PROJECT MANUAL

VOLUME 2

Replace HVAC, Structural Repairs & Replace Roof

George Washington Carver State Office Building

Jefferson City, Missouri

Designed By: Martin/Martin Inc.
31 West 31st Street
Kansas City, MO 64108

Date Issued: June 14, 2024

Project No.: O2440-01

STATE *of* MISSOURI

OFFICE *of* ADMINISTRATION
Facilities Management, Design & Construction

SECTION 000107 - PROFESSIONAL SEALS AND CERTIFICATIONS

PROJECT NUMBER: O2440-01

THE FOLLOWING DESIGN PROFESSIONALS HAVE SIGNED AND SEALED THE ORIGINAL PLANS AND SPECIFICATIONS FOR THIS PROJECT, WHICH ARE ON FILE WITH THE DIVISION OF FACILITIES MANAGEMENT, DESIGN AND CONSTRUCTION:

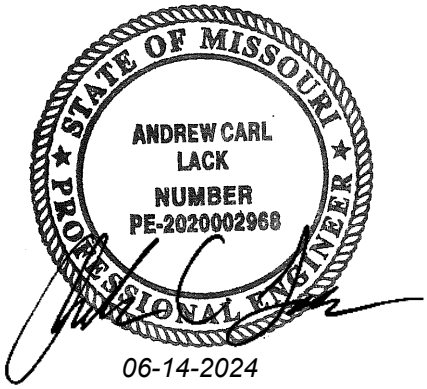

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

SECTION 000115 – LIST OF DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Bid Form, and other Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. This Section provides a comprehensive list of the drawings that comprise the Bid Documents for this project.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 LIST OF DRAWINGS

A. The following list of drawings is a part of the Bid Documents:

	TITLE	SHEET #	DATE	CAD #
1.	Cover Sheet	Sheet G-001	06/14/24	S-COV-00
2.	General Notes	Sheet S-001	06/14/24	S-NOT-01
3.	General Notes	Sheet S-002	06/14/24	S-NOT-02
4.	QAQC	Sheet S-003	06/14/24	S-NOT-03
5.	Second Floor Plan	Sheet S-101	06/14/24	S-FLR-02
6.	Third Floor Plan	Sheet S-102	06/14/24	S-FLR-03
7.	Roof Framing Plan	Sheet S-103	06/14/24	S-ROF-01
8.	Concrete Reinforcing Details	Sheet S-200	06/14/24	S-DET-01
9.	FRP Details	Sheet S-201	06/14/24	S-DET-02

END OF SECTION 000115

SECTION 011000 – SUMMARY OF WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. The Project consists of HVAC replacement, structural repairs, and roof replacement at the George Washington Carver State Office Building.

1. Project Location: George Washington Carver State Office Building, 1616 Missouri Blvd, Jefferson City, MO 65101.

2. Owner: State of Missouri, Office of Administration, Division of Facilities Management, Design and Construction, Harry S Truman State Office Building, Post Office Box 809, 301 West High Street, Jefferson City, Missouri 65102.

B. Contract Documents, dated 06/14/24 were prepared for the Project by the following designers:

1. Volume 1: Klingner & Associates, P.C, 3622 Endeavor Avenue, Suite 117, Columbia, Missouri 65201.

2. Volume 2: Martin/Martin, Inc., 31 West 31st Street, Kansas City, Missouri 64108.

3. Volume 3: Office of Administration – Division of Facilities Management, Design, and Construction, 301 West High Street, Jefferson City, Missouri.

C. The Work includes the following:

1. Volume 1: The Work consists of modifications to the existing hydronic cooling and heating system, including the removal and replacement of hydronic pumps, chillers, boilers, basement air handling unit, ductless split systems, and hydronic fan coil units. This Work will be coordinated with the slab reinforcement work of Volume 2.

2. Volume 2: The Work consists of the addition of reinforcing elements at concrete slabs and at slab-to-column interfaces. This Work will be coordinated with the HVAC work of Volume 1 and the roof replacement work of Volume 3.

3. Volume 3: The Work consists of removing the existing roof system down to the roof deck, removing existing gutters and downspouts, disposing of debris, installing new roof system, installing new gutters and downspouts, and installing new cage ladder. This Work will be coordinated with roof structural reinforcement work of Volume 2.

D. The Work will be constructed under a single prime contract.

1.3 WORK SEQUENCE

A. The Work will be conducted in one phase. Construction at the site may not begin until August 1, 2025. The project shall be Substantially Complete by July 1, 2026.

1.4 WORK UNDER OTHER CONTRACTS

A. Separate Contracts: The Owner will award separate contracts for performance of certain construction operations at the site. Those operations will be conducted in coordination with work under this contract. The Separate Contracts include, but are not limited to, the following:
   1. Remodel the first, second, and third floor men's and women's restrooms.
   2. Replace exterior windows and doors.
   3. Replace carpet, ceilings, and paint.
   4. Replace the fire alarm system.
   5. Replace the parking lot, sidewalks, and exterior lighting.
   6. Replace the camera and building access systems.

B. Cooperate fully with separate contractors so that work under those contracts may be carried out smoothly, without interfering with or delaying work under this Contract.

1.5 CONTRACTOR USE OF PREMISES

A. General: During the construction period the Contractor shall have full use of the premises for construction operations, including use of the site. The Contractor's use of the premises limited only by the Owner's right to perform work or to retain other contractors on portions of the Project.

B. Use of the Existing Building: Maintain the existing building in a weathertight condition throughout the construction period. Repair damage cause by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.

1.6 OCCUPANCY REQUIREMENTS

A. Partial Owner Occupancy: The Owner reserves the right to occupy and to place and install equipment in completed areas of the building prior to Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placing of equipment and partial occupancy shall not constitute acceptance of the total Work.
   1. The Designer will prepare a Certificate of Partial Occupancy for each specific portion of the Work to be occupied prior to substantial completion.
   2. Prior to partial Owner occupancy, mechanical and electrical systems shall be fully operational. Required inspections and tests shall have been successfully completed. Upon occupancy, the Owner will operate and maintain mechanical and electrical systems serving occupied portions for the building.
   3. Upon occupancy, the Owner will assume responsibility for maintenance and custodial service for occupied portions for the building.

1.7 MISCELLANEOUS PROVISIONS

A. The State of Missouri has an existing contract with Walter Louis Fluid Technologies for water treatment services. The State of Missouri will utilize this existing contract to provide all chemicals needed for startup as well as all future chemicals needed to protect and maintain the equipment. The Contractor shall coordinate with Walter Louis Fluid Technologies to ensure that the water treatment system is compatible with new equipment.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

END OF SECTION 011000

SECTION 012200 – UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions and other Division 1 Specification Sections apply to this Section.

B. Quantities of Units to be included in the Base Bid are indicated in the Work List on the Contract Documents.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for Unit Prices.

B. Related Sections include the following:

1. Division 1 Section "Allowances" for procedures for using Unit Prices to adjust quantity allowances.
2. Division 1 Section "Contract Modification Procedures" for procedures for submitting and handling Change Orders.
3. Division 2 Section "Selective Demolition" for procedures for measurement and payment for repair of damages to the structure floor slab and columns.

1.3 DEFINITIONS

A. Unit Price is **an amount proposed by bidders, stated on the Bid Form Attachment 004322** a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES

A. Unit Prices include all necessary material plus cost for delivery, installation, insurance, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of Unit Prices. Methods of measurement and payment for Unit Prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of Work in-place that involves use of established Unit Prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of Unit Prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each Unit Price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

A. Unit Price No. 1 – Ground Penetrating Radar Nondestructive Testing:

1. Description: Perform GPR at column location to determine the top cover of the top reinforcement in the concrete slab.
2. Unit of Measurement: Square Feet (1 location is approximately 36 square feet)
3. Base Bid: 1080 Square Feet

B. Unit Price No. 2 – Fiber Reinforced Polymer Installation:

1. Description: Install FRP to the top side of the concrete slab according to Division 3 Section "Fiber Reinforced Polymer Reinforcing".
2. Unit of Measurement: Square Feet
3. Base Bid: 1200 Square Feet

C. Unit Price No. 3 – Intumescent Fire Protection:

1. Description: Cover FRP with Intumescent coating according to Division 7 Section "Intumescent Fire Protection".
2. Unit of Measurement: Square Feet
3. Base Bid: 1200 Square Feet

END OF SECTION 012200

SECTION 013300 – SUBMITTALS

PART 1 - GENERAL (refer to Project Manual Volume 1)

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 REQUIRED SUBMITTALS

A. Contractor shall submit the following information for materials and equipment to be provided under this contract.

SPEC SECTION	TITLE	CATEGORY
017900	Post-installed Anchor Installation Training	Certification
017900	Special Inspector Qualifications	Certification
020700	Proposed Demolition Schedule	Construction Schedule
020700	Shoring Structural Design Calculations	Shop Drawings
020700	Shoring Drawings	Shop Drawings
031000	Formwork Product Data	Product Data
031000	Formwork Shop Drawings	Shop Drawings
031000	Formwork quality control reports	Test Report
031000	Minutes of preinstallation conference	Operation / Maintenance Manual
032000	Minutes of preinstallation conference	Operation / Maintenance Manual
032000	Reinforcing Steel Special Inspection Report	Test Report
032000	Reinforcing Steel Shop Drawings	Shop Drawings
032000	Post-installed Anchor Product Data	Product Data
032500	Minutes of preinstallation conference	Operation / Maintenance Manual
032500	Installer qualifications	Certification
032500	FRP Field Quality control reports	Test Report
032500	FRP Manufacturer recommended QAQC	Product Data
032500	FRP Test Reports	Test Report
032500	FRP Structural Calculations	Shop Drawings
032500	FRP Shop Drawings	Shop Drawings
033000	Shoring Plan	Shop Drawings
033000	Reinforcing Steel Mill Certifications	Product Data
033000	Environmental Certifications for Concrete Materials	Product Data
033000	Contractor Field Quality Control Logs	Test Report
033000	Concrete Cylinder Strength Test	Test Report
033000	Concrete Slump Test	Test Report

033000	Concrete Temperature	Test Report
033000	Concrete Unit Weight	Test Report
033000	Shoring Calculations	Shop Drawings
033000	Concrete Mix Designs	Product Data
033000	Concrete Product Submittals	Product Data
078123	Intumescent Paint Product	Product Data

END OF SECTION 013300

SECTION 020700 – SELECTIVE DEMOLITION

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 this Section.

1.2 SUMMARY

A. This Section requires the selective removal and subsequent offsite disposal of the following:

1. Miscellaneous finishes and items incidental to the concrete retrofit process.

1.3 SUBMITTALS

A. General: Submit the following in accordance with the Conditions of Contract and Division 01 Specification Sections.

B. Schedule indicating the proposed sequence of operations for selective demolition work to Owner's Representative for review prior to start of work. Include coordination for shutoff, capping, and continuation of utility services as required, together with details for dust and noise control protection.

C. Provide a detailed sequence of demolition and removal work to ensure uninterrupted progress of the Owner's on-site operations.

1. Contractor shall review with the Owner and Engineer the types of equipment which he proposed to use during operations and obtain the Owner's approval for such use.

D. Photographs of existing conditions of structure surfaces, equipment, and adjacent improvements that might be misconstrued as damage related to removal operations. File with the Owner's Representative prior to the start of work.

E. Shoring plans, details, and calculations, signed and sealed by a professional engineer registered in the project's jurisdiction for all shoring required for construction.

1.4 JOB CONDITIONS

A. Condition of Structures: The Owner assumes no responsibility for the actual condition of items or structures to be demolished.

1. Examine areas and conditions under which the Work is to occur. Notify the Engineer immediately in writing of any conditions detrimental to the proper and timely completion of this Work.

2. Proceed with the Work only after unsatisfactory conditions have been acceptably remedied.

3. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner insofar as practicable.

B. Partial Demolition and Removal: Items indicated to be removed but of salvageable value to Contractor may be removed from structure as work progresses. Transport salvaged items from the site as they are removed.

1. Storage or sale of removed items on site will not be permitted.

C. Protections: Provide temporary barricades and other forms of protection to protect occupants from injury due to selective demolition work.

1. Erect temporary covered passageways as required by authorities having jurisdiction.
2. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
3. Protect from damage existing finish work, signs, windows, doors, parking equipment, etc. that is to remain in place during demolition operations.
4. Protect floors with suitable coverings when necessary.
5. Construct temporary insulated dustproof partitions where required to separate areas where noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
6. Provide temporary weather protection during intervals between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to the structure or interior areas of the existing building.
7. Remove protections at the completion of the work.
8. Protect adjoining properties, public thoroughfares, sidewalks, and utilities from damage due to demolition operations.
9. Take adequate precautions to prevent unauthorized personnel from entering the job site.

D. Damages: Promptly repair damages caused to adjacent facilities by demolition work.

E. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.

1. Do not close, block, or otherwise obstruct streets, walks, or other occupied or used facilities without written permission from the Owner and Authority having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

2. Protect vehicles and their occupants within or adjacent to the building from hazards or damages. Provide clean and unobstructed driveways and parking areas.

F. Utility Services: Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.

1. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to governing authorities.

2. Maintain fire protection services during selective demolition operations.

3. Temporarily shore utilities as necessary should hanger supports need to be temporarily removed as a result of concrete demolition and retrofit operations, until such supports can be suitably reestablished.

G. Environmental Controls: Use water sprinkling, temporary enclosures, and other methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection.

1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.

2. Provide necessary protection to prevent airborne construction material, debris, fumes, etc from entering the adjacent building, air intakes, etc.

3. Provide necessary ventilation systems, independent of building systems, to remove dust and fumes from the work area.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. General: Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of areas to be demolished and adjacent facilities to remain.

1. Cease operations and notify the Owner's Representative immediately if the safety of the structure appears to be endangered. Take precautions to support structure until a determination is made for continuing operations.

2. Cover and protect furniture, equipment, and fixtures from soilage or damage when demolition work is performed in areas where such items have not been removed.

3.2 DEMOLITION

A. General: Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on the Drawings in accordance with the demolition schedule and governing regulations.

1. The Contractor shall size and locate demolition equipment throughout the structure and promptly remove debris in a manner to avoid imposing excessive loads on supporting walls, floors, or framing.

2. Provide services for effective air and water pollution controls as required by local authorities having jurisdiction.

3. Perform demolition using procedures and equipment which will avoid spalling, cracking, or other damage to existing concrete or finishes.

B. If unanticipated mechanical, electrical, or structural elements that conflict with the intended function or design are encountered, investigate and measure both the nature and extent of the

conflict. Submit a report to the Owner's Representative in written, accurate detail. Pending receipt of a directive from the Owner's Representative, rearrange the selective demolition schedule as necessary to continue overall job progress without undue delay.

3.3 DISPOSAL OF DEMOLISHED MATERIALS

A. Remove from building site debris, rubbish, and other materials resulting from demolition operations. Transport and legally dispose of demolished materials off-site.

1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling, and protection against exposure or environmental pollution.

2. Burning of removed materials is not permitted on the project site.

3.4 CLEANUP AND REPAIR

A. General: Upon completion of demolition work, remove tools, equipment, and demolished materials from the site. Remove protections not required for subsequent construction activities and leave interior areas broom clean.

1. Repair demolition performed in excess of that required. Return elements of construction and surfaces to remain in the condition existing prior to starting operations. Repair adjacent construction or surfaces soiled or damaged by selective demolition work.

2. Clean adjacent facilities of dust, dirt, and debris resulting from demolition operations.

END OF SECTION 020700

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Form-facing material for cast-in-place concrete.
2. Shoring, bracing, and anchoring.

1.3 DEFINITIONS

A. 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.

B. 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.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, and contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.5 ACTION SUBMITTALS

A. Product Data: For each of the following:

1. Exposed surface form-facing material.
2. Concealed surface form-facing material.
3. Form ties.
4. Form-release agent.

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

1. Indicate dimension and locations of construction joints required to construct the structure in accordance with ACI 301.
   a. Location of construction joints is subject to approval of the Engineer.
2. Indicate proposed schedule and sequence of stripping of forms and shoring removal.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing and inspection agency.

B. Field quality-control reports.

C. Minutes of preinstallation conference.

1.7 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork and shores in accordance with ACI 301, to support vertical, 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.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-In-Place Concrete, and as follows:

   a. Plywood, metal, or other approved panel materials.

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

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

2.3 RELATED MATERIALS

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

B. 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.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
2. Form release agent for form liners shall be acceptable to form liner manufacturer.

C. 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.

1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. 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 033000 "Cast-In-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

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

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

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

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

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

H. Do not chamfer exterior corners and edges of permanently exposed concrete.

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

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. 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.

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

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

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

3.2 INSTALLATION OF EMBEDDED ITEMS

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

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 FIELD QUALITY CONTROL

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

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

C. Inspections:

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

END OF SECTION 031000

SECTION 032000 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section Includes:

1. Steel reinforcement bars.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Steel-reinforcement installation.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Epoxy repair coating.
3. Zinc repair material.
4. Bar supports.

B. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Statements: For testing and inspection agency.

B. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

a. For reinforcement to be welded, mill test analysis for chemical composition and carbon equivalent of the steel in accordance with ASTM A706/A706M.

C. Field quality-control reports.

D. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

B. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.4/D 1.4M.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

B. Low-Alloy Steel Reinforcing Bars: ASTM A706/A706M, deformed.

C. Headed-Steel Reinforcing Bars: ASTM A970/A970M.

2.2 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place.

1. Manufacture bar supports from steel wire, plastic, or precast concrete in accordance with CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

a. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.
b. For stainless steel reinforcement, use CRSI Class 1 plastic-protected steel wire, all-plastic bar supports, or CRSI Class 2 stainless steel bar supports.

B. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain.

2.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars shall be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.

3.3 INSTALLATION TOLERANCES

A. Comply with ACI 117.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

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

C. Inspections:

1. Steel-reinforcement placement.

END OF SECTION 032000

SECTION 032500 – FIBER REINFORCED POLYMER REINFORCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

A. This Section includes the provisions of all labor, materials, supervision, equipment, and incidentals required to install externally bonded fiber-reinforced polymer (FRP) reinforcement to strengthen concrete structures in the form of:

1. Externally bonded glass fiber reinforced polymer (GFRP) fabric reinforcement wrap
2. Externally bonded carbon fiber reinforced polymer (CFRP) fabric reinforcement wrap

B. Related Sections

1. Division 01 Section “Quality Requirements" for independent testing agency procedures and administrative requirements.
2. Division 02 Section “Shoring And Bracing” for shoring and bracing procedures.
3. Division 03 Section “Cast-in-place Concrete” for materials and procedures for repairing spalled and delaminated concrete.

C. Cooperation and coordination with all other trades in executing the work described in the contract.

D. Contractor shall fully acquaint themselves with the existing site conditions and work area accessibility limitations.

E. Contractor shall ensure that there is adequate ventilation in work areas and that work does not result in nauseating, annoying, or toxic fumes/odors migrating to occupied areas.

F. Contractor shall provide fencing or other guards around the work area with appropriate signage to keep non-construction people from entering the work area.

G. Contractor shall provide all traffic cones or barriers to direct traffic, based on the approved traffic routing plans developed and submitted by the Contractor.

1.3 REFERENCES

A. American Concrete Institute (ACI)

1.	ACI 440R	Report On Fiber-Reinforced Polymer (FRP) Reinforcement For Concrete Structures
2.	ACI 440.2R	Guide For The Design And Construction Of Externally Bonded FRP Systems For Strengthening Concrete Structures

3. ACI 440.3R Guide Test Methods For Fiber-Reinforced Polymer (FRP) Composites For Reinforcing Or Strengthening Concrete And Masonry Structures
4. ACI 440.9R Guide To Accelerated Conditioning Protocols For Durability Assessment Of Internal And External Fiber-Reinforced Polymer (FRP) Reinforcement
5. ACI 440.12 Strengthening of Concrete Structures with Externally Bonded Fiber-Reinforced Polymer (FRP) Materials Using the Wet Layup Method - Specification

B. International Concrete Repair Institute (ICRI)

1. ICRI 210.3R Guide for Using In-Situ Tensile Pulloff Tests to Evaluate Bond of Concrete Surface Materials
2. ICRI 310.2R Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair
3. ICRI 330.2 Guide Specification For Externally Bonded FRP Fabric Systems For Strengthening Concrete Structures

C. ICC Evaluation Service, Inc. (ICC-ES)

1. AC 125 Concrete and Reinforced and Unreinforced Masonry Strengthening Using Externally Bonded Fiber-reinforced Polymer (FRP) Composite Systems
2. AC 178 Inspection and Verification of Concrete and Reinforced and Unreinforced Masonry Strengthening Using Fiber-reinforced Polymer (FRP) Composite or Steel-reinforced Polymer (SRP) Composite Systems

D. American Society for Testing and Materials (ASTM)

1. ASTM C1583 Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method)
2. ASTM D3039 Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
3. ASTM D4065 Standard Practice for Plastics: Dynamic Mechanical Properties: Determination and Report of Procedures
4. ASTM D5687 Guide for Preparation of Flat Composite Panels with Processing Guidelines for Specimen Preparation
5. ASTM D7522 Standard Test Method for Pull-Off Strength for FRP Laminate Systems Bonded to Concrete Substrate
6. ASTM D7565 Standard Test Method for Determining Tensile Properties of Fiber Reinforced Polymer Matrix Composites Used for Strengthening of Civil Structures
7. ASTM E122 Standard Practice for Calculating Sample Size to Estimate, With Specified Precision, the Average for a Characteristic of a Lot or Process

1.4 PREINSTALLATION MEETING

A. Preinstallation Conference: Before proceeding with the work of this section conduct a preinstallation conference at the project site.

B. Contractor shall invite sub-contractors, representatives of authorities having jurisdiction, manufacturer's technical representative, Owner, Engineer, consultants, independent testing

agency, and other concerned entities to participate in the preinstallation conference either in person or remotely by conference call. Notify participants at least seven days before the conference.

C. Review project requirements of this section, including installation phasing, shoring, protective measures, environmental limitations, forecasted weather conditions, substrate repair, crack injection, surface preparation, priming, layup procedure, installation procedures, finishing system, minimum curing period, contractor's quality control plan, testing and inspection procedures, and repair procedures.

1.5 ACTION SUBMITTALS

A. Make submittals in accordance with the requirements of Division 01 and as specified in this Section.

B. Product Data: Manufacturer's most current Product Data Sheets (PDS), Safety Data Sheets (SDS), Current Evaluation Service Report (ESR), and installation instructions for each product proposed for use on the project.

C. Shop Drawings: Where not fully detailed on the Engineering Contract Documents or where deviation from the Contract Documents is requested submit Shop Drawings showing locations and extent of the FRP assemblies and details of all typical conditions. Include plans, sections, details, and attachments to other work. Clearly indicate and mark requested deviations from the design drawings.

D. Phasing Plan: Written execution process and plans depicting the phasing of the demolition and installation process. The Contractor shall coordinate the phase plan with all trades. The phasing plan shall indicate when work for each trade will be performed for specific zones.

E. Material Test Reports:

1. FRP Structural Performance Report: Evaluation Service Report (ESR) or other special report indicating tested FRP structural strengths and manufacturers' recommended procedure for accommodating structural loading with the FRP.

2. Chemical Exposure performance Report: Report indicating FRP's durability to resist specific chemical exposure in service.

F. Delegated-Design Submittal: Where strengthening design has been delegated to the FRP Manufacturers/Contractor retained engineer or where the Contractor requests the use of a substitute FRP system, submit project-specific engineering calculations for review by the Structural Engineer of Record. All designs and calculations shall be performed in accordance with the recommendations of ACI 440.2R-17. Engineering calculations shall be signed and sealed by a Professional Engineer registered in the jurisdiction where the project is located.

1. Structural Engineer of Record will provide load requirements and available record documents of the structure for substitute design, if requested.

1.6 INFORMATION SUBMITTALS

A. Minutes of Pre-installation Meetings.

B. Qualification Data: Submit documentation of the required qualifications specified in part Quality Assurance of this Section.

C. Applicator Certification: Signed by the manufacturer certifying that the Installer is approved, authorized, or licensed by the manufacturer to install the specified systems and is eligible to receive the specified manufacturer's warranty.

D. Field Quality Control/Assurance Reports: Submit electronic copies of The Contractor's field quality control logs and reports, quality assurance inspection reports, and testing reports.

1.7 QUALITY ASSURANCE

A. Work shall conform to requirements of the American Concrete Institute (ACI) as applicable except where more stringent requirements are shown on Drawings, specified in this Section, in the FRP system Evaluation Service Report (ESR), or in the manufacturer's published instruction.

B. Qualifications:

1. Manufacturer's Qualifications: Companies furnishing the materials shall have a proven track record of at least 5 years with no less than 50 documented successful field installations. These companies FRP system shall hold a current Evaluation Service Report (ESR) or provide testing data and design guidance showing conformance with ICC-ES AC125, ICC-ES AC178, and ACI 440.2R. These companies shall have a program involving training and certification for installers. These companies shall also be capable of providing local manufacturers' site representation.

2. Contractor's Qualifications: Contractor performing the work of this Section shall be a manufacturer-approved installer, and shall have at least 5 years of FRP experience in work related to this project.

3. Installer's Qualifications:

   a. Certification: Written approval or license of the applicator by FRP system manufacturer. Show evidence of a minimum of 3 projects completed by the applicator over the previous 5 years using the submitted system.

   b. Only adequately trained and experienced personnel shall be used for the work of this Section.

C. Quality Control Plan:

1. Manufacturer's Quality Control Procedures: Obtain documentation from the manufacturer indicating field inspections and testing that the manufacturer requires to be performed by the Contractor (Quality Control) or Testing and Inspection Agencies (Quality Assurance). Additionally, submit a written list of field inspections and testing that are recommended, but not required. Indicate how often the inspections and testing should be performed for both required and recommended field inspections and testing.

2. Contractors Quality Control Plan: Submit a written plan of field inspections to be performed by the Contractor on a routine basis. The quality control plan shall meet the requirements of Part "Quality Control" below, indicating how often the inspections will

be performed, to what extent the inspections will be performed, and what individual will be responsible for performing each of the inspections.

D. Quality Control Plan: At a minimum, the Contractor quality control plan shall address the following items and indicate the required frequency.

1. Procedures for tracking and verifying the quality of all FRP constituent materials.
2. Procedures for the inspection of all prepared surfaces prior to installation of the FRP.
3. Temperature, humidity, and other weather constraints
4. Final cure time requirements.
5. Procedures for the inspection of the installation of the FRP system and completed work.
6. Procedure for preparation and testing of quality control test samples.
7. Procedures for the repair of defective work.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in manufacturer's original, factory-sealed, unopened packages and containers bearing the manufacturer's name and label, and the following information:

1. Product name or title of the material.
2. Manufacturer's stock/batch number, date of manufacture, and expiration date.
3. Color name and number for the finish system.
4. Handling instructions and precautions.

B. Unless otherwise recommended by the FRP manufacturer, store epoxy and coating materials not in use in tightly covered containers in a well-ventilated area at an ambient temperature between 45°F (7°C) and 100ºF (38ºC). Maintain storage containers in a clean condition, free of foreign materials and residue.

C. Store all materials off of the ground, under opaque cover, and in a dry location. Protect from dust, direct sunlight, physical damage, rain, water, freezing and excessive heat, foreign matter, or other detrimental conditions until ready for use. Maintain storage materials in a clean, dry condition, free of foreign materials and residue.

D. Comply with the manufacturer’s written instructions for handling all constituent materials comprising the FRP system, cleaning solvents, and any other materials required to complete the project.

1. Handle fiber sheets with care. Avoid separating fibers, folding, or wrinkling fiber sheets to prevent damage to the sheets and breakage of fibers.
2. Stack cut fiber sheets flat or on a roll with a radius in compliance with the manufacturer’s written recommendations. Do not fold sheets.

E. Damaged Material: Any materials that are found to be damaged or stored in any manner other than stated above will be rejected, removed, and replaced.

1.9 FIELD CONDITIONS

A. Weather Limitations: Apply FRP within the range of ambient and substrate temperatures recommended by the FRP manufacturer. Do not apply RFP to a damp or wet substrate, or when

the temperature is below 40°F (5°C) or above 130°F (55°C) unless otherwise approved by the FRP manufacturer.

1. Do not apply RFP in snow, rain, fog, or mist.

2. When the ambient temperature is below 40°F (5°C) Contractor shall provide an auxiliary heat source to raise the ambient and surface temperature to the desired level. Only clean burning or clean service heat sources like propane or electric heaters shall be used. Such auxiliary heat sources shall not contaminate the uncured FRP system. The Contractor shall provide adequate ventilation to prevent accelerated carbonation of the concrete substrate due to carbon dioxide build-up for burred fuel-based heat sources.

B. Maintain adequate ventilation during the application and curing of FRP materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain and use materials for work governed by this section from a single manufacturer.

2.2 SYSTEM EVALUATION SERVICE REPORTS

A. Fabric Saturated Systems: ICC-ES AC 125

1. Sika Corporation; ESR-3288
2. MAPEI Corporation; ESR-3499
3. V2 Composites; ESR-3573
4. Simpson Strong-Tie; ESR-3403
5. Critical Infrastructure | ClockSpring | NRI, GeoTree; ESR-3663
6. Structural Technologies; ESR-3606

2.3 FABRICS/FIBER SHEETS

A. Unidirectional Fabric: ACI 440.8

1. GFRP Fabric: Approximately 14 oz/yd^2 (915 g/m^2)
   a. V2 Composites; StructureWrap V2 140 UG

2. GFRP Fabric: Approximately 27 oz/yd^2 (915 g/m^2)

   a. Sika Corporation; SikaWrap Hex-100 G
   b. MAPEI Corporation; MapeWrap G Uni-AX
   c. V2 Composites; StructureWrap V2 280 UG
   d. Simpson Strong-Tie; CSS-CUGF27
   e. Structural Technologies; V-Wrap EG50

3. CFRP Fabric: Approximately 7 oz/yd^2 (237 g/m^2)

   a. Sika Corporation; SikaWrap Hex-230 C

4. CFRP Fabric: Approximately 9 oz/yd^2 (305 g/m^2)

    a. Sika Corporation; SikaWrap Hex-117 C
    b. MAPEI Corporation; MapeWrap C Uni-AX 300
    c. V2 Composites; StructureWrap V2 090 UC
    d. Simpson Strong-Tie; CSS-UCF10
    e. ClockSpring | NRI, GeoTree; RenewWrap ESR CF335
    f. Structural Technologies; V-Wrap C100HM

5. CFRP Fabric: Approximately 11 oz/yd^2 (373 g/m^2)

    a. Simpson Strong-Tie; CSS-CUCF11

6. CFRP Fabric: Approximately 18 oz/yd^2 (610 g/m^2)

    a. Sika Corporation; SikaWrap Hex-103 C
    b. MAPEI Corporation; MapeWrap C Uni-AX 600
    c. V2 Composites; StructureWrap V2 190 UC
    d. Simpson Strong-Tie; CSS-UCF20
    e. ClockSpring | NRI, GeoTree; RenewWrap ESR CF600
    f. Structural Technologies; V-Wrap C200HM

7. CFRP Fabric: Approximately 22 oz/yd^2 (746 g/m^2)

    a. Simpson Strong-Tie; CSS-CUCF22

8. CFRP Fabric: Approximately 37 oz/yd^2 (1255 g/m^2)

    a. Sika Corporation; SikaWrap Hex-103 C 2X
    b. Structural Technologies; V-Wrap C400HM

9. CFRP Fabric: Approximately 44 oz/yd^2 (1492 g/m^2)

    a. Simpson Strong-Tie; CSS-CUCF44

B. Bidirectional Fabric: ACI 440.8, Balanced 0°/90° fiber orientation

1. GFRP Fabric: Approximately 9 oz/yd^2 (305 g/m^2)

    a. Sika Corporation; SikaWrap Hex-106 G
    b. MAPEI Corporation; MapeWrap G Bi-Ax

2. GFRP Fabric: Approximately 12 oz/yd^2 (407 g/m^2)

    a. Simpson Strong-Tie; CSS-BGF012
    b. ClockSpring | NRI, GeoTree; RenewWrap GF400 BD
    c. Structural Technologies;

3. GFRP Fabric: Approximately 18 oz/yd^2 (610 g/m^2)

    a. Simpson Strong-Tie; CSS-BGF018
    b. ClockSpring | NRI, GeoTree; RenewWrap GF600 BD

4. CFRP Fabric: Approximately 6 oz/yd^2 (203 g/m^2)

a. Sika Corporation; SikaWrap Hex-113 C
b. MAPEI Corporation; MapeWrap C BI-AX 230
c. Simpson Strong-Tie; CSS-BCF06

5. CFRP Fabric: Approximately 11 oz/yd^2 (373 g/m^2)

a. MAPEI Corporation; MapeWrap C BI-AX 360

6. CFRP Fabric: Approximately 18 oz/yd^2 (610 g/m^2)

a. Sika Corporation; SikaWrap Hex-115 C
b. Simpson Strong-Tie; CSS-BCF018
c. Structural Technologies; V-Wrap C220B

C. Bidirectional Fabric: ACI 440.8, Balanced -45°/45° fiber orientation

1. GFRP Fabric: Approximately 24 oz/yd^2 (814 g/m^2)

a. Simpson Strong-Tie; CSS-CBGF424
b. Structural Technologies; V-Wrap EG50B

2. CFRP Fabric: Approximately 17 oz/yd^2 (576 g/m^2)

a. Sika Corporation; SikaWrap-600C +-45
b. Simpson Strong-Tie; CSS-BCF418

2.4 PRE-SATURATED FABRICS/FIBER SHEETS

A. Pre-Saturated Unidirectional GFRP Fabric; 13 oz/yd^2 (440 g/m^2)

1. Sika Corporation; SikaWrap 430 G Pre-saturated
2. ClockSpring | NRI, GeoTree; Titan-113G MCU

B. Pre-Saturated Unidirectional GFRP Fabric; 27 oz/yd^2 (915 g/m^2)

1. Sika Corporation; SikaWrap 100 G Pre-saturated
2. ClockSpring | NRI, GeoTree; Titan127GMCU

C. Pre-Saturated Unidirectional CFRP Fabric; 9 oz/yd^2 (305 g/m^2)

1. Sika Corporation; SikaWrap 117 C Pre-saturated
2. ClockSpring | NRI, GeoTree; Titan-109C MCU

D. Pre-Saturated Unidirectional CFRP Fabric; 18 oz/yd^2 (610 g/m^2)

1. Sika Corporation; SikaWrap 103 C Pre-saturated
2. ClockSpring | NRI, GeoTree; Titan-118C MCU

2.5 PROTECTIVE HIGH-PERFORMANCE ACRYLIC FINISH COATS

A. Intumescent Coatings

1. ClockSpring | NRI, GeoTree; RenewWrap Top Coat E84

2. Structural Technologies; Tstrata FC

2.6 ACCESSORY PRODUCTS

A. Epoxy Fillers: Epoxy paste for filling small holes in the substrate surface.

1. Sika Corporation; Sikadur 30
2. MAPEI Corporation; MapeWrap 11 or 12
3. V2 Composites; StructureWrap Patch and Fill
4. Simpson Strong-Tie; CSS-EP Epoxy Paste
5. ClockSpring | NRI, GeoTree; RenewWrap EZ Paste or FB-E7S Adhesive
6. Structural Technologies; V-Wrap PF Putty Filler

B. Epoxy Putty: Epoxy paste for smoothing substrate surface irregularities such as shallow ridges.

1. Sika Corporation; Sikadur 30
2. MAPEI Corporation; MapeWrap 11 or 12
3. V2 Composites; StructureWrap Patch and Fill
4. Simpson Strong-Tie; CSS-EP Epoxy Paste
5. ClockSpring | NRI, GeoTree; Filler Putty FE-Z or FB-E7S Adhesive
6. Structural Technologies; V-Wrap 770 or 700S Epoxy Polymer Matrix

C. GFRP Anchors

1. Simpson Strong-Tie; CSS-GA
2. Structural Technologies; V-Wrap Glass Fiber Anchor

D. CFRP Anchors

1. Sika Corporation; SikaWrap FX-50 C
2. MAPEI Corporation; MapeWrap C Fiocco
3. Simpson Strong-Tie; CSS-CA
4. ClockSpring | NRI, GeoTree; RenewAnchors
5. Structural Technologies; V-Wrap HM Carbon Fiber Anchor

2.7 SUBSTITUTIONS

A. Product substitutions may be considered provided complete technical information and job references are submitted and approved prior to commencement of work.

B. Changes in products required to suit temperature, environmental conditions, and local VOC regulations at the time of material application shall be specified as separate line items by the Contractor showing credit or additions to the price for the various tasks.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Identify and Mark the Location of Repair. Field verify dimensions of concrete members to be strengthened with FRP.

B. Visually assess the member to be strengthened and all surfaces to receive the FRP system for conditions that may affect the installation. Report all areas exhibiting evidence of deterioration or distress to the Engineer prior to the initiation of surface preparation or FRP installation.

C. Provide all necessary equipment that is in clean and operating condition and in sufficient quantities to ensure continuous and uninterrupted FRP installation.

D. For NSM reinforcement non-destructively located and document the depth of existing embedded reinforcement with Ground Penetration Radar (GPR) and other embedded items at proposed locations for new NSM reinforcement. Verify embedded reinforcement and other embedded items will not interfere with the proposed NSM reinforcement.

1. Notify the Engineer and Owner if existing obstructions interfere with the installation of the proposed NSM reinforcement.

E. Shore or unload members to receive FRP where indicated on the Contract Documents.

3.2 SUBSTRATE REPAIRS

A. Substrates must be free from delamination, spalls, and other defects as determined by sounding. Make all necessary substrate and crack repairs prior to initiating surface preparation.

1. Perform concrete spall and delamination repair as specified in ACI 546R and ICRI Standards.
2. Perform epoxy injection of concrete cracking as specified in ACI 548.15 and ICRI 110.2 Standards. All cracking greater than 1/100 inch (0.25 mm) in width shall be injected.

3.3 SURFACE PREPARATION

A. Remove localized out-of-plane variations like form lines that exceed 1/32-inch. (0.8 mm) or to the tolerances recommended by the FRP System manufacturer.

1. Surface levelness for precured laminates shall be a maximum of 1/4-inch (6 mm) per 6 feet (2 meters) and no more than 1/8-inch (3 mm) per 1 foot (305 mm).

B. Surface Profile: Abrasively prepare the concrete surface to a surface profile of ICRI CSP-3 and per the requirements of the FRP system manufacturer.

C. Rounding Corners: Round all outside corners and sharp edges where the FRP is wrapped around the member to a minimum radius of 1/2-inch (13 mm) per the requirements of the FRP system manufacturer.

D. NSM Grooves: Groove width and depth shall be 1.5 times the FRP reinforcement diameter unless otherwise recommended by the FRP manufacturer. Grind or sawcut groove edges and chip out concrete within the groove as shown in the Project Details for NSM strengthening and indicated in the manufacturer's instructions. Do not damage existing embedded reinforcement and other embedded items during grinding, sawcutting, and chipping.

E. Surface Cleaning: Clean concrete surfaces using methods recommended by the FRP System Manufacturer to remove any dust, laitances, grease, oil, curing compounds, wax, impregnations, stains, paint coatings, surface lubricants, foreign particles, weathered layers, and any other bond-inhibiting material.

F. Contractor shall obtain all regulatory approvals to perform abrasive blasting from all authorities having jurisdiction. Abrasive-blasting operations shall comply with the requirements of OSHA and DHHS (NIOSH) Publication No. 75-120 (NTIS Standard PB-246-697).

G. Contractor shall obtain all regulatory approvals to perform abrasive blasting from the California Air Resource Board or the Local Air District where abrasive blasting will be performed. Abrasive-blasting operations shall comply with the requirements of SCAQMD Rule 1140, OSHA, and DHHS (NIOSH) Publication No. 75-120 (NTIS Standard PB-246-697).

3.4 CUTTING AND DRY FITTING FRP

A. Fabrics shall be cut to appropriate lengths by using sharp commercial quality, heavy-duty scissors. Cutting shall be completed cleanly with a single cutting pass of the scissors to avoid weakening or fraying the fabric.

B. Rods and laminates may be cut to the required lengths using a diamond cutting blade chop saw or grinder. The rods shall be wrapped with duct tape in the cutting zone to minimize splintering.

C. Dry fit non-pre-saturated FRP materials to ensure fit up prior to impregnating the fabric with saturant resin.

D. Lap splices in the FRP shall not be permitted unless otherwise detailed on the project documents or otherwise approved in writing by the Engineer.

3.5 MIXING OF RESIN CONSTITUENT MATERIALS

A. Mix all resin materials in accordance with the manufacturer's instructions. Follow the manufacturer's instructions regarding mix ratio, temperature range, paddle type, mix duration, etc.

B. Condition epoxy materials at a temperature between 65°F (18°C) and 80°F (27°C), unless otherwise recommended by the FRP manufacturer.

C. Do not dilute any resin constituent materials with any organic solvents or thinners. Discard any mixed resin that exceeds its pot life or shows signs of increased viscosity.

D. Mix only the quantity of resin which can be used within its pot life.

E. Environmental Limitations for Mixing and Application.

1. Do not apply the FRP system or any of its constituent materials to frozen or wet surfaces. Do not apply FRP materials if rain, snow, or dew point condensation is expected.
2. Ensure ambient and concrete surface temperatures are within the range specified by the manufacturer for FRP installation.
3. If necessary, enclose the workspace and use propane, electric, or other clean heat sources to raise and maintain the ambient and concrete surface temperatures to the ranges recommended by the manufacturer. Do not use kerosene heaters.
4. Ensure moisture levels in the concrete substrate and moisture vapor transmission rates comply with the manufacturer's written recommendations.
5. Do not install the FRP system when environmental conditions support moisture vapor transmission from the concrete substrate.

6. Commencement of FRP installation will constitute acceptance of substrate conditions by the Contractor

3.6 PRIMING AND PUTTY FILLING

A. Coat the concrete surface to receive the FRP system with a primer resin using a medium nap paint roller or other tools recommended by the manufacturer. Apply primer at a coverage rate such that it penetrates the pores of the concrete substrate but does not drip or run.

B. Fill any bug holes or small voids and level any uneven surfaces with the putty resin using a trowel or putty knife or other tools recommended by the manufacturer to apply the putty. Do not apply the putty until the primer is tack-free, unless approved by the manufacturer. Fillers or other thickening agents may be added to the putty in accordance with the manufacturer's instructions.

1. Do not apply putty to a previously applied primer or putty coat if that coat has fully cured, unless first prepared per the manufacturer's instructions.

3.7 SURFACE-MOUNTED FABRIC/FIBER SHEET WRAP INSTALLATION

A. Apply FRP in accordance with the Manufacturer's instructions and recommendations.

B. Wet Lay-Up Method

1. Impregnating fabric/fiber sheet with saturating resin following the manufacturer's instructions. Apply saturating resin using a medium nap roller or mechanical saturator.

2. Factory prepared; pre-saturated fabric/fiber sheet may be used instead of field saturation.

3. Do not apply saturating resin or impregnated fiber sheet to a previously applied resin coat if that coat has fully cured, unless prepared per the manufacturer's instructions.

4. Place the fiber sheet onto the substrate with the fibers aligned in the direction indicated on the drawings.

5. Roll fiber sheets in the direction of the fibers using a fin roller to remove any air entrapped between the fiber sheets and the concrete surface and to fully impregnate the fiber sheets with saturating resin.

C. Achieve full contact with the concrete substrate during rolling.

1. Do not roll unidirectional fiber sheets in the direction transverse to the fibers to avoid damaging the fibers.

2. Do not turn fiber sheets at inside corners such as at the intersection of beams/joints to the underside of slabs.

D. Follow the manufacturer's instructions for installing multiple fiber sheet plies. Each ply shall be oriented as shown in the Contract Documents.

1. Limit the number of plies applied in a single day to that which can be supported by the previously applied system without sloughing or sliding.

2. Do not apply additional fiber sheet plies to previously cured plies unless first prepared per the manufacturer's instructions. Apply an additional coat of saturating resin, if required by the manufacturer.

E. Lap Splicing of Fiber Plies: Provide lap splices equal to or exceeding the length recommended by the manufacturer and not less than 8-inch (200 mm) such that the full tensile strength of the fiber sheet is achieved. Install lap splices in acceptable regions (low moment or low shear) as indicated on the drawings or sketches. Stagger lap splices for multiple plies or side-by-side installations unless noted otherwise on the drawings or sketches.

1. No lap splice is required in the perpendicular direction relative to the fiber orientation for unidirectional sheets

F. Anchoring of FRP Sheets: Secure approval of the FRP anchoring system before the start of construction. Install FRP anchoring system in accordance with drawings and manufacturer's written recommendations.

G. Adhesion Testing FRP Extensions: Where possible and in coordination with the Owner, Engineer, and Testing Laboratory, FRP termination shall be extended approximately 8-inches (200 mm) beyond what is structurally required by the project documents for the purpose of adhesion testing. When not possible an isolated 12-inch (305 mm) square FRP patch may be installed adjacent to the FRP work for the purpose of adhesion testing.

1. Damage caused by adhesion testing at these extensions or isolated test patches does not need to be repaired with FRP. Test patches shall be coated with the protective high-performance finish coat or fully removed by grinding to the concrete substrate.

3.8 FINISHING

A. Finishing: Coat FRP repair with a protective high-performance acrylic concrete coating as specified in Section "High-Performance Concrete Coatings."

1. Fire Protection: The FRP strengthen has been designed considering the impact of high temperature by ensuring that the existing unstrengthened members have adequate strength to resist the applied fire service loads in accordance with ACI 440.2R and ASCE 7, and therefore the use of a fire protection finishing system is not required.

3.9 PROTECTION

A. Protect finished installation of FRP Reinforcement from rain, sand, dust, etc. using protective sheeting or other barriers. Do not allow protective sheeting to come in contact with the finished application.

B. Do not allow bare metal to come into direct contact with the CFRP system. Protect metal hardware from galvanic corrosion by providing an insulating barrier of GFRP locally between the CFRP and the metal.

C. Do not install penetrations or anchors through installed FRP systems unless otherwise noted on the structural contract documents.

D. Do not install sharp-edged equipment or items over the installed FRP systems that may damage or cut the embedded fabric fibers.

E. Do not expose installed FRP to temperatures exceeding the service range of the FRP system as recommended by the FRP manufacturer.

F. Do not allow the FRP to be loaded until the system is fully cured. Provide barricades or shoring system as needed to prevent the FRP from being loaded.

3.10 CURING

A. Allow FRP repair to cure for at least two weeks at an average ambient temperature of 68°F (20°C) or as recommended by the FRP product manufacturer before loading the element.

B. If the average ambient conditions for curing will be less than 50°F (10°C) the Contractor shall condition the environment surrounding the FRP Reinforcement to meet the above requirements. This artificial environment shall be kept in place for the full curing period and shall be protected from being disturbed using barriers.

3.11 IDENTIFICATION AND REPAIR OF DEFECTS

A. Identification and repair of FRP defects shall be in accordance with ICC-ES AC178 and ACI 440.2R. The following FRP defects do not require repair.

1. Small entrapped air pockets and voids not larger than 1/8-inch (3.2 mm) diameter naturally occur in mixed resin systems and do not require repair.

2. Delaminations of less than 2 square inches (13 square cm) with an occurrence rate of no more than 10 delaminations per 10 square feet (1 square m) of the laminated area do not require repair. The maximum total delamination area shall not be more than 5% of the total laminated area.

B. Repair all unacceptable defects found in the cured FRP system following the manufacturer's written recommendations for making repairs to the FRP system. All repairs shall be subject to the same application, curing, and quality control specifications as the original Work.

C. Submit all proposed repair procedures, other than those specified in this section, for the repair of defects in the FRP system, to the Engineer for approval before performing the repairs.

D. Surface Mounted Fabric Sheet FRP Repairs

1. Smaller delaminations not greater than 25 square inches (160 square cm) may be repaired by resin injection. The Engineer, in consultation with the manufacturer, shall approve the injection repair procedure. If any delamination growth is suspected between the FRP plies due to injection, the procedure shall be halted and reported to the Engineer and FRP Manufacturer.

2. Larger delaminations greater than 25 square inches (160 square cm) shall be repaired by selectively cutting away the delaminated FRP sheet, preparing the concrete and epoxy surfaces, and applying an overlapping FRP sheet of equivalent plies and width for the full length of the FRP strengthening. Shorter lap-spliced, patch-type repairs may be approved by the Engineer for low-stress zones in the FRP strengthening system.

3.12 CLEANUP

A. Remove excess epoxy resin before curing the FRP strengthening using clearers approved by the FRP manufacturer. Cured epoxy resin on surfaces other than the FRP shall be removed by abrasive means.

1. Do not damage the installed FRP during the abrasive removal of epoxy resin.

2. Do not use solvents to remove or clean already cured epoxy resin.

3.13 FIELD QUALITY CONTROL

A. Responsibilities

1. Manufacturer's Responsibility:

a. Manufacturer is responsible for performing quality assurance during the manufacturing process.

b. Manufacturer's field representation shall be responsible for periodically performing quality control reviews when required by Part 1 "Quality Assurance" in the Specification Section.

2. Contractor's Responsibility:

a. Contractor is responsible for performing continuous field quality control during the progress of work including workmanship and materials furnished by his subcontractors and suppliers.

b. Contractor is responsible for maintaining logs of quality control inspections and testing performed in the field. Logs shall be submitted to the Owner, Engineer, Inspection and Testing agencies, and Manufacturer on a weekly basis.

B. Minimum Quality Control Requirements

1. The Contractor shall perform all manufacturer's recommended and required field quality control procedures to ensure proper preparation and application.

2. The Contractor shall coordinate with the Manufacturer to ensure the availability of a local qualified manufacturer representative throughout the duration of work.

3. The Contractor shall employ surface profile comparators in general conformance with ICRI 310 for concrete and ASTM D 4417 Method A for metal to verify the required surface profile has been achieved for all shot/abrasive blasting.

4. The Contractor shall perform testing for moisture in the concrete substrate by plastic sheet method according to ASTM D 4263.

5. The Contractor shall employ environmental and substrate monitoring of temperature, dewpoint temperature, and relative humidity during mixing and application of the epoxy.

6. The Contractor shall record all material batch numbers and their installed location within the structure and testing samples.

7. The Contractor shall employ wet mil gage testing in general conformance with ASTM D 4414 Method A.

8. The Contractor shall review and sound all installed FRP systems, 24 hours after installation, for the presence of delaminations, voids, and bubbles to be repaired.

9. Fabric FRP Test Samples: During the installation of the fabric-based FRP work for the project, the Contractor shall prepare 3 fabric FRP test samples for unidirectional and balanced bidirectional FRP or 6 fabric FRP test samples for unbalanced bidirectional FRP. Each fabric FRP sample shall be a minimum 12-inch (305 mm) square prepared on glass in accordance with ASTM D3039 using the same methods used for the field installation of the FRP system.

3.14 FIELD QUALITY ASSURANCE

A. Responsibilities

1. Owner's Responsibility

a. Owner shall retain the Inspection and Testing Agencies under a separate contract in accordance with the referenced building code and Contract Documents for the project.

b. Cost associated with re-inspection, re-testing, additional inspections, and, additional testing shall be paid for by the Owner.

c. The Contractor shall retain the Testing and Inspection Agencies. Testing and Inspection Agencies shall be an agency acceptable to the Owner and Engineer.

d. Cost associated with re-inspection, re-testing, additional inspections, and, additional testing shall be paid for by the Contractor.

2. Contractor's Responsibility

a. It is the Contractor's responsibility to request and schedule all inspections and testing required by this Section.

b. Schedule all inspections and testing with the Inspection and Testing Agencies at least 7 days before performing the work.

c. Notify the Owner and Engineer of the work schedule at least 7 days in advance.

d. When the Inspection or Testing Agencies report results that are not in conformance with the project requirements or manufacturer's requirements, the Engineer and Owner reserve the right to amend the rate of testing, amend the rate of inspections, request additional testing, and request additional inspections.

1) Contractor shall reimburse the cost of all re-testing, re-inspection, additional testing, and additional inspections.

2) The cost of repair, rework, and/or replacement shall be borne by the Contractor.

3. Inspection and Testing Agencies' Responsibility

a. Inspection and Testing Agencies are responsible for conducting, monitoring, and reporting the results of all tests required under this Section.

b. Inspection and Testing Agencies have the authority to reject materials and work not meeting Specifications.

B. Inspections

1. Material Inspections: The Inspection Agency shall periodically inspect on-site materials for general conformance to the project documents and manufacturer's instructions.

   a. Verify material manufacture and model numbers comply with the project documents.
   b. Verify the expiration date of all epoxy materials.
   c. Verify FRP fabric's weights are as specified in the project documents.
   d. FRP rods and laminates are of the sizes specified in the project documents.

2. Inspection Agency shall document the ambient temperature, substrate surface temperature, relative humidity, the visual presence of surface moisture, and general weather conditions present during their inspections where epoxy is being mixed or installed. Document containment measures and auxiliary heat source types employed by the Contractor.

3. Inspection Agency shall periodically inspect prepared and cleaned surfaces that are ready for FRP application.

   a. Verify concrete spall repairs have been performed, have adequacy been cured, and are sound.
   b. Verify concrete cracks have been epoxy injected.
   c. Verify the concrete surface profile using ICRI surface profile chips.
   d. Note areas that do not meet the surface preparations requirements of the Evaluation Service Report, manufacturer's instructions, and the construction documents.

4. Inspection Agency shall periodically inspect the mixing and application procedures of all epoxy materials.

   a. Verify installation is in conformance with the Evaluation Service Report, manufacturer's instructions, and the construction documents.
   b. Verify the fiber orientation, size/weight, and quantity of plies are in conformance with the contract documents.
   c. Verify the fibers are not being installed crossing any sharp or unrounded edges.
   d. Verify Contractor is maintaining a record of all material batch numbers and their installed location within the structure and testing samples.
   e. Verify the mix proportion of epoxy primers, putties, fillers, saturants, and other adhesives.

5. Inspection Agency shall inspect all lap splices, FRP anchors, and special termination conditions detailed in the construction documents or shop drawings.

   a. Verify lap splice locations and lengths comply with project documents.
   b. Verify FRP anchor laps and splays comply with the FRP manufacturer's instructions; and that the spacing of the FRP anchors comply with project documents.

c. Verify special terminations have been installed as specified in the project documents.

6. Inspection Agency shall inspect all cured FRP systems for the presence of delaminations, voids, bubbles and any other defects to be repaired. Note the location and size of any defects found.

7. Inspection Agency shall continuously inspect all repairs to FRP defects.

C. Testing

1. Testing Agency shall test all cured FRP systems for the presence of delaminations, voids, bubbles and any other defects to be repaired by sounding. Note the location and size of any defects found.

2. Testing Agency shall prepare 3 samples of epoxy saturant material and conduct testing for Glass Transition Temperature (Tg) in accordance with ASTM D 3418, using post-cured samples.

3. Testing Agency shall mold three 1/2-inch (13 mm) x 1/2-inch (13 mm) x 5-inch (127 mm) bars using epoxy saturant and conduct testing for the Heat Deflection Temperature (HDT) in accordance with ASTM D 648.

4. Fabric FRP Testing Samples: Testing Agency shall test, Contractor prepared, fully cured, FRP Samples per ASTM D 3039. Cut test samples into at least 5 specimens that are 1-inch (25 mm) x 10-inch (254 mm). Test unidirectional FRP for properties of the major axis. Test balanced bidirectional FRP for properties of either of the two major axes. For unbalanced bidirectional FRP test half of the samples for properties of the major axis and test the remainder of the samples for properties of the minor axis. Report tensile modulus, ultimate tensile strength, percent elongation, and laminate thickness. Acceptability criteria shall be defined by the design mechanical properties published in the manufacturer's product data-sheet. Design mechanical properties shall be the ultimate mechanical properties that have been reduced in accordance with ACI 440.2R.

5. Testing Agency shall perform 3 adhesion tests of the installed FRP system per ASTM D 7522. The Engineer shall indicate locations to be tested. The system topcoat shall be locally omitted until after adhesion testing is complete. The acceptable tensile stress criteria is 200 psi (1380 kPa) for each test. Report individual readings and mode of failure. The Contractor shall repair test areas per the manufacturer's instructions.

END OF SECTION 032500

SECTION 033000 - CAST-IN-PLACE CONCRETE

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 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. The Contractor shall fully acquaint themselves with the existing site conditions and work area accessibility limitations.

C. Contractor shall ensure that there is adequate ventilation in work areas and that work does not result in nauseating, annoying, or toxic fumes/odors migrating to occupied areas.

D. Contractor shall provide fencing or other guards around the work area with appropriate signage to keep non-construction people from entering the work area.

E. Contractor shall provide all traffic cones or barriers to direct traffic, based on the approved traffic routing plans developed and submitted by the Contractor.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 REFERENCES

A. American Concrete Institute (ACI):

1.	ACI 117	Specification for Tolerances for Concrete Construction and Materials and Commentary
2.	ACI 201.2R	Guide to Durable Concrete
3.	ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
4.	ACI 211.5R	Guide for Submittal of Concrete Proportions
5.	ACI 232.1R	Report on the Use of Raw or Processed Natural Pozzolans in Concrete
6.	ACI 301	Specifications for Structural Concrete
7.	ACI 305R	Hot Weather Concreting
8.	ACI 306R	Cold Weather Concreting
9.	ACI 318	Building Code Requirements For Structural Concrete And Commentary

10. ACI 347 "Guide to Formwork for Concrete."
11. ACI 347.2 "Guide for Shoring/Reshoring of Concrete Multistory Buildings."

B. Concrete Reinforcing Steel Institute (CRSI):

1. CRSI "Manual of Standard Practice."

C. American Society for Testing and Materials (ASTM):

1. ASTM C39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
2. ASTM C109 Test Method for Compressive Strength of Hydraulic Cement Mortars
3. ASTM E2634 Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems

D. International Concrete Repair Institute (ICRI):

1. ICRI 310.2R Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair

E. International Code Council (ICC)

1. ICC AC353 Stay-in-place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete

F. American Welding Society (AWS):

1. AWS D1.4 "Structural Welding Code – Reinforcing Steel."

1.5 PREINSTALLATION MEETING

A. Preinstallation Conference: Conduct the conference at the Project site.

1. Before submitting design mixtures, review the concrete design mixture and examine procedures for ensuring the quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

   a. Contractor's superintendent.
   b. Owner's Testing/Inspection Agency related to concrete work.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.
   e. Special concrete finish Subcontractor.

2. Review as applicable to Project special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, curing procedures, forms, and form removal limitations, shoring and reshoring procedures, anchor rod, and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

3. The Contractor shall record the meeting minutes including topics discussed, decisions and agreements reached during the meeting. Electronically transmit meeting minutes to all parties in attendance.

1.6 RESPONSIBILITY

A. The design, construction, and safety of all formwork shall be the responsibility of the Contractor. All forms, shores, reshores, 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, reshores, backshores, and other bracing may be safely removed.

1.7 ACTION SUBMITTALS

A. Make submittals in accordance with requirements of Division 01 and as specified in this Section.

B. Product Data: Manufacturer's most current Product Data Sheets (PDS), Safety Data Sheets (SDS), and installation instructions for each product proposed for use on the project.

1. Curing compound data demonstrating specified moisture loss performance.
2. Evaporative retarder product and application data.
3. Certification of chloride screen effectiveness for penetrating sealers.

C. Formwork and Shoring Shop Drawings:

1. Formwork Drawings: Formwork drawings, prepared under the supervision and sealed by the formwork design engineer, shall be submitted for review and record purposes. Such shop drawings shall indicate all dimensions and 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.

2. 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 record purposes only and will not be reviewed or returned.

D. Temporary Structure Design Submittals:

1. Design Calculations: Submit, for record purposes, calculations of all concrete formwork sealed by the formwork design engineer.

E. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at the Project site.
2. Submit substantiating data for each concrete mix design proposed for use to the Engineer at least 15 working days prior to the start of construction. Data for each mix shall include the following:

    a. Mix identification number (unique for each mix submitted).
    b. Statement of intended mix use.

c. Method by which the concrete is intended to be placed (bucket, chute, or pump).
d. Mixture proportions.
e. Water/cementitious materials ratio and maximum allowable water content.
f. Aggregate type, source, size, gradation, fineness modulus.
g. Cement type and brand.
h. Pozzolan type and brand (if any).
i. Admixtures including air entrainment, water reducers, high-range water reducers, accelerators, and retarders.
j. Wet and dry unit weight.
k. Total air content.
l. Design slump or flow and allowable range after additions of all admixtures.
m. Compressive strength and associated age (28-day, 56-day, etc.).
n. Required average strength qualification calculations per ACI 301 4.2.3.3a and 4.2.3.3b. Submit separate qualification calculations for each production facility that will supply concrete to the project.
o. Documentation of Average Strength (Trial Mixture Data or Field Test Data) per ACI 301. When field test data is used to qualify average strength, submit separate documentation for each production facility that will supply concrete to the project.
p. Field test data submitted for qualification of average strength under ACI 301 including copies of the Concrete Testing Agency's reports from which the data was compiled.

3. Shrinkage testing per ASTM C 157.
4. Concrete strength maturity curves: For concrete specified with a 56-day f'c concrete strength, develop and submit strength-maturity relationship curves in accordance with ASTM C 1074. Extend maturity testing to 56 days.

F. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.

1. Submit shop drawings for all reinforcing steel and related accessories for review and approval. Shop drawings shall show arrangement and layout, bending and assembly diagrams, bar schedules, stirrup spacing, splicing and laps of bars and shall be prepared in accordance with CRSI Standards.

2. Show all reinforcing, top and bottom profile of concrete element, supports below, including beams, columns and walls, grade beams, concrete walls, joists, etc. framing into element.
3. Show locations of approved construction joints, locations of pour strips, splices of reinforcing, type of splice used and splice location. Identify all non-typical reinforcement type locations.

G. Certificates:

1. Submit, for the record, mill certificates, and/or test results signed by the Producer, for all reinforcement.
2. Provide certification from fiber reinforcement manufacturer that fiber reinforcement complies with specified requirements.

H. Test and Evaluation Reports:

1. Submit International Code Council (ICC) Evaluation Service Reports indicating approval from ICC Evaluation Service, Inc. for mechanical splices, hooked anchorage systems, large-headed stud punching shear reinforcement, and dowel bar replacement systems.
2. Submit test results for deformed bar material not identifiable as outlined in Part 2 below.

I. Special Procedure Submittals: Submit the shop welding program for fusion welding including the type of the specific fusion welding machine and the quality control/inspection protocol for the shop welding.

J. Qualification Statements: Submit welding certificates.

K. Environmental Certification: Certification that products and installation comply with applicable EPA, OSHA, and VOC requirements regarding health and safety hazards.

1.8 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit documentation of the required qualifications specified in part Quality Assurance of this Section.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials. Testing of cement in lieu of mill certificate submittal will be required if:

    a. The cement has been in storage at the mixing site for over 30 days.
    b. It is suspected by the Owner, Architect, Engineer, or Testing Agency that the cement has been damaged in storage, transit, or is in any way defective.

2. Supplementary Cementitious Materials
3. Admixtures.
4. Form materials and form-release agents.
5. Steel reinforcement and accessories.
6. Fiber reinforcement.
7. Curing compounds.
8. Bonding agents.
9. Adhesives.
10. Repair materials.

C. Material Test Reports: For the following, from a qualified testing agency:

1. Aggregates**:** Include service record data indicating the absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

    a. Submit test reports indicating that aggregates are not potentially reactive based on the ASTM C295 or ASTM 1260 testing limits set forth in section 5.1 of “Guide Specification for Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association).
    b. Alternatively, submit ASTM C1567 test reports indicating that the combination of mix ingredients reduces the expansion due to Alkali aggregate reactivity such that the mix complies with section 5.2 of “Guide Specification for Concrete Subject to Alkali-Silica Reactions” (2007 Portland Cement Association).

c. All tests for submitted reports shall have been performed within one year of the submittal date

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

1. Shoring and Reshoring: Indicate the proposed schedule and sequence of stripping formwork, shoring removal, and reshoring installation and removal.

E. Field Quality Control/Assurance Reports: Submit electronic copies of the Contractor's field quality control logs and reports, quality assurance inspection reports, and testing reports, including any Special Inspection Reports ordered by the Contractor.

F. Minutes of preinstallation conference.

G. Placement Notification: Advance notification of concrete placement. Submit notification to Engineer at least 24 hours in advance of placement.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.

B. Formwork Design Qualifications: The formwork design engineer retained by the Contractor shall be a professional engineer registered in the state where the project is located and shall be experienced in the design of concrete formwork.

C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products that comply with ASTM C 94 requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

D. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
3. Personnel inspecting concrete reinforcing steel have current certification as an ACI Concrete Construction Inspector or have experience in concrete construction acceptable to the Engineer.

E. Testing Agency Requirements:

1. The Testing Agency shall review the Welding Procedure Specification (WPS) submitted by the Contractor for any reinforcing steel other than ASTM A 706 that is proposed to be welded for consistency with acceptable welding practices and AWS.

2. The Testing Agency shall review the welder qualifications by certification or verify by retesting and shall obtain the welder certificates.

F. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4 for reinforcement and AWS D1.1 for studs.

1. Field welding shall be performed by welders certified by the LADBS for reinforcing steel. Continuous inspection by a deputy inspector is required. Shop welds shall be performed in an LADBS-licensed fabrication shop.

G. ACI Publications: Concrete work shall conform to the requirements of ACI 301 and be placed withing the tolerances of ACI 117.

H. Record of Work: Maintain a record listing time and date of all structural concrete placement. Such record shall be kept until completion of Project and shall be available to Architect for examination at any time.

I. Pre-Placement Inspection: Formwork installation, reinforcing steel placement and installation of all items to be embedded or cast into concrete shall be verified by Contractor prior to placement.

1.10 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on galvanized and epoxy-coated steel reinforcement.

B. Marking and Shipping: Bundle reinforcement and tag in accordance with the CRSI “Manual of Standard Practice.” Transport and store at the site so as not to damage the material. Keep a sufficient supply of tested, approved, and proper reinforcement at the site to avoid delays. Maintain reinforcing bars free of mud, dirt, grease, or other coatings.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Comply with the requirements of ACI 117 and ACI 301:

2.2 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in the largest practicable sizes to minimize the number of joints. Form surface shall be texture to meet the roughness requirements required for coating and waterproofing specified in the project.

1. Plywood, metal, or other approved panel materials.

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

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

3. Overlaid Finnish birch plywood.

2.3 FORMWORK COATINGS

A. Form-Release Agent: 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. Formulate form-release agent with rust inhibitor for steel form-facing materials. Provide a product that has a maximum VOC of 100 g/L but not greater than that permitted by the local government agency having jurisdiction in the area where the project is located.

1. Sika Corporation; Form Release 8000
2. Master Builders Solutions; MasterFinish RL 211
3. RPM International | Euclid Chemical Company; Formshield WB
4. Dayton Superior; Farm Fresh XL or Clean Strip J1EF
5. L&M Construction Chemicals; Debond, Debond, Gold, EZ Strip
6. W.R. Meadows; Duogard, Duogard II, or Duogard Citrus
7. US Spec; COkote
8. SpecChem; Bio Strip WB, Bio Strip WB Concentrate, SpecStrip WB, or SpecStrip VOC 100

2.4 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.

2.5 FORM TIES

A. Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist the 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 (19 mm) to the plane of the concrete surface and that will leave holes not larger than 1 inch (25 mm) in diameter in the 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 (38 mm) on surfaces that will be exposed to weather or in an

unconditioned space in the final structure. The ties shall leave holes no larger than one inch in diameter in concrete surfaces when the ends or end-fasteners are removed.

2.6 REINFORCEMENT

A. Refer to the structural general notes on the drawings for grades of reinforment.

2.7 REINFORCEMENT ACCESSORIES

A. Tie Wire: Tie wire shall be annealed steel tie wire, minimum 16 gauge.

1. Tie wire for epoxy-coated reinforcement shall be epoxy-coated.
2. Tie wire for galvanized reinforcement shall be galvanized.
3. Tie wire in architecturally exposed concrete shall be plastic coated or stainless steel.

B. Holding Wire: Holding wire shall conform to ASTM A 82 or ASTM A 1064.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view, where the leg of the wire bar support contacts the forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. Exposed to View Concrete: Provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel protected (CRSI, Class 2).

2.8 CONCRETE MATERIALS

A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from a single source, and obtain admixtures from a single source from a single manufacturer.

B. Refer to the structural general notes on the drawings for classes and strengths of concrete required.

C. Cementitious Materials

1. Cement Materials

a. Portland Cement: ASTM C 150

1) Alternate cementitious materials when proposed to control alkali-silica reactions and tested as part of a representative concrete mix in accordance with ASTM C1567, may be used subject to approval.

b. Hydraulic Cement: ASTM C 1157 or AASHTO M 85; or ASTM C 595 or AASHTO M 240 (excluding Type IS).

c. Blended Hydraulic Cement: ASTM C 595 or AASHTO M 240, Type IS, portland blast-furnace slag, Type IP, portland-pozzolan cement or Type IL Portland-

limestone cement, Type I (PM), pozzolan-modified portland cement, or Type IT, ternary blended cement.

d. Expansive Cement: ASTM C 845, Type G, K, M, or S.

e. Limitations On Cement Type And Use

1) Do not use Type III Hydraulic Cement in slabs-on-grade.

2) Exposure Class S1: Use ASTM C 150, Type II or ASTM C 1157, Type MS.

a) Alternate Cement Types for Exposure Classes S1: ASTM C 150, Type I or III cement with tricalcium aluminate (C_3A) content less than 8%

3) Exposure Class S2: Use ASTM C 150, Type V or ASTM C 1157, Type HS.

a) Alternate Cement Types for Exposure Classes S2: ASTM C 150, Type I or III cement with tricalcium aluminate (C_3A) content less than 5%

4) Exposure to Seawater: ASTM C 150, Type I or III cement with tricalcium aluminate (C_3A) content not exceeding 10% and water/cementitious ratio not exceeding 0.40.

5) Exposure Class S3: Use ASTM C 150, Type V plus pozzolan or slag; ASTM C 1157, Type HS plus pozzolan or slag; or ASTM C 595, Type IP (HS) or Type IS (HS). The amount of pozzolan or slag added to a blended mix shall be determined by testing or service record to improve sulfate resistance when used with Type V cement.

a) Alternatively, the amount of pozzolan or slag used shall produce a sample bar that does not expand more than 0.1% at 18 months when tested according to ASTM C 1012.

6) Low-alkali cement: Cement that has the additional requirement that equivalent alkalis (Na2O + 0.658K2O) do not exceed 0.60% according to ASTM C 150, Table 2.

2. Supplementary Cement Materials

a. Fly Ash: ASTM C 618 or AASHTO M 295, Class F or Class C.

b. Ground Granulated Blast-Furnace Slag Cement: ASTM C 989 or AASHTO M 302; Grade 100 or Grade 120

c. Natural Pozzolans: ASTM C 618, Class N or AASHTO M295

d. Silica Fume: ASTM C 1240 or AASHTO M307, amorphous silica.

1) Sika Corporation; Sikacrete 950 DP
2) Master Builders Solutions.; MasterLife SF 100
3) RPM International | Euclid Chemical Company; Eucon MSA
4) MAPEI Corporation; Microsillica

5) GCP Applied Technologies; Force 10,000 D
6) Elkem Chemicals, Inc.; Elkem Microsilica 920 ASTM
7) RussTech, Inc.; Russtech CSF
8) Advanced Cement Technologies; Silica Fume
9) Kryton International, Inc.; Con-Fume

e. Metakaolin: ASTM C 618, Class N or AASHTO M321, amorphous aluminosilicate.

1) Sika Corporation; Sikacrete M-100
2) GCP Applied Technologies; HRMK 100
3) Advanced Cement Technologies; PowerPozz (HRM)
4) CARBO Ceramics; Metakao

f. Limitations on Cement to Supplementary Cement Material Proportioning

1) Exposure Class F3: Maximum amount of supplementary cementitious materials shall not exceed the limits noted in Table 4.2.1.1(b) “Limits on supplementary cementitious materials for concrete assigned to Exposure Class F3” of ACI 301.

a) Fly ash / natural pozzolans conforming to ASTM C618: 25%
b) Slag cement: 50%
c) Silica fume / metakaolin: 10%
d) Total of fly ash / natural pozzolans, slag cement, and silica fume / metakaolin: 50%
e) Total of fly ash / natural pozzolans and silica fume / metakaolin: 35%

D. Aggregates

1. Normal-Weight Aggregates: ASTM C 33, Class 3S, or AASHTO M 80 and M 6, graded coarse aggregate. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials. Submit material certificates from the aggregate supplier or test results from an independent testing agency certifying conformance to this specification for each source of aggregate.

a. Freeze and Thaw Categories: Minimum class designation number shall be as recommended in ASTM C 33, Table 4.

1) Freeze and Thaw F0: Use Coarse Aggregate Class Series for Negligible Weathering Region (N) or better.

2) Freeze and Thaw F1: Use Coarse Aggregate Class Series for Moderate Weathering Region (M) or better.

3) Freeze and Thaw F2 and F3: Use Coarse Aggregate Class Series for Severe Weathering Region (S)

b. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

c. For concrete identified on the drawings as exposed to Exposure Classes C1 and C2, submit certification that aggregate does not contain any deleterious materials that react with alkalis in the concrete mix to cause excessive expansion of the

concrete, for concrete that is exposed to wetting, has extended exposure to humid atmosphere, or is in contact with moist ground unless low-alkali cement is used.

2. Lightweight Aggregate: ASTM C 330 or AASHTO M 195, Submit material certificates from the aggregate supplier or test results from an independent testing agency certifying conformance to this specification for each source of aggregate.

3. Limitations on Aggregates: Aggregates determined to be susceptible to alkali-carbonate reactions, in accordance with ASTM C 1778, shall not be used.

E. Water: ASTM C 94 (potable), ASTM C 1602 (tested non-potable which is compatible with admixtures), or AASHTO M 157.

1. Provide sample and obtain approval from Owner of color and finish of exposed concrete mixes where non-potable water is used.

2.9 ADMIXTURES

A. General Requirements

1. Admixture products listed are subject to compliance with specified code requirements.
2. Submit manufacturer's certification that the product conforms to the requirements specified and is compatible with all other admixtures to be used.
3. Admixtures shall not contribute water-soluble chloride ions exceeding those permitted in hardened concrete.
4. Do not use calcium chloride.
5. For shrinkage compensating concrete, industrial slabs, and concrete designated as Exposure Class S2 or S3, admixtures must be free of calcium chloride.
6. Written conformance to all the above-mentioned requirements and the chloride ion content of the admixture as tested by an accredited laboratory will be required from the admixture manufacturer at the time of design mixture review.

B. Air-Entraining Admixture: ASTM C 260 or AASHTO M 154

1. Sika Corporation; Sika AER
2. Master Builders Solutions; MasterAir VR 10, MasterAir AE 90, MasterAir AE 200
3. RPM International | Euclid Chemical Company; Air Mix, AEA-92, Eucon Air 30 or Eucon Air 40
4. MAPEI Corporation; Polychem AE, SA, SA-50, VR, or VRC
5. GCP Applied Technologies; Darex or Daravair series
6. RussTech, Inc.; RSA-10, RAE-260, or RVR-15

C. Water-Reducing Admixture: ASTM C 494 or AASHTO M 194, Type A

1. Sika Corporation; Plastocrete 161
2. Master Builders Solutions; MasterPozzolith Series
3. RPM International | Euclid Chemical Company; Eucon WR-75, Eucon WR-91, Eucon NW or Eucon LW
4. MAPEI Corporation; Polychem 400 NC or Paver Plus
5. GCP Applied Technologies; WRDA series, Zyla Series, Daracem Series, or ADVA XT2
6. RussTech, Inc.; LC-400CL or Extendflo X90

D. Mid-Range Water-Reducing Admixture: ASTM C 494 or AASHTO M 194, Type A and Type F

1. Sika Corporation; Sikament HP
2. Master Builders Solutions; MasterPolyheed Series
3. RPM International | Euclid Chemical Company; Eucon MR, Eucon X-15 or Eucon X-20
4. MAPEI Corporation; Polychem 441, 775, 850, 3000, or SPC; Mapeplast MR107; Dynamon NRG 546 or 1092; EVO 2500; Melchem
5. GCP Applied Technologies; Daracem 19 or 55; Mira 62, 85, 95, or 110
6. RussTech, Inc.; Superflor 443, Superflor 2000 RM, or Finishease-NC

E. High-Range, Water-Reducing Admixture: ASTMC 494 or AASHTO M 194, Type F or Type G

1. Sika Corporation; Sikament Series
2. Master Builders Solutions; MasterRheobuild 1000; MasterGlenium Series, PS 1466
3. RPM International | Euclid Chemical Company; Eucon 37/1037, Plastol series, Eucon SP or Eucon RD2
4. MAPEI Corporation; Dynamon SX37
5. GCP Applied Technologies; ADVA Series or Daracem 100
6. RussTech, Inc.; Superflo 2040 RM

F. Accelerator Admixture: ASTM C 494 or AASHTO M 194, Type C, non-chloride based.

1. Sika Corporation; Sika Rapid 1
2. Master Builders Solutions; MasterSet AC 534
3. GCP Applied Technologies; Polarset, Daraset 400, or DCI
4. RussTech, Inc.; Enumeron

G. Water-Reducing and Accelerator Admixture: ASTM C 494 or AASHTO M 194, Type C and E, non-chloride based.

1. Sika Corporation; Plastocrete 161FL, SikaSet NC, or SikaSet NC-4
2. Master Builders Solutions; MasterSet FP 20, MasterSet AC 122
3. RPM International | Euclid Chemical Company; Accelguard 80/90, Accelguard NCA, or Accelguard G3
4. RussTech, Inc.; LCNC-166, Fast Set 100 HE, or Flow Set 2000 NC

H. Water-Reducing and Retarding Admixture: ASTM C 494 or AASHTO M 194 Types B and D.

1. Sika Corporation; Plastiment Series or SikaTard 440
2. Master Builders Solutions; MasterPozzolith R series, MasterSet Delvo series, or MasterSet R series
3. RPM International | Euclid Chemical Company; Eucon Retarder 75 or 100, Eucon LR or NR
4. MAPEI Corporation; Polychem R, or Renu
5. GCP Applied Technologies; Daratard series, Zyla 614R, or Zyla R
6. RussTech, Inc.; LC-400P or LC-500

I. Viscosity Modifying Admixture: ASTMC 494 or AASHTO M 194, Type F or Type G and ASTM C 1017

1. Sika Corporation; VisoCrete series
2. Master Builders Solutions; MasterMatrix VMA series
3. RPM International | Euclid Chemical Company; Eucon SL or Visctrol
4. MAPEI Corporation; Polychem VMA or Mapecrete V3K
5. GCP Applied Technologies; V-MAR series or ADVA Series
6. RussTech, Inc.; Superflor 2000 SCC

J. Anti-Washout Admixture: CRD-C 661

1. Sika Corporation; Sikament 100 SC or Stabilizer-4 R
2. Master Builders Solutions; MasterMatrix UW 450
3. RPM International | Euclid Chemical Company; Eucon ABS, Eucon AWA, or Eucon V-Mod
4. MAPEI Corporation; DG-F
5. GCP Applied Technologies; V-MAR 3
6. RussTech, Inc.; VMA-758, AWA-C61, or AWA-C61P

K. Shrinkage Reducing Admixture: ASTM C494 Type S

1. For Air-Entrained Concrete:

   a. Sika Corporation; SikaControl 75
   b. Master Builders Solutions; MasterLife CRA 007 or MasterLife SRA 35
   c. RPM International | Euclid Chemical Company; Eucon SRA-XT
   d. GCP Applied Technologies; Eclipse 4500
   e. RussTech, Inc.; SRA-157-EXT

2. For Non-Air-Entrained Concrete

   a. Sika Corporation; SikaControl 75
   b. Master Builders Solutions; MasterLife SRA 35 or MasterLife CRA 007
   c. RPM International | Euclid Chemical Company; Eucon SRA Series
   d. MAPEI Corporation; SRA-157
   e. GCP Applied Technologies; Eclipse Floor 200 or Eclipse 4500
   f. RussTech, Inc.; SRA-157 Series

L. Shrinkage Compensation Admixture

1. Sika Corporation; SikaControl NS or SC
2. RPM International | Euclid Chemical Company; Conex
3. MAPEI Corporation; Expancrete

M. Water Repellent Admixture

1. Sika Corporation; SikaMix W-10 or SikaMix AE-6
2. Master Builders Solutions; MasterPel 235, 240, or 200HD
3. RPM International | Euclid Chemical Company; Eucon Baracade WPT
4. MAPEI Corporation; Idrocrete MN
5. GCP Applied Technologies; Optec EC Series
6. RussTech, Inc.; Waterpel

N. Polymer Modification Admixture

1. BASF; Styrofan ND 614 or Styrofan 1186
2. Sika Corporation; SikaLatex R
3. MBCC Group | Master Builders Solutions; MasterEmaco A 660
4. RPM International | Euclid Chemical Company; AKKRO-7T, SBR Latex, or Flex-Con
5. MAPEI Corporation; Planicrete UA

O. Carbon Nanotube Admixtures:

1. EdenCrete; EdenCrete or EdenCrete Pz

P. Corrosion-Inhibitor Admixtures: A corrosion inhibiting admixture is required for all concrete designated Freeze and Thaw F2 or F3.

1. Corrosion-Inhibiting, Set-Accelerating Admixture: 30% calcium nitrite based, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C 494, Type C.

    a. Sika Corporation; Sika CNI
    b. Master Builders Solutions; MasterLife CI 30
    c. RPM International | Euclid Chemical Company; Eucon CIA or Eucon BCN
    d. MAPEI Corporation; Polychem CI
    e. GCP Applied Technologies; DCI
    f. RussTech, Inc.; Russteck RCI

2. Corrosion-Inhibiting, Non-Set-Accelerating Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.

    a. Sika Corporation; FerroGard 901 S
    b. Master Builders Solutions; MasterLife CI 222
    c. GCP Applied Technologies; DCI-S
    d. Cortec; MCI 2000 or MCI 2005 Series

Q. Hardening Admixture:

1. Sika Corporation; SikaControl FD-100
2. RussTech, Inc.; Hard-Cem

R. Crystalline-Forming Waterproofing Admixture: A powder admixture capable of producing concrete that is watertight under hydrostatic pressure up to seven atmospheres when tested in accordance with Corps of Engineers test CRD-C48 and capable of sealing cracks up to 0.4 mm.

1. Xypex Chemical Corporation; Xypex Admix C Series
2. Sika Corporation; Sika WT-215P or Sika WT-240P
3. Master Builders Solutions; MasterLife 300D
4. RPM International | Euclid Chemical Company; Eucon Vandex AM-10
5. MAPEI Corporation; Idrocrete KR 1000
6. Aquafin; Aquafin-IC Admix
7. ICS/Penetron International/Ltd; Penetron Admix
8. Kryton International, Inc.; Krystol Internal Membrane (ESR-1515)
9. RussTech, Inc.; Krystol Internal Membrane

S. Moisture Vapor Reduction Admixture: Acceptable products include:

1. Barrier One, Inc.; Barrier-1.
2. US Concrete, Inc.; Aridus.
3. Concure Systems; Concure Systems Admixture.
4. Specialty Products Group; Vapor Lock 20/20.
5. ISE Logik Industries; MVRA 900.

T. ASR Inhibitor: ASTM C494, Type S, Lithium nitrate-based admixture that is designed to control alkali-silica reactivity

1. Sika Corporation; SikaControl ASR
2. Master Builders Solutions; MasterLife ASR 30
3. RPM International | Euclid Chemical Company; Eucon Intergral ARC
4. MAPEI Corporation; ASR Mitigator
5. GCP Applied Technologies; RASIR
6. RussTech, Inc.; Prevent ASR-LN

2.10 CONCRETE MIXTURES, GENERAL

A. The Contractor, acting in conjunction with his Concrete Supplier and his Testing Laboratory, shall submit in writing, with his design mixtures, the method used to select mixture proportions. Either of the following methods, as outlined in ACI 301, may be used:

1. Field Experience Method.
2. Laboratory Trial Mixture Method.

B. Required types of concrete and compressive strengths shall be as indicated on the Structural Drawings.

C. Low Alkali Concrete: For concrete identified on the drawings as Exposure Classes C1 and C2, the total alkali contribution from cementitious materials in the concrete mix shall not exceed 4.0 pounds per cubic yard of concrete unless the aggregate used is certified to contain no deleterious materials that react with alkalis in the concrete mix as defined in ASTM C 33. This requirement may be met by the use of low-alkali cement.

D. Supplementary Cementitious Materials: Fly ash and/or ground granulated blast-furnace slag replacement of Portland cement shall be within percentage replacement levels listed on the drawings unless noted otherwise.

1. Cement replacement shall not exceed a percentage level that has been shown by experience on other projects to exhibit satisfactory performance using materials from identical sources as proposed for this project. As an alternate, trial concrete batches can be performed to identify design mixtures that maximize cement replacement while meeting strength requirements per ACI 301 and finishability criteria.
2. The use of fly ash or slag in architecturally exposed structural concrete shall be coordinated with the Architect, Engineer, and Contractor.
3. Overall replacement percentages with combined fly ash and slag shall not exceed the maximum identified with slag or be less than the minimum identified with fly ash for each type of element. In addition, the replacement percentage of fly ash within the combined mixture shall not exceed the maximum identified with fly ash alone.
4. Replacement percentages exceeding the maximum may be permitted at the discretion of the Architect, Engineer of Record, and Contractor.
5. For concrete identified on the drawings as being subject to Exposure Class F3, the maximum amount of supplementary cementitious materials shall not exceed the limits noted in Table 4.2.1.1(b) “Limits on supplementary cementitious materials for concrete assigned to Exposure Class F3” of ACI 301.
6. Except for Mass Concrete, the Contractor may submit for approval a revised design mixture with lower supplementary cementitious material percentages than herein specified should finishability or other issues arise due to changing weather conditions.

E. Aggregate: Comply with the following special requirements:

1. For exposed concrete, provide aggregates from a single source.
2. For exposed surfaces subject to Exposure Class C1 or C2, do not use aggregates containing spalling-causing deleterious substances.
3. For slabs and other designated concrete, combined aggregate gradation shall be 8% - 18% for large top size aggregates (1-1/2 inches (38 mm)) or 8% - 22% for smaller top size aggregates (1 inch or 3/4 inch (19 mm)) retained on each sieve below the top size and above the No. 100. Deviations from this gradation may be allowed upon the approval of the Engineer subject to the following limitations:

    a. The percent retained on two adjacent sieves shall be not less than 5%.
    b. The percent retained on three adjacent sieves shall be not less than 8%.
    c. If the percent retained on two adjacent sieves is less than 8%, the total percent retained on either of those sieves and the adjacent outside sieve shall be not less than 13%.

F. Admixtures:

1. Admixtures to be used in concrete shall be subject to the approval of the Engineer and Testing Agency and shall be used for the purpose intended by the manufacturer to produce concrete to meet the specified requirements.
2. Quantities of admixtures to be used shall be in strict accordance with the manufacturer's instructions.
3. Air Content Requirements: For concrete subject to Exposure Class F1, F2, or F3 as noted on the drawings, use air-entrainment admixtures to provide concrete such that the air content at the point of placement shall conform to the requirements of ACI 301 Table 4.2.2.7.b "For Exposure Category F: Freezing and thawing exposures" within plus or minus 1.5%. Required air content levels may be reduced by 1.0% for concrete strengths above 5,000 PSI.

    a. Interior steel troweled surfaces shall not have more than 3% total air content.
    b. Surfaces scheduled to receive hardeners shall not have more than 3% total air content.
    c. Air-entraining admixtures are not permitted in industrial slabs.

G. Self-Consolidating Concrete (SCC): Proportion SCC mixture with specified admixtures to produce concrete having properties that allow it to flow freely into all spaces of the formwork, through tight openings under its own weight and is resistant to segregation during transport and placement. Flowable spread shall be between 20 inches to 30 inches and shall show no evidence of segregation, mortar halo, or aggregate pile, although some slight bleeding is acceptable. Workability, pumpability, finish, and setting time of the proposed design mixture must be demonstrated by a successful trial placement onsite.

H. Adjustments of Concrete Mixtures: Design mixture adjustments may be requested by the Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant. Such adjustments shall be provided at no additional cost. Any adjustments in approved design mixtures including changes in admixtures shall be submitted in writing for approval prior to field use.

I. Chloride Ion Content:

1. Unless noted otherwise, the maximum water-soluble chloride ion concentration in hardened concrete measured at ages from 28 days to 42 days contributed from all ingredients including water, aggregates, cementitious materials, and admixtures shall not exceed the limits specified in ACI 318-14 Table 19.3.2.1 "Requirements for concrete by exposure class" depending on to which Corrosion Exposure Class (C0, C1 or C2) the concrete is subject as noted on the drawings. Water-soluble chloride ion tests shall conform to ASTM C 1218. One test shall be run for each class of concrete before the design mixture submittal and each time a change is made to the design mixture (such as a change in aggregate type or source).
2. The chloride ion content in all concrete used for prestressed or post-tensioned concrete shall not exceed 0.06% by weight of cement.
3. The Concrete Supplier shall certify that the chloride ion content in all concrete design mixtures used on the project does not exceed the limits stated above.

2.11 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete with maximum VOC content of 100 g/L.

1. Sika Corporation; Sika Film or Sikagard 50 ER
2. Master Builders Solutions; MasterKure ER 50
3. RPM International | Euclid Chemical Company; Eucobar
4. MAPEI Corporation; Mapecrete Film
5. Dayton Superior; AquaFilm J74RTU or AquaFilm Concentrate J74 concentrate
6. L&M Construction Chemicals; E-Con
7. W.R. Meadows; Evapre
8. US Spec; Monofilm ER
9. SpecChem; SpecFilm RTU or SpecFilm Concentrate

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz/yd^2 (305 g/m^2) when dry.

C. Moisture-Retaining Cover: ASTM C171, Waterproof paper, polyethylene film, burlap-polyethylene sheet, or natural cellulose-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1 or 1D, Class B, dissipating, with maximum VOC content of 100 g/L. Film must chemically break down in a 4 to 6 week period. Provide data from independent laboratory indicating maximum moisture less than 0.30 kg/m^2 at 72 hours when tested in accordance with ASTM C 156.

1. Sika Corporation; Lithochrome Colorwax Concrete Curing Compound
2. RPM International | Euclid Chemical Company; Kurez DR-100
3. Dayton Superior; Clear Resin Cure J11W or Clear Cure VOC J7WB
4. L&M Construction Chemicals; L&M Cure
5. W.R. Meadows; Sealtight 1100
6. SpecChem; SpecRez or Crystal Rez

F. Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C1315, Type 1, Class A, with maximum VOC content of 100 g/L. Do not apply to surfaces that are to receive waterproofing, coatings, repellents, adhered flooring, or bonded overlays.

1. RPM International | Euclid Chemical Company; Super Diamond Clear VOX
2. Dayton Superior; Cure & Seal 1315 EF
3. W.R. Meadows; Vocomp 30
4. US Spec; Roca 1315
5. SpecChem; Cure & Seal WB 30

2.12 WATER AND CHLORIDE ION REPELLING PENETRATING SEALER

A. Clear, Silane Reactive Penetrating Sealers With 100% Solids with a VOC content less than 350 g/L.

1. Sika Corporation; Sikagard 705 L or Sikagard 100 Hydrozo
2. RPM International | Euclid Chemical Company; Baracade Silane 100 C
3. Evonik Degussa; Protectosil 100
4. Mapei; Planiseal WR 100
5. SpecChem; SpecSilane 100

B. Clear, Solvent-Based Silane Reactive Penetrating Sealers With 40% Solids with a VOC content less than 600 g/L.

1. Sika Corporation; Sikagard-440 HZ
2. RPM International | Euclid Chemical Company; Baracade Silane 40
3. Evonik Degussa; Protectosil Chem-trete 40 VOC

C. Clear, Water-Based Silane Reactive Penetrating Sealers With 40% Solids with a VOC content less than 350 g/L.

1. Sika Corporation; Sikagard 740 W or Sikagard-400 Enviroseal
2. RPM International | Euclid Chemical Company; Baracade Silane 40 WB
3. Evonik Degussa; Protectosil Aqua-trete 40
4. Mapei; Planiseal WR 40
5. SpecChem; SpecSilane 40 WB

D. Siloxane, Water Based Concentrate with a diluted VOC content less than 100 g/L.

1. RPM International | Euclid Chemical Company; Chemstop WB Heavy Duty
2. Evonik Degussa; Protectosil Aqua-trete Concentrate or Protectosil Aqua-trete EM
3. Mapei; Planiseal WR
4. Prosoco; Siloxane WB Concentrateor or Siloxane PD
5. SpecChem; SpecShield WB

E. Non-Sacrificial, Water Based, Water Repellant and Clear Antigraffiti Coat with a VOC content less than 50 g/L.

1. Evonik Degussa; Protectosil Antigraffiti + Protectosil Aqua-Treat Concentrate
2. Prosoco; Blok-Guard and Graffiti Control II

F. Migrating Corrosion Inhibitor And Reactive Penetrating Sealers

1. Sika Corporation; FerroGard 908
2. Cortec Corporation; MCI 2022 or MCI 2022 V/O
3. Evonik Industries; Protectosil 300C

2.13 MIGRATING CORROSION INHIBITOR

A. Reactive Penetrating Migrating Corrosion Inhibitor

1. Sika Corporation; FerroGard 903
2. Cortec Corporation; MCI 2020 or MCI 2020 V/O
3. Evonik Industries; Protectosil CIT
4. Mapei; Mapeshield CI 100

2.14 ACCESSORY PRODUCTS

A. Concrete Repair Materials: If minor concrete repairs become required, request the specification section be provided in an RFI.

B. Acrylic Bonding Agent: ASTM C1059, Type II, nonredispersible, acrylic emulsion or styrene butadiene product that is preblended or an additive for a mixed sand/cement bonding slurry.

1. Sika Corporation; SikaLatex or SikaLiquid Weld
2. RPM International | Euclid Chemical Company; Akkro-7T, Flex-Con, or Eucoweld 2.0
3. W.R. Meadows; Acry-Lok

C. Epoxy Bonding Adhesive: ASTM C881, Type II, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade suitable for application temperature and application position, for bonding hardened or freshly mixed concrete to hardened concrete.

1. Sika Corporation; Sikadur 32 Hi-Mod or Sikadur 32 Hi-Mod LPL
2. RPM International | Euclid Chemical Company; Dural LPL MV
3. MAPEI Corporation; Planibond EBA

D. Structural Epoxy Bonding Adhesive: ASTM C881, Type IV or V, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade suitable for application temperature and application position, for bonding hardened or freshly mixed concrete to hardened concrete:

1. Sika Corporation; Sikadur 32 Hi-Mod
2. RPM International | Euclid Chemical Company; Dural 452 Series or Euco #452 Series

2.15 SUBSTITUTIONS

A. Product substitutions may be considered provided complete technical information and job references are submitted and approved prior to commencement of work.

B. Changes in products required to suit temperature, environmental conditions, and local VOC regulations at the time of material application shall be specified as separate line items by the Contractor showing credit or additions to the price for the various tasks.

PART 3 - EXECUTION

3.1 REINFORCEMENT FABRICATION

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

B. Bending and Forming: Fabricate bars of indicated sizes and accurately form to shapes and lengths indicated and required, by methods not injurious to materials. Do not heat reinforcement for bending. Bars shall be free from injurious defects, have a workman-like finish with no excessive rust and/or pitting, and have no unusual kinks or bends.

3.2 FORMWORK INSTALLATION

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until the structure can support such loads.

1. The formwork design engineer shall design the concrete formwork, formwork removal, shoring, reshoring, and backshoring.

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

1. Concrete adjacent to elevator hoistway shall be installed to tolerances required by elevator manufacturer.
2. Concrete adjacent to crain rails shall be installed to tolerances required by crain manufacturer.

C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. The permissible irregularity is a cumulative value due to all sources including layout, plumbness, member size, formwork offsets, joints, and member levelness. The permissible irregularity shall also apply between adjacent concrete surfaces on opposite sides of construction joint, expansion joint or shrinkage pour strip if present.

D. Construct forms tight enough to prevent loss of concrete mortar.

E. Construct 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.
1. Do not use rust-stained steel form-facing material.

F. 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.

G. Provide temporary openings for cleanouts and inspection ports where the 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.

H. Chamfer exterior corners and edges of permanently exposed concrete unless otherwise noted on the drawings. Where existing members are being locally rebuilt exterior corners and edges shall match the comer/edge condition of the existing adjacent construction.

I. Coordination of Openings: Provide openings in concrete formwork to accommodate work specified in other sections and other work on the project. Determine the size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.

3.3 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 concrete mortar leaks and maintain proper alignment.

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

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 the 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 been displaced and that completed work will be within specified tolerances.

B. Construct forms 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. Prior to each concrete pour, the Contractor shall engage a qualified surveyor to verify that work is within specified tolerances. The surveyor shall report in writing to the Architect, Engineer, and Contractor certifying that the work is acceptable or indicating any deviations from allowable tolerances.

D. The Owner shall hire an independent qualified surveyor to verify the proper form, line, position, and elevation of the finished concrete work. The results of each survey shall be sent to the Owner, Architect/Engineer, and Contractor and shall identify any deviation from specified tolerances. All work not in conformance with specified tolerances shall be removed at the Contractor's sole expense if so specified by the Owner.

3.5 SHORING AND RESHORING INSTALLATION

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.

C. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

D. Reshoring:

1. If formwork and shoring are removed before concrete is 15 days old, reshoring shall remain in place a minimum of 15 days after placement irrespective of concrete strength.
2. For multi-story construction, reshoring shall remain in place a minimum of 15 days after placing of concrete deck above irrespective of concrete strength.

E. 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 method for the design of certain members is 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 the placement of successive floors.
6. Strength of concrete at the 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 of concrete 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. Where shores are not vertically aligned, calculations shall include verification that the structure can support the reaction.

3.6 REMOVAL OF FORMS AND SUPPORTS

A. Determination by Contractor's Registered Engineer: The Contractor's registered professional engineer shall determine and submit for record purposes 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 the 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.

C. 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 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 shall 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.

D. Formwork Supporting Weight of Concrete: Formwork supporting the weight of concrete such as beam soffits, joists, slabs, and other structural elements shall not be removed until the concrete has attained at least the following percentages of the design compressive strength:

1. Joists and Beam Bottoms: 70%, but not less than 2,800 psi.
2. Slabs: 70%, but not less than 2,800 psi.

E. 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 or maturity method) 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 the 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.

3.7 REUSING FORMS

A. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing materials are not acceptable for exposed surfaces. Apply a new form-release agent.

B. When forms are reused, clean surfaces, remove fins and laitances, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Owner.

3.8 EMBEDDED ITEM INSTALLATION

A. 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.

B. Anchor rods: Utilize cold-formed steel templates for presetting rods and other anchors to accurate locations as shown on the drawings in keeping with the tolerances noted in ACI 117 for embedded anchor rods. Set anchor rods to elevations required by the drawing and complying with tolerances in Section 7.5 of AISC 303.

1. Plumbness: Within ±1/16 inch (2 mm) over anchor rod projection.

C. Embedded plates, angles, anchor rods and other items to be embedded into the concrete shall be securely fasten to the formwork or held in place with templates. Insertion of these items into concrete during or after concrete placement is prohibited. Embedded steel tolerances are:

1. Location: ±1 inch (25 mm) vertical, ±1 inch (25 mm) horizontal.
2. Plumb and Alignment: 1/4 inch in 12 inches (1:48).

D. Install dovetail anchor slots in concrete structures as indicated. Where masonry or veneer intersects concrete, provide one vertical dovetail slot for each 8 inches of masonry thickness. Where concrete serves as the backup, space slots at 16 inches on center.

E. Do not install sleeve penetrations through any concrete member unless otherwise noted on the structural drawings or approved in writing.

F. Epoxy doweled reinforcement and other elements penetration through waterproofing shall be flashed in with waterproofing prior to laying out non-doweled reinforcement and placing the concrete overlay.

3.9 STEEL REINFORCEMENT INSTALLATION

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

2. Do not cut or puncture waterproofing and drainage composite. Repair damage waterproofing and drainage composite before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D 1.4, where indicated.

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

E. Size, length, number and placement of supports shall be sufficient as to maintain reinforcing position within specified tolerances during construction traffic and concrete placement.

F. On vertical formwork, use approved bar chairs or spacers as required to maintain concrete cover and bar position. Do not staple or use any other metallic fastener to secure bolsters, chairs, etc. to formwork for concrete surfaces exposed to exterior.

G. Do not bend reinforcement that is embedded partially in concrete except in locations noted on the drawings or approved in writing.

3.10 SPLICING REINFORCING STEEL

A. Provide splices as indicated on the drawings. Splice lengths are indicated in the Structural General Notes. Splice reinforcing bars only at locations shown on the structural drawings and approved shop drawings. Unauthorized or unscheduled splices not approved in writing will not be accepted.

B. All lap splices in reinforcing steel shall be contact lap splices unless detailed otherwise on the drawings.

C. Maintain proper cover and spacing between reinforcing bars at splices.

D. Lap unscheduled reinforcing bars not otherwise specified with a Class B lap splice. Lap welded wire reinforcement per ACI 318 Chapter 25.5.3 or 25.5.4.

E. Manufacturer of mechanical tension splice shall be present for first day's installation.

3.11 COORDINATION BEFORE CONCRETE PLACEMENT

A. Coordinate the installation of joint materials, vapor retarders, and blind side waterproofing with placement of forms and reinforcing steel.

B. Clean formed cavities of all debris, snow, and ice prior to placing concrete. Flush with water above freezing-levels or use compressed air or other methods to remove remaining foreign matter. Ensure that water and debris drains to exterior through clean-out ports or is pumped out.

C. Pre-placement Inspection: Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.

D. Moisten wood forms immediately before placing concrete where form coatings are not used.

3.12 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and furnish batch ticket information. Fiber reinforced concrete shall additionally conform to the requirements of ASTM C 1116.

1. When air temperature is between 85°F and 90°F (30°C and 32°C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 yd^3 (0.76 m^3) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released, unless otherwise directed by concrete manufacturers written instructions. For mixer capacity larger than 1 yd^3 (0.76 m^3), increase mixing time by 15 seconds for each additional 1 yd^3 (0.76 m^3), unless otherwise directed by concrete manufacturers written instructions.
2. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

3.13 CONCRETE PLACEMENT

A. Concrete Batch Trip Tickets: The Contractor shall collect and retain concrete batch trip tickets. At a minimum project identification (name or number), mix identification, compressive strength, max aggregate size, slump, air content, and temperature tests shall be identified by reference to a particular trip ticket. Tickets shall contain the information specified in ASTM C 94. Each ticket shall also show the amount of water that may be added in the field for the entire batch that will not exceed the specified water to cement ratio for the design mixture. The Contractor and Testing Agency shall immediately notify the Engineer and each other of tickets not meeting the criteria specified.

B. Environmental condition limits for concrete placement shall be as follows unless appropriate provisions in concrete practices have been made for cold or hot weather placement.

1. Cold Weather Limit: Air temperature must be 40°F (4°C) and rising or the average daily temperature cannot have been lower than 40°F (4°C) for three consecutive days unless the temperature rose about 50°F (10°C) for at least one-half of any of those 24-hour periods.
2. Hot Weather Limit: Environmental conditions must be such that cause an evaporation rate from the concrete surface of 0.2 pounds per square foot per hour or less as determined by the figure “NRMCA Nomograph for Estimating Evaporation Rate on the Basis of Menzel Formula” in Appendix A of ACI 305.1.
3. Concrete may be placed at other environmental condition ranges when the provisions of the following are followed for placement and protection:

    a. Cold Weather Concreting: Comply with ACI 306.1 or ACI 306R. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
    b. Hot Weather Concreting: Comply with ACI 305.1 or ACI 305R.

1) Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2) Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

4. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
5. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

C. Causes for Concrete Rejection: The Contractor shall reject concrete delivered to the site for any of the following reasons:

1. Wrong class of concrete including incorrect design mixture identification or properties.
2. Concrete Temperature at the point of discharge greater than 95°F (35°C) or lower than:

a. 55°F (13°C) for sections with least dimension less than 12 inch (300 mm).
b. 50°F (10°C) for sections with least dimension 12 to 36 inch (300 to 900 mm).
c. 45°F (7°C) for sections with least dimension 36 to 72 inch (900 to 1800 mm).
d. 40°F (4°C) for sections with least dimension greater than 72 inch (1800 mm).

3. Slumps outside the mix design limits.
4. Air contents outside the limits specified in the design mixtures.
5. Water added to the mix that exceeds the maximum allowed water-to-cementitious ratio.
6. Excessive Age: Concrete shall be discharged within 90 minutes of plant departure and before it begins to set. Additionally, concrete shall be discharged before the drum has made 300 revolutions, unless approved by the Testing Agency job inspector or other duly appointed representative.

a. Modification of the excessive age requirements may be approved if special set retarring admixtures are proposed for use in the mix design. Modifications shall be based on admixture manufacture recommendations and field experience or laboratory trial mixture method setting time results.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation. Deposit concrete as nearly as practicable to its final location to avoid segregation. Spread concrete using short-handled, square-ended shovels, or come-alongs.

1. Deposit concrete in forms in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while the preceding layer is still plastic to avoid cold joints.

2. Consolidate placed concrete with mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping according to ACI 301. Use internal vibrators of the largest size and power that can properly be used in the work.

3. Do not vibrate Self-Consolidating Concrete.

4. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit the duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners. Eliminating air and stone pockets that may cause honeycombing, pitting, or planes of weakness.
2. Place concrete for beams, girders, brackets, column capitals, haunches, and drop panels at the same time as concrete for slabs. Do not place concrete over columns and walls until concrete in columns and walls is no longer plastic and has been in place at least one hour.
3. Maintain reinforcement in position on chairs during concrete placement.

F. Placing Concrete by Pump: If concrete is placed by using a pump, the mix used for pump priming shall not become a part of the completed structure unless approved in advance by the Engineer.

G. Protect adjacent finish materials against damage and spatter during concrete placement.

3.14 CLASSIFICATION OF FINISHES

A. Surface Finish 1.0 (SF-1.0)

1. No formwork facing material is specified.
2. Patch voids greater than 1-1/2 inch (38 mm) wide or 1/2 inch (12 mm) deep.
3. Remove projections larger than 1.0 inch (25 mm).
4. Provide surface tolerance Class D as specified in ACI 117.
5. Tie holes need not be patched.

3.15 FINISHING FORMED SURFACES

A. General: Formed surfaces shall have the finishes as described below and as shown on the drawings after formwork is removed and repairs made.

B. Standard Finish: Provide SF-1.0 on all formed concrete surfaces not exposed to view in the final condition unless otherwise specified.

C. Self-Consolidating Concrete: Use Self-Consolidating Concrete where shown on the plans to produce a smooth and uniform finish such that upon form removal no patching, stoning, rubbing or other form of repair, except washing, is required. The surface shall match the approved jobsite mock-up.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

E. Sediment wash-off from the use of surface applied retarder shall be collected filtered and legally disposed of. Do not allow sediment to flow into storm drains or sewers.

3.16 MISCELLANEOUS CONCRETE ITEM INSTALLATION

A. Filling In: Fill in holes and openings left in concrete structures after work associated with the penetration is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Adhesive Anchors: All drilled holes for adhesive anchors shall be within six degrees of perpendicular to the surface of the concrete member.

3.17 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x hour (1 kg/sq. m x hour) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.

D. Unformed Surfaces: Begin curing as soon as free water has disappeared from the concrete surface and immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Curing Duration

1. General Method: The curing period shall be 7 days for all concrete except high early strength concrete that shall be cured for 3 days minimum.

2. Alternative Method: curing times may be reduced if either of the following provisions is complied with:

a. If tests are made of cylinders kept adjacent to the structure and cured by the same methods, curing measures may be terminated when the average compressive strength has reached 70% of the specified compressive strength.

b. If the temperature of the concrete is maintained at a minimum of 50°F for the same length of time required for laboratory cured cylinders of the same concrete to reach 85% of the specified compressive strength, then curing may be terminated thereafter.

F. Curing Methods

1. Cure concrete according to ACI 308.1, by one or a combination of the following methods. Avoid rapid drying at the end of the curing period.

2. Moisture Curing: Keep surfaces continuously moist with the following materials:

    a. Keep concrete surface continuously wet by covering with water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

3. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.

    a. Moisture-retaining-cover shall be inspected each day by Contractor. Any areas which do not show condensation on underside of cover or any slab areas which are not wet shall be immediately rewetted and cover replaced to prevent moisture loss.
    b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    c. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    d. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.

4. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

    a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer.

5. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

6. Do not use membrane-forming curing and sealing compounds on surfaces which are to be covered with coating material applied directly to concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glued-down carpet, vinyl composition tile, linoleum, sheet vinyl, rubber, athletic flooring, synthetic turf, or wood), paint, or other coatings and finish materials. Dissipating resin type cures are acceptable in these locations.

G. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces, including undersides of beams, supported slabs and other similar surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by one or a combination of the methods specified below, as applicable:

1. Columns and Shear Walls Not Exposed to View: Moist cure in forms or by one or a combination of Methods 1, 2, or 3 specified below. Use a high–solids, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, Type I, Class A or B for Method 3.
2. Columns and Shear Walls Exposed to View: Moist cure in forms or by one or a combination of Methods 1, 2, or 3 specified below. Use a high-solids, non-yellowing, liquid membrane-forming curing and sealing compound conforming to ASTM C 1315, Type 1, class A for Method 3.
3. Sides and Soffits of Beams and Pan-Joist Ribs, Soffits of Slabs: Moist cure in forms or by one or a combination of Methods 1, 2, or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C 309, Type 1, class A or B for Method 3.
4. Basement Walls, Sides of Exterior Retaining Walls: Moist cure in forms or by one or a combination of Methods 1, 2, or 3 specified below. Use a liquid membrane-forming dissipating resin curing compound conforming to ASTM C 309, Type 1, class A or B for Method 3.

3.18 INVESTIGATION OF LOW CONCRETE STRENGTH TEST RESULTS

A. Contractor Responsibility for Low Strength Concrete:

1. If the average of any three consecutive strength tests falls below the required f ’c for a class of concrete but no individual strength test is more than 500 PSI below the required f ’c, the Contractor shall immediately notify the Engineer by telephone or email and take immediate steps to increase the average of subsequent strength tests.

2. If any individual strength test falls more than 500 PSI below the required f ’c, the Contractor shall immediately notify the Engineer by telephone or e-mail and take immediate steps to assure that the load-carrying capacity of the structure is not jeopardized.

B. Additional Field Tests to Confirm Low Concrete Strengths:

1. The cost of all investigations of low-strength concrete, as defined by any individual strength test being more than 500 PSI below the required f ’c, shall be borne by the Contractor.

2. Code-Prescribed Acceptance: The only accepted field-test methods of determining actual in-situ concrete strength is by the way of core tests as prescribed by ACI 318.

3. Non-Destructive Tests: If any individual strength test falls more than 500 PSI below the required f ’c, the Engineer may request that non-destructive field tests be performed on the concrete in question using Swiss Hammer, Windsor Probe, or other appropriate methods as approved by the Engineer. Report the comparative test results of the suspect concrete under consideration with identical tests done on concrete of known strength and of the same class. These test results are only approximate indicators of strength and may not necessarily, by themselves, resolve the low concrete strength issue. These test results will be considered as additional information by which to make an informed judgment. The Engineer reserves the right to accept the concrete based on the results of these approximate tests or order that core tests be taken as prescribed below. At the Contractor’s option, the approximate non-destructive field-tests may be waived and core tests immediately initiated.

4. Core Tests: If, in the opinion of the Engineer, the likelihood of low-strength concrete is confirmed and it has been determined that the load-carrying capacity of the structure is significantly reduced as a result, the Engineer may request that core tests be taken from the area in question as directed by the Engineer. There shall be a minimum of three cores taken for each strength test more than 500 PSI below the required f ’c in accordance with ASTM C 42. If concrete in the structure will be dry under service conditions, cores shall be air dried (temperature 60° to 80°F, relative humidity less than 60%) for seven days before test and shall be tested dry. If concrete in the structure will be more than superficially wet under service conditions, cores shall be immersed in water for at least 40 hours and tested wet. The Contractor shall fill all holes made by drilling cores with an approved drypack concrete.

5. Acceptance Criteria for Core Test: Concrete in an area represented by core tests shall be considered adequate if the average of three cores is equal to at least 85% of the required f ’c and no single core is less than 75% of the required f ’c. If approved by the Engineer, locations of erratic core strengths may be retested to check testing accuracy.

6. Load Test: If the concrete strength is not considered adequate based on core tests and the structural adequacy remains in doubt, the Engineer may order a load test as specified in ACI 318 be conducted for the questionable portion of the structure.

7. Strengthening or Demolition of the Structure: If the structural adequacy of the affected portion of the structure remains in doubt following the load test, the Engineer may order the structure to be strengthened by an appropriate means or demolished and rebuilt at the Contractor's expense.

3.19 FIELD QUALITY ASSURANCE

A. Field Inspection:

1. Columns and Walls:

   a. Verify that forms are plumb and straight, braced against movement, lubricated for removal, and conform to approved shop drawings.
   b. Verify proper dimensions and orientation.
   c. Verify top of column elevation is set in form and that it is 1/2 inch (12 mm) below the future slab soffit.

2. In-Situ Concrete Strength Verification Prior to Form Stripping: The Testing Agency shall verify that the concrete has reached the required minimum strength before form removal by evaluating the specified tests.

B. Field Reinforcement Inspection: The scope of the work to be performed by the inspector on the jobsite shall be as follows:

1. Reinforcing Steel: The Inspection Agency or designated Special Inspector shall inspect 100% of reinforcement before each concrete pour to verify the information noted below. Inspection reports shall be prepared and distributed in accordance with the Building Code and as specified in this specification.

   a. Primary and secondary longitudinal reinforcement has correct size and number in proper layers.
   b. Longitudinal reinforcement has correct length and lap.

c. Ties and stirrups are of correct size, spacing, and number and have the proper termination hook geometry.
d. Unscheduled face reinforcement in beams are provided and are of correct size, number and spacing and have the proper end terminations.
e. Proper hooks are provided at bar ends as detailed.
f. Reinforcement is properly supported and braced to formwork to prevent movement during concrete placement.
g. Reinforcement has proper cover.
h. Sufficient spacing between reinforcement for concrete placement.
i. Dowel reinforcement is of proper size, at proper spacing, and has proper lap length and embedment length.
j. Welded wire reinforcement is composed of flat sheets, has proper wire gage and spacing, is properly supported, and is properly lapped.
k. Proper construction/control/expansion joint spacing and reinforcement.
l. Reinforcement around embedded items is placed according to details.
m. Welded reinforcement has been done according to AWS requirements.
n. Proper installation of flat slab shear head reinforcement.
o. Reinforcing Steel Compression Butt Splices: The Inspection Agency shall provide 100% visual inspection of compression butt splices on the project. Inspection shall verify splice conformance with the requirements for end bearing splices as set forth in ACI 318 as well as the manufacturer's instructions.
p. Mechanical Tension Splices: The Inspection Agency shall provide 100% visual inspection of mechanical tension splices on the project and consult with the manufacturer regarding recommendations for installation. Inspection shall verify compliance with specifications and conformance with the manufacturer's recommendations for installation after consulting with the manufacturer, who is to be present for the first installation of the splice on the project.

C. Concrete Source Inspection:

1. Concrete Batch Plant Inspection: An initial batch plant inspection shall be made by the Testing Agency prior to the start of concrete work. The scope of batch plant inspection shall include the following:

a. Inspection of Batch Plant Facilities: The Testing Agency shall inspect batch plant facilities proposed for use in the work and report in writing inspection results to the Architect, Engineer, and Owner for approval. The inspection shall confirm the batch plant conforms to the standards set forth in ASTM C 94 and can show proof of certification by the National Concrete Ready Mix Association. Inspection shall include:

1) Batch Plant operations and equipment.
2) Truck mixers.
3) Scales.
4) Stockpile placement.
5) Material storage.
6) Admixture dispensers.

b. Multiple Batch Plants: The Contractor shall reimburse the costs accrued to the Testing Agency visits to more than one batch plant.

D. Field Concrete Inspection: The scope of the work to be performed by the inspector on the jobsite shall be as follows:

1. Before Concrete Placement:

    a. Inspect concrete formwork.
    b. Inspect concrete reinforcing.
    c. Inspect bolts and rods to be embedded in concrete for proper grade, size, length, and embedment.
    d. For slabs-on-grade, verify that the moisture retarder is provided, is lapped properly, and is not torn or punctured.
    e. Verify that the waterproofing and drainage composite is provided and undamaged. Verify reinforcement and other items penetrating the waterproofing have been flashed-in.
    f. Verify that there is no standing water in pour area and that all debris has been removed from the area and from the formwork.
    g. Verify that openings and sleeves in slabs or walls are correct size and location. Verify that the openings are shown on the structural drawings and notify the Engineer immediately of any openings in the field that are not shown on the drawings.
    h. Verify that horizontal and vertical sleeves through girders, beams, or joists have been approved in writing and that approved reinforcement is provided.
    i. Verify the tops of previously poured columns and/or walls are 1/2 inch (12 mm) below the deck soffit.

2. During Concrete Placement: Provide continuous monitoring to:

    a. Upon arrival of concrete, inspect the concrete to verify that the proper concrete mix number, type of concrete, concrete strength is being placed at the proper location. Verify that the mix meets the project specifications and is not over 90 minutes old at the time of placement. Report concrete not meeting the specified requirements and immediately notify the Contractor, Batch Plant Inspector, Architect, Engineer, and Owner.
    b. Inspect plastic concrete upon arrival at the jobsite to verify proper batching. Observe mix consistency and adding of water as required to achieve target slumps in design mixtures.
    c. Verify that the Contractor is following appropriate Hot Weather or Cold Weather concreting practices consistent with any extreme environmental conditions at the point of placement in the structure.
    d. Verify that concrete deposited is uniform and that vertical drop does not exceed six feet and is not permitted to drop freely over reinforcement causing segregation.
    e. Verify that the formwork has remained stable during the concreting operation.
    f. Verify that there are no cold joints.
    g. Verify that the concrete is properly vibrated.
    h. Inspect bolts embedded in concrete during concrete placement for verification that they have been properly installed to the specified embedment.
    i. Verify that the finishing of the concrete surface is done according to specifications.
    j. The Testing Agency shall report any irregularities that occur in the concrete at the job site or test results to the Contractor, Architect, Owner, and Engineer.

3. After Concrete Placement:

    a. Verify that the curing process is according to Specifications and that any curing compound used is applied in accordance with the manufacturer's recommendations.
    b. Verify that sawcut control joints in slab-on-grades are cut within 12 hours of placement.

c. Post-Installed Anchors in Concrete: Provide inspection of post-installed anchor installations at the frequency noted in the specifications and in accordance with the published, currently valid, Evaluation Service Report (ESR) for each anchor product. Post-installed anchors include anchors and reinforcing steel. Inspection of post-installed anchors shall include but not be limited to the following:

1) Periodic Inspection: Verify initial installation of post-installed anchors in concrete for each individual installer with each individual anchor product in accordance with the requirements stated below for each type of anchor. Periodically inspect anchor installation after the initial verification.
2) Continuous Inspection: Verify each installation of post-installed anchors in concrete in accordance with the requirements stated below for each type of anchor.
3) All Post-Installed Anchors: Verify that the anchor is installed in accordance with manufacturer's printed installation instructions as well as the following design requirements.

a) Concrete type, concrete strength and concrete thickness are in accordance with design drawings.
b) Anchor manufacturer and product, including material, is in accordance with design drawings or approved substitution.
c) Anchor diameter, length and installed embedment depth.
d) Drill bit type and diameter.
e) Anchor edge distance and spacing.
f) Hole diameter and depth.
g) Hole cleaning procedure and cleanliness.
h) Anchor maximum tightening torque.

4) Adhesive Anchors: In addition to the requirements for All Post-Installed Anchors, verify adhesive identification and expiration date.

a) The installation of all adhesive anchors shall be continuously inspected when anchors are subject to sustained tension loads, such as anchors for shelf angles, or when anchors are installed in an upwardly inclined condition.

E. Field Reinforcement Testing: The following tests shall be completed by the Testing Agency:

1. Mechanical Tension Splices: The Testing Agency shall conduct monotonic tension tests in accordance with ASTM A 1034 of mechanical tension splices of the type as specified on the structural drawings. It is not necessary that the specimens to be tested are production splices, however, the specimens to be tested shall have been made by the Contractor's personnel under field conditions. The rate of testing shall be as follows:

a. Two specimens for the first 50 splices (or fraction thereof) at the beginning of the job. Splices not meeting tension requirements shall be retested at Contractor's expense until all splices meet the tension requirements.
b. One specimen for every 100 (or fraction thereof) additional splices occurring on the job. Any splices not meeting tension requirements shall be retested at Contractors expense until all splices have passed the test.
c. A minimum of one test specimen shall also be selected from transition splices (splices of one bar size to another bar size), if any.

F. Field Concrete Testing: The following tests shall be completed by the Testing Agency:

1. During Concrete Placement:

    a. Record the amount of water added and note if it exceeds the amount allowed to be added shown in the approved design mixture.
    b. Mold concrete test cylinders as specified below in "Concrete Test Cylinders" Paragraph below.
    c. Perform tests to determine slump, concrete temperature, unit weight, and air entrainment as specified below.
    d. Record information for concrete test reports as specified below.
    e. Pick up and transport to Laboratory cylinders cast the previous day.

2. After Concrete Placement:

    a. In-situ Concrete Strength Verification for Form Stripping: The Testing Agency shall perform the tests necessary to determine the concrete strength prior to form stripping:

        1) If concrete strength for form stripping is to be determined using field-cured cylinders, the cylinder shall be broken at the time of form removal as authorized and paid for by the Contractor.

        2) If concrete strength for form stripping is to be determined using the Maturity Method, the Testing Agency shall verify that the requirements of ASTM C 1074 are being followed and that the proper criteria for determining concrete strength by this method has been established and is being followed.

    b. Investigation of Low Strength Concrete Test Results:

        1) Cost of Investigations for Low Strength Concrete: The Contractor shall reimburse the costs of investigations of low strength concrete.
        2) Scope of Investigations: See above for the investigations that may be required by the Engineer. The Testing Agency will conduct these investigations if required.

    c. Post-Installed Anchors in Concrete:

        1) Verify maximum anchor tightening torque for all applicable post-installed anchors.
        2) Verify that all drilled holes for adhesive anchors are within six degrees of perpendicular to the surface of the concrete member.

        3) Provide pull tests on individual anchors as specified in the ICC Evaluation Services Report, on the drawings, or as directed by the Engineer-of-Record.

    d. Floor Flatness and Levelness Measuring: Perform tests as defined below.

    e. Testing of Concrete Floor Slabs for Acceptability to Receive an Adhesive-Applied, Low-Permeable Floor Covering: Perform tests as defined below.
    f. Testing of Non-Shrink Grout for Base Plates, Bearing Plates, and Precast Wall Panels:

        1) Compressive Strength Tests: Compressive strength of grout shall be determined by testing grout cubes according to the requirements of ASTM C

109. Test one set of three cubes at one day, and one set of three cubes at 28 days.

2) Frequency of Testing: One set of cubes (six cubes) shall be made for every ten base plates and bearing plates or fraction thereof but not less than one set for each day's operation. One set of cubes shall be made for each day's operation of grouting wall panels.

3. Standards for Concrete Tests:

a. Concrete Test Cylinders: Mold and test concrete cylinders as described below:

1) Cylinder Molding and Testing: Cylinders for strength tests shall be molded and Laboratory cured in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Cylinders may be either 6 inch in diameter by 12 inch or 4 inch in diameter by 8 inch, however, the diameter of the cylinder shall be at least three times the nominal maximum size of the coarse aggregate in the mix tested. All of the cylinders for each class of concrete shall be of the same dimension for all sets of that class.

2) Field Samples: Field samples for strength tests of fresh concrete shall be obtained according to ASTM C 172 at the point of placement.

3) Quantity of Cylinders: Each set of test cylinders shall consist of a minimum of four standard test cylinders. If concrete strength for form stripping is to be determined using field-cured cylinders, one additional cylinder per set will be required for formed slab and pan-formed beam floors for the purpose of evaluating the concrete strength at the time of form stripping. This cylinder shall be stored on the floor where form removal is to occur under the same exposure conditions as the floor concrete. The cylinder shall be cured under field conditions in accordance with ASTM C 31. Field-cured test cylinders shall be molded at the same time and from the same samples as laboratory-cured test specimens. The Contractor shall reimburse the cost of making and testing these cylinders.

4) Frequency of Testing: A set of test cylinders shall be made according to the following minimum frequency guidelines:

a) One set for each class of concrete taken not less than once a day.
b) Mat Foundation: One set for each 150 cubic yards or fraction thereof.
c) Piers, Piles, Underreamed Footings: One set for each 50 cubic yards or fraction thereof.
d) Pressure-injected Footings: One set for each 50 cubic yards or fraction thereof.
e) Spread Footings: One set for each 50 cubic yards or fraction thereof.
f) Pile Caps: One set for each 50 cubic yards or fraction thereof.
g) Basement Walls: One set for each 150 cubic yards.
h) Floors: One set for each 150 cubic yards or fraction thereof but not less than one set for each 5,000 square foot of floor area.
i) Columns: One set for each 50 cubic yards or fraction thereof with a minimum of two sets per floor.
j) Shear Walls: One set for each 50 cubic yards but not less than two sets per floor.
k) Tilt-Up Panels: One set for every 50 cubic yards or fraction thereof.

l) All Other Concrete: A minimum of one set for each 150 cubic yards or fraction thereof but not less than one set for each 5,000 square foot of area for walls.
m) No more than one set of cylinders at a time shall be made from any single truck.
n) If the total volume of concrete is such that the frequency of testing as specified above would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
o) The above frequencies assume that one batch plant will be used for each pour. If more than one batch plant is used, the frequencies cited above shall apply for each plant used.

5) The cylinders shall be numbered, dated, and the point of concrete placement in the building recorded.

6) For concrete specified on the drawings to reach the required strength at 28 days, break one cylinder of the set at seven days, two 6 inch by 12 inch cylinders or three 4 inch by 8 inch cylinders at 28 days, and keep one in reserve for testing at the Engineer's direction.
7) For concrete specified on the drawings to reach the required strength at 56 days, break one cylinder of the set at seven days, one cylinder at 28 days, two 6 inch by 12 inch cylinders or three 4 inch by 8 inch cylinders at 56 days, and one kept in reserve for testing at the Engineer's direction.
8) For concrete specified on the drawings to reach the required strength at 90 days, break one cylinder of the set at seven days, one cylinder at 28 days, one cylinder at 56 days, two 6 inch by 12 inch cylinders or three 4 inch by 8 inch cylinders at 90 days, and one kept in reserve for testing at the Engineer's direction.
9) Cylinder Storage Box: The Contractor shall be responsible for providing a protected concrete cylinder wooden storage box at a point on the job site mutually agreeable with the Testing Agency for the purpose of storing concrete cylinders until they are transported to the Laboratory. The box shall be constructed and equipped to maintain the environment specified for initial curing in ASTM C 31.
10) Transporting Cylinders: The Testing Agency shall be responsible for transporting the cylinders to the Laboratory in a protected environment such that no damage or ill effect will occur to the concrete cylinders including loss of moisture, freezing temperatures or jarring.
11) Information on Concrete Test Reports: The Testing Agency shall make and distribute concrete test reports after each job cylinder is broken. Such reports shall contain the following information:

a) Truck number and ticket number.
b) Concrete Batch Plant.
c) Design mixture number.
d) Accurate location of pour in the structure.
e) Strength requirement.
f) Date cylinders made and broken.
g) Technician making cylinders.
h) Concrete temperature at placing.
i) Air temperature at point of placement in the structure.

j) Amount of water added to the truck at the batch plant and at the site and whether or not it exceeds the amount allowed by the design mixture.
k) Slump.
l) Unit weight.
m) Air content.
n) Cylinder compressive strengths with type of failure if concrete does not meet Specification requirements. 7 day breaks are to be flagged if they are less than 60% of the required 28 day strength. 28 day breaks are to be brought to the attention of the Architect and Engineer in writing if either cylinder fails to meet specification requirements.

b. Slump Tests: ASTM C 143, Slump Tests shall be completed at the beginning of concrete placement for each batch plant and for each set of test cylinders made. The slump test shall be made from concrete taken from the end of the concrete truck chute. The concrete shall be considered acceptable if the slump is within the slump tolerance noted in the approved design mixture submittal for that class of concrete.

c. Air Entrainment: ASTM C 231, pressure method, for normal-weight concrete; and ASTM C 173, volumetric method, for structural lightweight concrete. Air entrainment tests shall be made at the same time slump tests are made as cited above. Samples for air entrainment tests shall be taken at the point of placement.

d. Concrete Temperature: ASTM C 1064, Concrete temperature at placement shall be measured at the same time slump tests are made as cited above.

e. Unit Weight Test: ASTM C 138.

f. Strength Test: A strength test shall be defined as the average strength of two six inch cylinder breaks or three four inch cylinder breaks from each set of cylinders tested at the time indicated above.

g. Quality Control Charts and Logs: The Testing Agency shall keep the following quality control logs and charts for each class of concrete containing more than 2,000 cubic yards. The records shall be kept for each batch plant and submitted on a weekly basis with cylinder test reports:

1) Number of strength tests made to date.
2) Strength test results containing the average of all strength tests to date, the high test result, the low test result, the standard deviation, and the coefficient of variation.
3) Number of tests under specified strength.
4) A histogram plotting the number of strength test cylinders versus compressive strength.
5) Quality control chart plotting compressive strength test results for each test.
6) Quality control chart plotting moving average for strength where each point plotted is the average strength of three previous test results.
7) Quality control chart plotting moving average for range where each point plotted is the average of 10 previous ranges.

h. Acceptance Criteria: The strength level of an individual class of concrete shall be considered satisfactory if both of the following requirements are met:

1) The average of all sets of three consecutive strength tests equal or exceed the required f ’c.
2) No individual strength test falls below the required f ’c by more than the greater of 10% of f ’c or 500 PSI.

i. If either of the above Acceptance Criteria requirements is not met, the Testing Agency shall immediately notify the Engineer by telephone. Steps shall immediately be taken to increase the average of subsequent strength tests.

4. Testing Reports: Compressive strength, slump, air, and temperature tests shall be identified by reference to a particular trip ticket.

END OF SECTION 033000

SECTION 078123 - INTUMESCENT FIRE PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mastic and intumescent fire-resistive coatings.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Mastic and intumescent fire-resistive coatings.
2. Substrate primers.
3. Topcoat.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Evaluation reports.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by mastic and intumescent fire-resistive coating manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Assemblies: Provide fire protection, including auxiliary materials, according to requirements of each fire-resistance design and manufacturer's written instructions.

B. Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Asbestos: Provide products containing no detectable asbestos.

2.2 MASTIC AND INTUMESCENT FIRE-RESISTIVE COATINGS

A. Mastic and Intumescent Fire-Resistive Coating: Manufacturer's standard, factory-mixed formulation, and complying with indicated fire-resistance design.
   1. Application: Designated for "interior general purpose" use by a qualified testing agency acceptable to authorities having jurisdiction.
   2. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
   3. Surface-Burning Characteristics: Comply with ASTM E84.

      a. Flame-Spread Index: 25 or less.
      b. Smoke-Developed Index: 450 or less.

2.3 AUXILIARY MATERIALS

A. Provide auxiliary materials that are compatible with mastic and intumescent fire-resistive coating and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

B. Substrate Primers: Primers approved by mastic and intumescent fire-resistive coating manufacturer for the required fire-resistance design.

C. Topcoat: Suitable for application over applied mastic and intumescent fire-resistive coating; of type recommended in writing by mastic and intumescent fire-resistive coating manufacturer for each fire-resistance design.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.

3.2 PREPARATION

A. Cover other work subject to damage from fallout or overspray of fire protection materials during application.

B. Prime substrates where included in fire-resistance design and where recommended in writing by mastic and intumescent fire-resistive coating manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.

C. For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection.

3.3 APPLICATION

A. Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other materials and procedures affecting fire protection Work.

B. Comply with mastic and intumescent fire-resistive coating manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

C. Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by mastic and intumescent fire-resistive coating manufacturer.

D. Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

E. Finishes: Where indicated, apply fire protection to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Test and inspect as required by the IBC, Subsection 1705.14, "Mastic and Intumescent Fire-Resistant Coatings."

B. Fire protection will be considered defective if it does not pass tests and inspections.

1. Remove and replace fire protection that does not pass tests and inspections, and retest.
2. Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

C. Prepare test and inspection reports.

3.5 CLEANING

A. Cleaning: Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

3.6 REPAIR

A. Repair fire protection damaged by other work before concealing it with other construction.

B. Repair fire protection by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

END OF SECTION 078123

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of high-performance coating systems on the following substrates:

1. Exterior Substrates:

a. Concrete, horizontal surfaces.

2. Interior Substrates:

a. Concrete, horizontal surfaces.

1.2 DEFINITIONS

A. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.

B. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.

C. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Exterior High-Performance Coating Schedule or Interior High-Performance Coating Schedule for the coating category indicated.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
3. Products shall be of same manufacturer for each coat in a coating system.

C. Colors: As selected by Owner from manufacturer's full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and coating systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

B. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 EXTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Horizontal Surfaces:

1. Epoxy Non-Slip Deck Coating System MPI EXT 3.2C:

a. Prime Coat: As recommended in writing by topcoat manufacturer.
b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
c. Topcoat: Epoxy deck coating (slip resistant), MPI #82.

3.5 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Concrete Substrates, Horizontal Surfaces.

1. Clear (Two-Component) Acrylic Polyurethane System MPI INT 3.2K:

a. Prime Coat: Two-component polyurethane matching topcoat.
b. Intermediate Coat: Two-component polyurethane, matching topcoat.
c. Topcoat: Varnish, aliphatic polyurethane, two component (MPI Gloss Level 6 or MPI Gloss Level 7), MPI #78.

END OF SECTION 099600