmitted to the various parts of the structure.

END OF SECTION