**SECTION 03 10 00**

**CONCRETE FORMING AND ACCESSORIES**

**BASED ON DFD MASTER SPECIFCATION DATED 9-10-2024**

***This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.***

**PART 1 - GENERAL**

**SCOPE**

Section includes concrete forming and accessories, including form-facing material for cast-in-place concrete, form liners, insulating concrete forms, and shoring, bracing, and anchoring. The work under this section consists of providing all work, materials, labor equipment and supervision necessary to provide concrete forming as required in these specifications and the drawings.

PART 1 - GENERAL

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RELATED WORK

Applicable provisions of Division 1 govern work under this Section.

(The A/E to review all scope of work and determine other related work, work which impacts this section, or work is impacted by this section. A/E to add or remove sections below as needed. (Examples may include site civil or utility work, interior flooring and finishes, coatings, etc.)

Related work specified elsewhere:

03 08 00 – Commissioning of Concrete

03 20 00 – Concrete Reinforcing

03 30 00 – Cast-In-Place Concrete

03 30 10 – Cast-In-Place Concrete for Site Work

04 20 10 - Unit Masonry

07 10 16 - Waterproofing for Utilities

07 63 00 - Sheet Metal Roofing Specialties

31 20 00 - Earthmoving

Section 00 00 00 – (Section Title)

Section 00 00 00 – (Section Title)

**REFERENCES**

Incorporated Guides and References

American Concrete Institute (ACI):

ACI 347 – Guide to Formwork for Concrete.

Specifications

American Concrete Institute (ACI):

ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.

ACI 301 - Specifications for Structural Concrete.

ACI 303.1 – Specification for Cast-In-Place Architectural Concrete.

ACI 306.1 – Specification for Cold Weather Concreting.

ACI 308.1 – Specification for Curing Concrete.

ACI 315 - Details and Detailing of Concrete Reinforcement.

ACI 318 - Building Code Requirements for Structural Concrete and Commentary.

ACI 347R - Guide to Formwork for Concrete

ASTM International (ASTM):

ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation

ASTM C595 - Standard Specification for Blended Hydraulic Cements

ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection

ASTM E2634 - Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems

PS1 – Construction and Industrial Plywood

**DEFINITIONS**

***(The A/E to include technical definitions for this section only. Do not include or repeat definitions found in related sections)***

Form-Facing Material: Temporary structure or mold for the support of concrete while the concrete is setting and gaining sufficient strength to be self-supporting.

Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

**PREINSTALLATION MEETINGS**

Preinstallation Conference: Conduct conference at [Project site] <**Insert location**>.

Review the following:

Special inspection and testing and inspecting agency procedures for field quality control.

Construction, movement, contraction, and isolation joints.

Forms and form-removal limitations.

Shoring and reshoring procedures.

Anchor rod and anchorage device installation tolerances.

**DESIGN RESPONSIBILITY**

The design of all concrete formwork, formwork removal, shoring, and backshoring requirements shall be performed by a registered professional engineer, experienced in the design of concrete formwork. The GPC shall employ the formwork engineer. Calculations, sealed by the registered professional engineer, shall be issued for DFD’s record but will not be reviewed or returned.

**SUBMITTALS**

Product Data: For each of the following:

Exposed surface form-facing material.

Concealed surface form-facing material.

Forms for cylindrical columns.

Pan-type forms.

Void forms.

Form liners.

Insulating concrete forms.

Form ties.

Waterstops.

Form-release agent.

Sustainable Design Submittals:

<Insert required sustainable design submittals>

Shop Drawings: Prepared by and signed and sealed by a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

Formwork Drawings: Formwork Drawings, prepared under the supervision and sealed by a registered professional engineer, shall be submitted for DFD’s record, and shall be reviewed by the AE or 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.

Pan Form Shop Drawings: The GPC shall submit pan shop drawings for Engineer's review and approval. Approval will be for conformance to structural layout only.

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 GPC. Shoring plans are to be submitted for DFD's record and reviewed for impact to structure.

For exposed vertical concrete walls, indicate dimensions and form tie locations.

Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

Location of construction joints is subject to approval of the AE.

Indicate location of waterstops.

Indicate form liner layout and form line termination details.

Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.

Indicate layout of insulating concrete forms, dimensions, course heights, form types, and details.

Samples:

Waterstops.

Form Liners: 12-inch by 12-inch <**Insert size**> sample, indicating texture.

Material Certificates: For each of the following, signed by the manufacturer:

Form Materials and form-release agents.

Qualification Data: For testing and inspection agency.

Research Reports: For insulating concrete forms indicating compliance with International Code Council Acceptance Criteria AC353.

Field quality-control reports.

Minutes of preinstallation conference.

**QUALITY ASSURANCE**

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

Professional Engineer Qualifications: Employ professional Engineer, registered in the State of Wisconsin, to perform design of formwork, shoring, and reshoring for construction loads. Sign and seal design Shop Drawings submitted to DFD for review.

Testing and Inspection Agency Qualifications: An independent agency, acceptable to the AE and DFD, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

Mockups: Formed surfaces to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

Build panel approximately [100 sq. ft.] <**insert area**> in the location indicated or, if not indicated, as directed by AE.

Subject to compliance with requirements, approved mockups may become part of the completed Work.

**DELIVERY, STORAGE, AND HANDLING**

Form Liners: Store form liners under cover to protect from sunlight.

Insulating Concrete Forms: Store forms off ground and under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

**PART 2 - PRODUCTS**

**PERFORMANCE REQUIREMENTS**

Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."

Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

**<Insert if used>** For architectural concrete specified in Section 03 33 00 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

Design, engineer, erect, shore, brace, and maintain insulating concrete forms in accordance with ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

Design cross ties to transfer the effects of the following loads to the cast-in-place concrete core:

Wind Loads: As indicated on Drawings.

Horizontal Deflection Limit: Not more than [1/240] [1/360] [1/600] [1/720] <**insert ratio**> of the wall height.

**FORM-FACING MATERIALS**

As-Cast Surface Form-Facing Material:

Provide continuous, true, and smooth concrete surfaces.

Furnish in largest practicable sizes to minimize number of joints.

Acceptable Materials: As required to comply with Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete”, and as follows:

Plywood, metal, or other approved panel materials.

Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

APA HDO (high-density overlay).

APA MDO (medium-density overlay); mill-release agent treated, and edge sealed.

APA Structural 1 Plyform, B-B or better; mill oiled, and edge sealed.

APA Plyform Class I, B-B or better; mill oiled, and edge sealed.

Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

Provide lumber dressed on at least two edges and one side for tight fit.

Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces [**with gradual or abrupt irregularities**] [**without spiral or vertical seams**] not exceeding specified formwork surface finish class SF-4.0 <**select class**>.

Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation, with **[straight] [or] [tapered]** end forms.

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.

Subject to pan tolerance and the surface finish required by the surface finish class SF-1.0 <**select class**> as shown on the drawings, pan forms that are **not exposed** to view 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.

Subject to pan tolerance and the surface finish required by the surface finish class SF-3.0 <**select class**> as shown on the drawings, pan forms in **exposed** areas shall be new 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.

New Pans. All pan forms used in areas designated to have Surface Finish-3.0 <**select class**> 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 3.0 <**select class**>.

New Pans. All pan forms used in areas designated to have Surface Finish-4.0 <**select class**> 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 4.0 <**select class**>. The pan form surfaces specified herein are intended to be architecturally exposed.

Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.

Form Liners:

Size: **<Insert dimensions>**.

Face Pattern: [Smooth] [Ribbed] [Stone] [Brick] [Wood] <**insert pattern**>.

**INSULATING CONCRETE FORMS**

Insulating Concrete Forms: Concrete-forming system complying with ASTM E2634, consisting of two panels of insulation connected with cross ties.

Insulation: ASTM C578, Type II, expanded polystyrene.

Thickness: Not less than 2-1/2 inches **<insert thickness>** each face.

Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Flame Spread: 25 or less.

Smoke Developed Index: 450 or less.

Sustainable design for recycled content:

Cross Ties: Polypropylene, with integral reinforcement supports, designed to allow passage of concrete during placement.

Core Thickness: [4 inches] [6 inches] [8 inches] [10 inches] [12 inches] **<Insert thickness>**

**WATERSTOPS**

***(AE Note: Bulb type waterstops are to be avoided, unless application requires chemically resistant waterstops, such as agricultural holding tanks or similar applications where hydrophilic materials are not allowed)***

Flexible Rubber Waterstops: U.S. Army Corps of Engineers CRD-C 513, with factory-installed metal eyelets,for embedding in concrete to prevent passage of fluids through joints, with factory fabricated corners, intersections, and directional changes.

Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] **<Insert profile>**.

Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/8 inch thick] **<insert dimensions>**; nontapered.

Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals, with factory fabricate corners, intersections, and directional changes.

Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] **<insert profile>**.

Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/16 inch thick] [9 inches by 3/8 inch thick] **<insert dimensions>**; nontapered.

Flexible PVC Waterstops: U.S. Army Corps of Engineers CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints, with factory fabricate corners, intersections, and directional changes.

Profile: [Flat dumbbell with center bulb] [Flat dumbbell without center bulb] [Ribbed with center bulb] [Ribbed without center bulb] [As indicated] **<insert profile>.**

Dimensions: [4 inches by 3/16 inch thick] [6 inches by 3/8 inch thick] [9 inches by 3/8 inch thick] **<insert dimensions>**; nontapered.

Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer-modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

**RELATED MATERIALS**

Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.

Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.

Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

Formulate form-release agent with rust inhibitor for steel form-facing materials.

Form release agent for form liners shall be acceptable to form liner manufacturer.

Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

Exposed Surfaces: For surfaces designated with Surface Finish Class SF-3.0 or SF-4.0, 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.

Dampproofed Surfaces: Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

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

**PART 3 - EXECUTION**

**FORMWORK INSTALLATION**

Work shall conform to ACI 117 and ACI 301, except as modified requirements of these Contract Documents.

Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 03 30 00 "Cast-In-Place Concrete" for as-cast finishes [and] [Section 03 33 00 "Architectural Concrete"**if applicable**].

Limit concrete surface irregularities as follows:

Surface Finish-1.0: ACI 117 Class D, 1 inch.

Surface Finish-2.0: ACI 117 Class C, 1/2 inch.

Surface Finish-3.0: ACI 117 Class B, 1/4 inch.

Surface Finish-4.0: ACI 117 Class A, 1/8 inch.

Construct forms tight enough to prevent loss of concrete mortar.

Minimize joints.

Exposed Concrete: Symmetrically align joints in forms.

Construct removable forms for easy removal without hammering or prying against concrete surfaces.

Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.

Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

Install keyways, reglets, recesses, and other accessories, for easy removal.

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.

Prior to each concrete pour, the GPC shall engage a qualified surveyor to verify that work is within specified tolerances.

Do not use rust-stained, steel, form-facing material.

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.

Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.

Locate temporary openings in forms at inconspicuous locations.

**[Chamfer] [Do not chamfer]** exterior corners and edges of permanently exposed concrete.

At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

Determine sizes and locations from trades providing such items.

Obtain written approval of Architect prior to forming openings not indicated on Drawings.

Pan Form Fabrication and Construction:

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.

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:

None in spans less than 20 feet.

One near the center of spans 20 to 30 feet.

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

Construction and Movement Joints:

Construct joints true to line with faces perpendicular to surface plane of concrete.

Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

Place joints perpendicular to main reinforcement.

Locate joints for beams, slabs, joists, and girders in the middle third of spans.

Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

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

Space vertical joints in walls [as indicated on Drawings] or minimum **<Insert drawing sheet references or joint spacing>**.

Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

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.

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

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.

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.

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

Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.

Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

**EMBEDDED ITEM INSTALLATION**

Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete.

Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.

Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.

Install dovetail anchor slots in concrete structures, as indicated on Drawings.

Clean embedded items immediately prior to concrete placement.

**WATERSTOP INSTALLATION**

Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm.

Install in longest lengths practicable.

Locate waterstops in center of joint unless otherwise indicated on Drawings.

Allow clearance between waterstop and reinforcing steel of not less than 2 times the largest concrete aggregate size specified in Section 03 30 00 "Cast-In-Place Concrete."

Secure waterstops in correct position at 12 inches on center.

Field fabricate joints in accordance with manufacturer's instructions using heat welding.

Miter corners, intersections, and directional changes in waterstops.

Align center bulbs.

Clean waterstops immediately prior to placement of concrete.

Support and protect exposed waterstops during progress of the Work.

Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated on Drawings, according to manufacturer's written instructions, by adhesive bonding, mechanically fastening, and firmly pressing into place.

Install in longest lengths practicable.

Locate waterstops in center of joint unless otherwise indicated on Drawings.

Protect exposed waterstops during progress of the Work.

**VOID FORMS INSTALLATION**

Placement:

Place forms on smooth, level, firm, dry surface.

Butt carton forms tightly end to end and side to side, seam side down.

Place cover sheets on carton forms and staple.

Protection:

Do not let carton forms become wet.

Remove and replace wet cartons.

Place soil retainers at edge of grade beams.

**INSULATING CONCRETE FORMS INSTALLATION**

Comply with ACI 301 and manufacturer's instructions.

Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

Install forms in running bond pattern.

Align joints.

Align furring strips.

Construct forms tight to prevent loss of concrete mortar.

Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

Determine sizes and locations from trades providing such items.

Obtain written approval of Architect prior to forming openings not indicated on Drawings.

Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.

Close temporary ports and openings with tight fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

Shore insulating concrete forms to ensure stability and to resist stressing imposed by construction loads.

**REMOVING AND REUSING FORMS**

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 70 percent of its 28-day design compressive strength.

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 [24] **<Insert number>** 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 for the remainder of the curing period. 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.

Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

Records of Weather Conditions:

The GPC shall be responsible for keeping records of weather conditions to be used in the decision on when to remove forms

Placing Reshores and Backshores:

All shoring operations shall be carried out in accordance with a planned sequence as determined by the Contractor's shoring engineer.

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.

Shores (backshores or reshores) shall not be removed until the structural member supported has sufficient strength to support all applied loads.

For backshoring operations, the forms shall be removed in such a manner that individual structural members are not allowed to deflect and carry load.

Reshoring operations require that the structural members be strong enough to safely support their own weight before stripping of formwork.

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.

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.

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 align and secure joints 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.

Do not use patched forms for exposed concrete surfaces unless approved by Architect.

**SHORING AND RESHORING INSTALLATION**

Definitions:

Shores: Vertical or inclined support members designed to carry the weight of formwork, concrete, and construction loads above.

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.

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.

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:

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.

Dead load weight of the concrete and formwork.

Construction live loads, such as placing crews and equipment or stored materials.

Design strength of concrete specified.

Cycle time between placement of successive floors.

Strength of concrete at time it is required to support shoring loads from above.

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.

Span of slab or structural member between permanent supports.

Type of formwork systems, i.e., span of horizontal formwork components, individual shore loads, etc.

Minimum age where appropriate.

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

**FIELD QUALITY CONTROL**

Special Inspections: Engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

Inspections:

Inspect formwork for shape, location, and dimensions of the concrete member being formed.

Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

Where special formed surface finish requirements are required, verify forming materials comply with requirements.

Adequacy of formwork, shoring, and reshoring to support vertical and lateral loads during construction is sole responsibility of GPC.

**END OF SECTION 03 10 00**