

03 10 00– CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division - 01 Specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

- A. The work of this section includes all labor, materials and equipment required to form all cast-in-place concrete shown on the drawings including but not limited to all slabs, joists, beams, columns, walls, stairs, and equipment pads.

1.3 CODES AND STANDARDS

- A. Comply with the provision of the current version of the 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. ACI 117 "Specifications for Tolerances for Concrete Construction and Materials".
 - 4. Concrete Reinforcing Steel Institute " Manual of Standard Practice"

1.4 RESPONSIBILITY

- A. The design, construction and safety of all formwork shall be the responsibility of the General Contractor. All forms, shores, backshores, falsework, bracing, and other temporary supports shall be engineered to support all loads imposed including the wet weight of concrete, construction equipment, live loads, lateral loads due to wind and wet concrete imbalance. The Contractor shall also be responsible for determining when temporary supports, shores, backshores, and other bracing may be safely removed.

1.5 ENVIRONMENTAL OBJECTIVES

- A. The Owner has established environmental goals and strategies for achieving them for this project based upon the LEED[®] Green Building Rating System for New Construction & Major Renovations Version 2009, as developed by the U.S. Green Building Council. Refer to Division 01 Section "Sustainable Design Requirements."
- B. Manufacturer to supply documentation of level of compliance or non-compliance with the following requirements before consideration as an "acceptable manufacturer:"
 - 1. The following are mandatory requirements for the overall project:
 - a. The material(s) in the product(s) supplied should have a recycled content such that the sum of the post-consumer recycled content plus one-half of

- the pre-consumer content constitutes at least «percentage of required recycled material»% of the total value of the material in the project.
- b. percentage of close proximity material»% of the product(s) supplied is extracted, processed, and manufactured regionally within a radius of 500 miles of this Project.
 - c. Paints and coatings must meet or exceed the VOC and chemical component limits of Green Seal requirements.
 - d. The VOC content of adhesives and sealants must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1113, Architectural Coatings, rules in effect on July 13, 2007.
- C. Products that conform to requirements of the Environmental Objectives yet do not fully meet other requirements of this Section may still be considered for use at the sole discretion of the Owner and Architect.

1.6 DESIGN RESPONSIBILITY

- A. The design of all concrete formwork, formwork removal, shoring, and backshoring requirements shall be performed by a registered professional engineer in the state of Texas and experienced in the design of concrete formwork. The Contractor shall employ the formwork engineer. Calculations, sealed by the registered professional engineer, shall be issued for Owner's record but will not be reviewed or returned.

1.7 SUBMITTALS

- A. Design Calculations: Submit for record calculations of all concrete formwork and the shoring plan sealed by a registered engineer in the state of Texas.
- B. Formwork Drawings: Formwork Drawings, prepared under the supervision and sealed by a registered professional engineer in the state of Texas, shall be submitted for Owners record and shall be reviewed by the Engineer for conformance to structural layout only. Such shop drawings shall indicate types of materials, sizes, lengths, connection details, design allowance for construction loads, anchors, form ties, shores, braces, construction joints, reveals, camber, openings, formwork coatings and all other pertinent information.
- C. Pan Form Shop Drawings: The Contractor shall submit pan shop drawings for Engineer's review and approval. Approval will be for conformance to structural layout only.
- D. Shoring Plan: Submit drawings to indicate the number of levels of shoring, proposed time and sequence of formwork and shore removal, minimum concrete strength for stripping of forms and shore removal, assumed construction loads, amount and layout of shores (specify whether backshores or reshores), and length of time shores are to be left in place. This plan shall be strictly followed by the Contractor. Shoring plans are to be submitted for Owner's record and reviewed for impact to structure.
- E. LEED Submittals (Projects authorized for LEED certification only)
- 1. Recycled Content- Credit MR4.1/MR 4.2: Provide documentation indicating percentages of post-consumer and pre-consumer recycled content by weight per unit of product or assembly containing the product. Indicate the percentage of the dollar value of the recycled content compared to the total dollar value of the product or assembly containing the product.

2. Material Proximity- Credit MR 5.1/MR 5.2: Where the distances to the project site is 500 miles or less, indicate location and distance to project site of extraction, harvesting, recovery and manufacturing of all materials. Indicate the dollar value of the material cost of the product containing local/regional materials. Where product components are sourced or manufactured in separate locations, provide location and percentage by weight of each component per unit of product.

PART 2 - PRODUCTS

2.1 PAN FORMS

- A. Specification: Unless specified otherwise, concrete joist construction shall conform to current version of Manual of Standard Practice, Chapter 10, as published by CRSI.
- B. Material and Pan Type:
 1. Material: Pans shall be fabricated either of steel that is free of dents, irregularities, sag and rust or of glass-fiber reinforced plastic that is molded under pressure with matched dies. Pan forms allowing warped surfaces, leakage of concrete at joints, and uneven surfaces beyond tolerance levels will not be acceptable.
 2. Subject to pan tolerance and the surface finish required by the surface finish class SF-1.0 as shown on the drawings, pan forms may be either new pans or reconditioned pans at Contractor's option. Forms may be "long forms", "flange forms", "long flange forms", or "adjustable forms" at Contractor's option. Pan splices may be lapped, reinforced butt jointed, or semi-butt jointed (using end caps welded back-to-back with 2" maximum distance between pan ends). The maximum number of joints in any bay shall be four located at approximately the one-fifth points in each bay.
 3. Subject to pan tolerance and the surface finish required by the surface finish class SF-1.1 as shown on the drawings, pan forms in exposed areas shall be new pans and pan forms in unexposed areas may be reconditioned pans. Forms may be "long forms", "flange forms", "long flange forms", or "adjustable forms" at Contractor's option. Pan splices may be lapped, reinforced butt jointed, or semi-butt jointed (using end caps welded back-to-back with 2" maximum distance between pan ends). The maximum number of joints in any bay shall be four located at approximately the one-fifth points in each bay.
 4. New Pans. All pan forms used in areas designated to have Surface Finish-2.3 shall be new pans either one piece continuous from beam to beam or beam to header ("longforms", "long flange forms", or "adjustable forms") without splices or with reinforced butt joint spliced. "Flange forms" are not acceptable, nor will forms be permitted that are lapped spliced or semi-butt joint spliced (using end caps welded back-to-back). Pans shall meet tolerances and the surface finish required for surface finish class 2.3.
 5. New Pans. All pan forms used in areas designated to have Surface Finish-3.3 shall be new pans either one piece continuous from beam to beam or beam to header ("longforms", "long flange forms", or "adjustable forms") without splices or reinforced butt joint spliced. "Flange forms" are not acceptable, nor will forms be permitted that are lapped spliced or semi-butt joint spliced (using end caps

welded back-to-back). Pans shall meet tolerances and the surface finish required for surface finish class 3.3.

The pan form surfaces specified herein are intended to be architecturally

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Unless otherwise specified, formwork for exposed concrete surfaces as defined by the Surface Finish Class noted on the drawings, shall consist of plywood, metal, metal framed plywood, or other acceptable surface. Formwork shall provide a continuous straight and smooth surface conforming to the joint system as specified on the Architect's drawings. Form material shall have sufficient thickness to withstand pressure of concrete without bow or deflection. Plywood shall be exterior grade plywood panels, suitable for concrete forms, complying with U.S. Product Standard PS-1, each piece bearing a legible inspection trademark, and as follows:
1. Phenolic Surface Film Overlay over Hardwood Face, Class 1 or better.
 2. High Density Overlay (100/30 min. rating) on Hardwood Face, Class 1 or better.
 3. High Density Overlay (100/30 min. rating) on Softwood Face, Class 1 or better
 4. Medium Density Overlay on Hardwood Face, Class 1 or better, mill-release agent treated and edge sealed.
 5. Medium Density Overlay on Softwood Face, Class 1 or better, mill-release agent treated and edge sealed.
 6. Structural 1, B-B, or better, mill oiled and edged sealed.
 7. "B-B (Concrete Form) Plywood", Class 1, or better, mill-oiled and edge sealed.
- B. Non-specific formed concrete: Unless otherwise specified, the default finish for formed surfaces shall be rough-form finish constructed with plywood, lumber, metal or other acceptable material. Lumber shall be dressed on at least two edges and one side for tight fit. The minimum grade shall be B-C, exterior grade.
- C. Textured-form finished concrete: For exposed surfaces as noted on the drawings provide units of form face design, size, arrangement and configuration that matches Architect's control sample. Provide solid backing and form supports to ensure stability of textured form liners. See Architect's drawings, specifications and control sample for special form textured finish concrete.

2.3 CYLINDRICAL COLUMNS AND SUPPORTS

- A. Round section members shall be formed with metal or fiberglass, unless otherwise specified. Units shall have sufficient wall thickness to resist loads imposed by wet concrete without detrimental deformation.

2.4 FORMWORK COATINGS

- A. Formwork coatings shall be a commercial formulation that will not bond with, stain, nor adversely affect concrete surfaces or impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede curing with water or curing compounds. Provide a product that has a maximum VOC (Volatile Organic Compounds) of 50 g/l but not

greater than that permitted by the local government agency having jurisdiction in the area where the project is located.

Products: Subject to compliance with requirements, provide one of the following:

"Bio-Release EF", Dayton Superior
"Farm Fresh", Unitex
"Form-Eze Natural", The Euclid Chemical Company, Inc.
"Bio-Form", Universal Form Clamp
"Aqua Blue", US Spec

2.5 NAILS AND FASTENERS

- A. Use only galvanized nails and fasteners for securing formwork in structures exposed to weather or unconditioned spaces such as garages, canopies and porte-cocheres.

2.6 FORM TIES

- A. Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to minimize spalling of concrete on removal.
 - 1. Exposed Surfaces: For surfaces designated with Surface Finish Class SF-2.x or SF-3.x , furnish units that will leave no portion of the tie closer than 3/4 inch to the plane of the concrete surface and that will leave holes not larger than 1 inch in diameter in concrete surface when the ends or end-fasteners have been removed.
 - 2. Dampproofed Surfaces: Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
 - 3. Exposed to Weather or Unconditioned Space: Provide removable, glass-fiber-reinforced plastic, stainless steel, or galvanized form ties that will leave no corrodible metal closer than 1 1/2 inches in surfaces that will be exposed to weather or in an unconditioned space in the final structure. The ties shall leave holes no larger than 1 inch in diameter in concrete surfaces when the ends or end-fasteners are removed.

2.7 CHAMFER STRIPS

- A. Provide wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

PART 3 - EXECUTION

3.1 FABRICATION AND CONSTRUCTION

- A. Design, erect, support, brace and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic construction loads that might be applied until the concrete structure can support such loads.
- B. 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 back-up at joints to prevent leakage of cement paste.

- C. 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 steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.
- D. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- E. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and patch forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
- F. Chamfer exposed corners and edges as indicated, using specified chamfer strips fabricated to produce uniform smooth lines and tight edge joints.
- G. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Coordinate size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- H. Pan Form Fabrication and Construction:
 - 1. Factory fabricate pan form units to specified sizes and shapes as indicated on the drawings. Units shall be designed for easy removal without damaging placed concrete. Units shall be properly shored and adjoining pan units shall be blocked if required to prevent lateral or vertical deflection of formwork during concrete placement.
 - 2. Load Distribution Ribs: Provide load distribution ribs at least 5" wide for all pans 30" wide and narrower and elsewhere where indicated on the drawings. Minimum rib spacing shall be:
 - a. None in spans less than 20 feet.
 - b. One near the center of spans 20 to 30 feet.
 - c. Two near the third points of spans over 30 feet.

Discontinue ribs between two adjacent joists or beams that have differences in span larger than 33%, between a joist and an adjacent parallel wall, and between a joist and an adjacent parallel beam that is 1 ½ or more times wider than the joist.

3.2 CLEANING AND TIGHTENING

- A. Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and all other debris just prior to concrete placement. Retighten forms and bracing prior to concrete placement as required to prevent mortar leaks and maintain proper alignment.

3.3 CLEANING AND RE-USE OF FORMS

- A. Forms reused in the work shall be repaired and cleaned. Split, frayed, delaminated, or otherwise damaged facing material will not be acceptable for exposed surfaces. Forms intended for successive concrete placement shall have surfaces cleaned, fins and laitance removed, and joints tightened to avoid surface offsets. New form coating compound shall be applied to reused forms. 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 in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.4 TOLERANCES

- A. Unless specified otherwise, all tolerances for concrete formwork shall conform to ACI Standard 117, "Standard Tolerances for Concrete Construction and Materials". Before concrete placement the Contractor shall check lines and levels of erected formwork and make any corrections and adjustments as required to ensure proper size and location of concrete members and stability of forming systems. During concrete placement the Contractor shall check formwork and supports to ensure that forms have not displaced and that completed work will be within specified tolerances.
- B. Construct forms so as to limit the offset between adjacent pieces of formwork facing material in accordance with the surface tolerance class as defined in ACI 117 corresponding to the surface finish class noted on the drawings. The offset limits shall apply to both abrupt and gradual variations in the surface.
- C. Pan Construction Surface Tolerance: Discontinuities in the concrete surface formed by pan construction shall be limited to the values noted in the surface tolerance classes of ACI 117 corresponding to the surface finish classes noted on the drawings.
- D. Prior to each concrete pour, the Contractor shall engage a qualified surveyor to verify that work is within specified tolerances.

3.5 SHORES AND SUPPORTS

- A. Definitions
 - 1. Shores: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.
 - 2. Reshores: Shores placed snugly under a stripped concrete structural member after the original forms and shores have been removed from the member, thus requiring the member to carry its own weight and superimposed construction loads at the time of installation. Reshores are assumed to carry no load at the time of installation. After the installation of reshores, superimposed construction loads are assumed to be distributed among all members connected by reshores.
 - 3. Backshores: Shores placed snugly under a stripped concrete structural member after the original formwork and shores have been removed from a small area without allowing the structural member to deflect or support its own weight or superimposed construction loads. It is assumed that backshores carry the same load as that carried by the original shores they replace.

Comply with requirements of ACI 301 for shoring, reshoring and backshoring in concrete construction and as herein specified where more stringent.

- B. Design: Shores and reshores or backshores must be designed to carry all loads transmitted to them. A rational analysis should be used to determine the number of floors to be shored, reshored, or backshored, subject to the minimums stated in the following paragraph, and to determine the loads transmitted to the floors, shores and reshores or backshores as a result of the construction sequence. The analysis should consider, but should not necessarily be limited to, the following:
1. Structural design load of the slab or member including live load, partition loads, and other loads for which the engineer designed the slab. The live load reduction factors for the design of certain members are shown on the structural drawings. The reduced live load and an allowance for construction loads shall be taken into consideration when performing the analysis.
 2. Dead load weight of the concrete and formwork.
 3. Construction live loads, such as placing crews and equipment or stored materials.
 4. Design strength of concrete specified.
 5. Cycle time between placement of successive floors.
 6. Strength of concrete at time it is required to support shoring loads from above.
 7. The distribution of loads between floors, shores, and reshores or backshores at the time of placing concrete, stripping formwork, and removal of reshoring or backshoring.
 8. Span of slab or structural member between permanent supports.
 9. Type of formwork systems, i.e., span of horizontal formwork components, individual shore loads, etc.
 10. Minimum age where appropriate.
 11. Alignment of shores. Where possible, Shores for any floor shall be placed directly above previously placed shores so that load will be transferred directly to such shores.

3.6 REMOVAL OF FORMS AND SUPPORTS

- A. Determination by Contractor's Registered Engineer: The Contractor's registered engineer shall determine and submit for Owner's record the time and sequence of formwork and shore removal subject to the criteria as specified below. The submittal shall clearly distinguish between reshoring and backshoring procedures.
- B. Determining *in situ* Strength of Concrete: The General Contractor shall be responsible for making and curing concrete cylinders, cured under field conditions, for the purpose of determining concrete strength at time of form and shore removal. Such cylinders shall be made by the Contractor and tested by his testing laboratory. Alternatively, the *in situ* strength of concrete may be determined by the Maturity Method following the

requirements of ASTM C 1074. An acceptable system for this method is the “*intelliRock*” system manufactured and supplied by Engius Constructive Intelligence of Stillwater, OK.

- C. Records of Weather Conditions: The General Contractor shall be responsible for keeping records of weather conditions to be used in the decision on when to remove forms.
- D. Formwork Not Supporting Concrete: Formwork not supporting concrete such as sides of beams, walls, columns and similar parts of the structure, may be removed after cumulatively (not necessarily consecutively) curing at a concrete temperature not less than 50°F for 12 hours after placing concrete, provided the concrete is sufficiently hard so as not to be damaged by form removal operations and provided curing and protection operations are maintained. If ambient air temperatures remain below 50°F, if retarding agents are used, or if Type II and Type V Portland cement is used, then this specified minimum period should be increased as required to safely remove the forms without damage to the concrete. Where such forms also support formwork for slab or beam soffits, the removal times of the latter shall govern.
- E. Formwork Supporting Weight of Concrete: Formwork supporting weight of concrete such as beam soffits, joists, slabs and other structural elements shall not be removed until concrete has attained at least the following percentages of the design compressive strength, while cured following the specified requirements, including hot or cold-weather concreting, where applicable:
- | | |
|----------------------|-----------------------------------|
| Joists, Beam Bottoms | - 70%, but not less than 2800 psi |
| Slabs | - 70%, but not less than 2800 psi |
- F. Placing Reshores and Backshores:
1. All shoring operations shall be carried out in accordance with a planned sequence as determined by the Contractor's shoring engineer.
 2. Shoring operations shall be performed so that at no time will areas of new construction be required to support combined dead and construction loads in excess of the available strength as determined by the design loads (as specified in the General Notes) and the developed concrete strength (as determined by field cured cylinders) at the time of stripping and reshoring or backshoring.
 3. Shores (backshores or reshores) shall not be removed until the structural member supported has sufficient strength to support all applied loads.
 4. For backshoring operations, the forms shall be removed in such a manner that individual structural members are not allowed to deflect and carry load.
 5. Reshoring operations require that the structural members be strong enough to safely support their own weight before stripping of formwork.
 6. For reshoring operations, no structural member shall be overstressed under its own dead weight plus the weight of the floors above and construction loads assigned to the structural member by a rational analysis that accounts for the relative stiffness of each floor with due consideration of concrete age and strength. While reshoring is underway, no construction loads shall be permitted on the new construction unless it can safely support the construction loads.
 7. Where possible, shores shall be located in the same position on each floor so that they will be continuous in their support from floor to floor.

- G. Post Tension Construction: Formwork supporting post-tensioned floor construction, including shores, reshores and backshores shall be designed to support any additional loads produced by the stressing operation.

END OF SECTION 03 10 00