

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All materials, equipment and labor required for formwork, reinforcing, placing, finishing and curing cast-in-place concrete.
- B. Installation of all specified items to be embedded in cast-in-place concrete.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Structural Steel - Section 05 12 00: Anchor rods, embed plates, and other items to be embedded in cast-in-place concrete.
- B. Miscellaneous Metals - Division 5

1.3 RELATED SECTIONS

- A. Polished Concrete Finishing – Section 033543
- B. Site Paving - Division 32

1.4 REFERENCES

- A. Work on this project shall conform to all requirements of the current version of the specifications listed below published by the current building codes except as modified by these contract documents.

ASTM specifications apply in their entirety where specifically referenced in the body of this section.

Refer to specific portions of other guides, guidelines, and manuals where referenced in the body of this specification section.

1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials
2. ACI 301 - Specifications for Structural Concrete
3. ACI 305.1 - Specification for Hot Weather Concreting.
4. ACI 306.1 - Specification for Cold Weather Concreting.
5. ACI 315 – Manual of Standard Practice for Detailing Reinforced Concrete Structures.
6. ACI 318 - Building Code Requirements for Structural Concrete.
7. CRSI Manual of Standard Practice.

1.5 INFORMATIONAL SUBMITTALS: PLACEMENT RECORDS

- A. Concrete Placement Daily Records: Turn over to the Architect/ Engineer on a weekly basis.

1.6 ACTION SUBMITTALS

A. Concrete Mix Designs:

1. Submit for review a mix design for each class of concrete required for the project under the provisions of Division 1 and including:
 - a. Standard deviation analysis, required average strength and documentation of average strength verifying compliance with ACI 318.
 - b. Mix proportions by weight, water-cement ratio, slump and air content.
 - c. Sieve analyses of fine and coarse aggregates.
 - d. Complete list of materials specified in PART 2 - PRODUCTS - CONCRETE MATERIALS article with product information demonstrating compliance with all specified requirements.
2. Submit with sufficient time allowed for review before concrete is required for the project.

B. Reinforcement Shop Drawings:

1. Submit the proposed Shop Drawing Submittal Schedule prior to submitting any of the shop drawings for review.
2. Prepare shop drawings giving complete details of fabrication and placement.
3. Shop drawing action codes:
 - a. Shop drawings marked "Reviewed" do not require a resubmittal. Fabrication may commence.
 - b. Shop drawings marked "Reviewed with exceptions" require the marked corrections to be made. No resubmittal is required. Fabrication may commence leading to reinforcement installation once all exceptions noted are corrected.
 - c. Shop drawings marked "Revise and Resubmit" require the marked corrections to be made. The drawings must be resubmitted for review. Fabrication may not commence.
 - d. Shop drawings marked both "Reviewed with Exceptions" and "Revise and Resubmit" require the marked corrections to be made. The drawings must be resubmitted for review. Fabrication may commence. Installation may not begin until the subsequent submission has been reviewed and returned for use in reinforcement installation.
 - e. Shop drawings marked "Rejected" must be resubmitted prior to any further review being completed.

4. Shop Drawings will be checked by the Architect/Engineer for correct interpretation of the Drawings but this check shall not relieve the Contractor of their primary responsibility to provide the correct number of properly detailed bars in all members.
 5. Resubmitted shop drawings:
 - a. All information which is correct on the original submittal will not be changed in any way on the resubmitted shop drawings.
 - b. Cloud all information changed due to a Change Order.
 6. See the General Notes and Typical Details for additional reinforcing around openings and other general information for the Detailer.
 7. Prepare shop drawings in accordance with the following:
 - a. Provide bar bending diagrams for all bent bars within a submittal in that same submittal.
 - b. Sections of walls and slabs shall be provided showing clearly bar positions and clearances to forms.
 - c. On wall sections, indicate spacers used to maintain clearances for vertical wall steel.
 - d. Include all details, sections, and installation instructions indicated on the structural drawings that are required by the Contractor to place the reinforcement without using the structural drawings.
 - e. Indicate grades of reinforcement on each shop drawing.
 - f. For slabs, show support system in number and quantity. The maximum spacing of support bars shall be 4'-0". The maximum overhang beyond a support bar or a slab bolster shall be 1'-0".
 8. Submit the following regarding the dowel bar replacement system and any other accessories to be used:
 - a. Shop drawings indicating fabrication and placement details per this section.
 - b. Manufacturer's literature, product samples, and certified test reports substantiating compliance with the Specification.
- C. Product Information: Submit product information for review for materials specified in PART 2 - PRODUCTS article under the provisions of Division 1 and demonstrating compliance with specified requirements.

1.7 QUALITY ASSURANCE

- A. Provide at least one experienced person present at all times during execution of this portion of the Work and who shall be thoroughly familiar with the type of materials being installed and the best methods for their installation and who shall direct all work performed under this Section.

- B. Perform work in accordance with ACI 301.
- C. Conduct field sampling and testing of concrete, including the making of test specimens, with personnel holding current certificates issued by the Concrete Technician Certification Committee of ACI.
- D. Field survey of cast in place embedments: Anchors rods, embed plates etc.
 - 1. Survey elevations and locations of anchor rods and embeds to receive structural steel, miscellaneous steel and cladding attachments. Survey is to be completed by a registered surveyor experienced in building construction in the state in which the project is located. Anchor rods not placed within the AISC 303 - Code of Standard Practice for Steel Buildings and Bridges (Article 7.5) shall be specifically noted in the field survey report. Survey shall be completed prior to fabrication of the base plates that accommodate the anchor rods.

1.8 DESIGN

- A. All formwork shall be designed by the Contractor who shall be solely responsible for this work.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Reinforcement protection:
 - 1. Use all means necessary to protect concrete reinforcement before, during and after installation and to protect the installed work and materials of all other trades.
 - 2. Store in a manner to prevent excessive rusting and fouling with dirt, grease, and other bondbreaking coatings.
 - 3. Use all necessary precautions to maintain identification after the bundles are broken.
 - 4. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect/Engineer and at no additional cost to the Owner.
- B. Deliver concrete in accordance with ASTM C94. Do not use non-agitating transporting equipment.
- C. Deliver materials and equipment in undamaged condition.
- D. Store materials and equipment in designated areas and in accordance with manufacturer's instructions.
- E. Store materials and equipment off the ground, totally protected from ground splash, mud, weather separation, intrusion of foreign materials, and other damage.

1.10 INCLEMENT WEATHER REQUIREMENTS

- A. Inclement Weather: Do not place concrete during rain, sleet or snow unless adequate protection is provided.
- B. Hot Weather: Perform work under provisions of PART 3 - EXECUTION - HOT WEATHER CONCRETING article.
- C. Cold Weather: Perform work under provisions of PART 3 - EXECUTION - COLD WEATHER CONCRETING article.

PART 2 - PRODUCTS

2.1 FORM MATERIALS AND ACCESSORIES

- A. Form Lumber:
 - 1. One of the following or a combination thereof.
 - a. Forms for all concrete unless otherwise indicated:
 - 1) Face Forms: Rough sawn lumber, CDX plywood, particle board BBOES plywood, MDO plywood
 - b. Forms for as cast concrete surfaces to remain exposed to public view (Architectural Finish, per drawings):
 - 1) Face Forms: Unless noted otherwise, High Density Overlaid Plyform Class I or II, exterior, bearing APA grade stamp on each piece. Minimum thickness: 3/4".
 - 2) Phenolic surface film, plastic, or steel material where specifically noted.
 - 2. Surfaces and lines for surfaces to remain exposed to public view (Architectural Finish, per drawings) shall comply with ACI 117 tolerances and form facing category compatible with concrete surface category per Table 3.1a, ACI 347.3R. Surfaces produced shall require only minor dressing to arrive at true surfaces.
 - 3. All form lumber in contact with exposed concrete shall be new or of sufficient quality to ensure an unblemished texture.
- B. Form Ties:
 - 1. Factory fabricated, adjustable length, snap-off metal form ties, designed to prevent form deflection and to prevent spalling of concrete upon removal. The metal after breaking should be at least 1" from the face of the wall.

C. Form Release Agent:

1. Non-staining, neutral, barrier type which will not cause softening or impede curing.
2. Standards:
 - a. DUO guard Chemical Release Agent – WR Meadows
 - b. Magic Kote E Symons Manufacturing Company
 - c. Clean Strip J1EF Form Release by Dayton Superior.
3. Refer to Division 1 Sustainable Design specification section for any restrictions on form release agent materials that may override the above products.

D. All other materials, not specifically described but required for proper completion of concrete formwork, shall be as selected by the Contractor.

2.2 CONCRETE REINFORCEMENT

A. All concrete reinforcement materials shall comply with the following reference standards:

1. Reinforcing Bars: ASTM A615 Grade 60
2. Wire Reinforcement: ASTM A1064
3. Welded Wire Reinforcement: ASTM A1064

B. Accessories:

1. Provide bar supports, ties, blocking and accessories in accordance with CRSI "Manual of Standard Practice".
2. Use bar supports for slab on grade that do not puncture specified underslab vapor barrier.
3. Use precast concrete blocks for bar supports of footing/foundation reinforcing placed directly on subgrade.

C. Dowel bar replacement system:

1. Shall conform to ACI 318.
2. Standards:
 - a. DBDI Splice System-Dayton Superior Corporation
 - b. Lenton Form Saver - Erico Products, Inc.
 - c. BDI Bar Splicer System - Bar Splice Products, Inc.

D. Rebar anchorage system (mechanical bar terminators):

1. Shall conform to ACI 318.

2. This anchorage system shall be used only in places indicated on the structural drawings or in areas approved by the Structural Engineer.
3. Standards:
 - a. Lenton Terminator – Erico
 - b. MRC D-158 Structural Rebar End Anchor - Dayton Superior

2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150, Type I or Type III.
- B. Portland Limestone Cement: ASTM C595, Type II.
- C. Flyash: ASTM C618, Class C or Class F.
 1. Maximum loss on ignition: 3.0 percent.
 2. Maximum amount retained when wet-sieved on No. 325 sieve: 30 percent.
 3. Flyash not permitted for concrete to be polished.
- D. Slag Cement: ASTM C989, Grade 100 or 120.
- E. Fine Aggregate: ASTM C33.
 1. Natural sand of clean, hard, durable particles.
 2. Sieve analysis to conform to the following gradation requirements:

Sieve Sizes	Percent Passing
3/8	100
No. 4	95-100
No. 6	--
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 80	--
No. 100	0-10

- F. Coarse Aggregate: ASTM C33.
 1. $\frac{3}{4}$ " maximum aggregate size, Crushed stone or gravel of clean, sound, tough, durable particles.
 - a. For air-entrained concrete mixes: ASTM C33, Class 4S.
 - b. For non air-entrained concrete mixes: ASTM C33, Class 2S.
 - c. Sieve analysis to conform to the following gradation requirements:

Sieve Size Passing	Percent
1"	100
3/4"	75-95
1/2"	40-70
3/8"	20-50
No. 4	0-15
No. 8	0-10
No. 30	--
No. 200	--

G. Aggregate for concrete slabs to be polished: Provide aggregates from single source.

1. River Rock as approved by Architect
2. Maximum Coarse Aggregate Size: 3/4 inch nominal
3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

H. Water: Clean and free from injurious amounts of oil, acids, alkalis, salts, organic materials and other deleterious substances.

I. Air-Entraining Admixture: ASTM C260.

1. Standards:
 - a. Master-Air AE 200 by Master Builders Solutions.
 - b. Master Air AE 90 by Master Builders Solutions.
 - c. Daravair Series by GCP Applied Technologies.
 - d. Air Mix by The Euclid Chemical Co.
 - e. AEA 92 by The Euclid Chemical Co.

J. Water-Reducing Admixture: ASTM C494, Type A.

1. Standards:
 - a. MasterPozzolith 200, 210, 322 by Master Builders Solutions.
 - b. WRDA with Hycol by GCP Applied Technologies.
 - c. Eucon WR-75 by The Euclid Chemical Co.

K. Mid-Range Water Reducing Admixture: ASTM C494, Type A.

1. Standards
 - a. Daracem 55 by GCP Applied Technologies.
 - b. Mira Series by GCP Applied Technologies
 - c. MasterPolyheed Series 900, 1025, or 997 by Master Builders Solutions.
 - d. Eucon Series by Euclid Chemical Co.

e. Plastol Series by Euclid Chemical Co.

L. High Range Water-Reducing Admixture: ASTM C494, Type F.

1. Standards:

- a. MasterGlenium 3030 by Master Builders Solutions.
- b. MasterRheobuild 1000 by Master Builders Solutions.
- c. Daracem Series by GCP Applied Technologies.
- d. Adva Series by GCP Applied Technologies.
- e. Eucon 37 by The Euclid Chemical Co.
- f. Eucon 537 by The Euclid Chemical Co.
- g. Plastol Series by The Euclid Chemical Co.

2. High range water reducing admixture shall be added to the concrete at the batch plant. Field added HRWR is allowed to correct slump non-compliance.

M. Accelerating Admixture: ASTM C494, Type C.

1. Standards:

- a. MasterSet FP20 or MasterSet AC534 Accelerator by Master Builders Solutions.
- b. Polaset by GCP Applied Technologies.
- c. Accelguard 80 or 90 by The Euclid Chemical Co.

2. The accelerator shall be non-chloride, non-corrosive. Calcium chloride, or admixtures containing more than 0.05% chloride ions, are not permitted.

3. Thiocyanate-based accelerators, when used at the given dosage rate, shall contribute thiocyanate ions less than 0.30 percent by weight of cement. This shall be certified by the manufacturer.

N. Water-Reducing & Retarding Admixture: ASTM C494, Type D.

1. Standards:

- a. MasterSet R122 or MasterSet R300 by Master Builders Solutions.
- b. Daratard-17 by GCP Applied Technologies.
- c. Eucon Retarder-75 by The Euclid Chemical Co.

O. Integral Curing Admixture:

1. Standards:

- a. E5 Internal Cure – Specification Products

P. Synthetic Fibers (for slabs on grade, not polished):

1. Virgin (non-recycled), nylon or polypropylene fibers.
2. 3/4 inch length (unless specified otherwise).
3. When using nylon fibers, add fibers at a minimum dosage rate of 1.0 pound/cubic yard. When using fibrillated polypropylene fibers, add fibers at a minimum dosage rate of 1.5 pounds/cubic yard. Use in strict accordance with manufacturer's instructions.
4. Fibers shall be introduced into the concrete at the batch plant, and it shall be noted on all delivery tickets.
5. Standards:
 - a. Fiberforce 300 by ABC Polymer.
 - b. Fibermesh 300 by SIKA.
 - c. Forta Ultra-Net by Forta Corp.

2.4 RELATED MATERIALS

A. Curing Compound: ASTM C309.

1. Clear curing, non-yellowing under ultra violet light.
2. Sodium silicate products are not permitted.
3. Compatible with applied sealers and finishes specified for the concrete surfaces to be cured.
4. Curing compound shall be applied at the coverage rate to comply with ASTM C309.
5. Contractor is responsible for verifying curing compound is compatible with floor finish or waterproofing system. Return of "Reviewed" curing compound submittal by Structural EOR does not imply compatibility with finishes.
6. Not permitted for polished concrete. Use moisture retention covers.

B. Moisture Retention Cover: ASTM C171.

1. Waterproof paper or polyethylene film.

C. Evaporation Retardant:

1. Apply in accordance with manufacturer's instructions.
2. Standard:
 - a. MasterKure ER50 by Master Builders Solutions.
 - b. EUCO-BAR by the Euclid Chemical Co.

D. Epoxy Bonding Adhesive:

1. Two-part structural epoxy adhesive.

2. Use to bond fresh, plastic concrete or patching mortar to hardened concrete.
3. Standards:
 - a. Sikadur 32, Hi-Mod by Sika Corporation.
 - b. Euco 452 by The Euclid Chemical Co.

E. Adhesive Anchor System:

1. Moisture insensitive epoxy.
2. Use to anchor reinforcing steel into hardened concrete.
3. Standards:
 - a. Hilti HIT HY 200 V3 by Hilti Fastening Systems.
 - b. Vertical holes: Sikadur 32, Hi-Mod by Sika Corporation or Euco 452MV Epoxy by The Euclid Chemical Co.
 - c. Horizontal holes: Sikadur Injection Gel by Sika Corporation.
 - d. Overhead application: Sikadur 31, Hi-Mod Gel by Sika Corporation Euco 452 Gel by The Euclid Chemical Co.
 - e. Approved equal: Submit literature including depth of embedment to fully develop reinforcing bars and spacing requirements.
4. Drilled hole size and installation procedure shall conform to manufacturer's instructions.
5. Use carbide bit drill to prevent damage to reinforcement

F. Patching Material:

1. Use to repair honeycombed and other defective concrete that will be concealed.
2. Standards:
 - a. SikaTop 122 PLUS (horizontal surfaces), by the Sika Corporation.
 - b. SikaTop 123 PLUS (overhead and vertical surfaces), by the Sika Corporation.
 - c. MasterEmaco T310 CI (horizontal surfaces) by Master Builders Solutions.
 - d. MasterEmaco N420 CI (vertical and overhead surfaces) by Master Builders Solutions.

G. Isolation Joint Filler: ASTM D1752

1. Isolation joint filler shall be flexible, lightweight, non-straining, polyethylene, and closed cell. It shall be a chemical-resistant, ultraviolet stable, non-absorbent, low density, compressible foam.
2. The joint filler shall have a pre-scored "removable strip" to provide a uniform sealing reservoir in the joint. This reservoir shall be used to provide a sealed joint with a flexible sealant in accordance to the Construction Documents.
3. Use at isolation joints filler when called out at columns and adjacent to walls.
4. Standards:

- a. Deck-O-Foam Expansion Joint Filler by W.R. Meadows.
 - b. Foamtech by NMW, Inc.
- H. Bondbreaker for Isolation Joints: Liquid, paper or plastic sheet to break bond between freshly placed concrete and hardened concrete.
- I. Waterstops:
- 1. PVC flat ribbed or dumbbell type.
 - a. Provide waterstops with center bulb at all expansion joints and as detailed.
 - b. Split-fin type waterstop is acceptable at construction joints and expansion joints.
 - c. Provide all corner joints and tee joints in prefabricated assemblies. Field splices shall be used for butt joints only, using controlled indirect heating element per manufacturer's requirements.
 - d. Standards:
 - 1) Greenstreak Plastic Products Company.
 - 2) Vinylex Corporation.
 - 3) Wirestop, Paul Murphy Plastics Company.
 - 4) Durajoint, Tamms/Horn
 - 2. Waterstop-RX by American Colloid Company
 - a. Keep dry at all times.
 - b. RX101: Use with concrete with two rows of reinforcement and with 3" minimum concrete cover.
 - c. RX102: Use with one row of reinforcement and with 2" minimum concrete cover.
 - d. Install in strict accordance with manufacturer's requirements.
- J. Self-leveling Underlayment Concrete:
- 1. Material shall be compatible with floor finishes.
 - 2. Material shall be used on floors that will receive a floor covering.
 - 3. Standards:
 - a. Ardex K-15 by Ardex Engineered Cements.
 - b. Level-Right by Gyp-Crete Corp.
 - c. Flo-Top/Flo-Top 90 by The Euclid Chemical Co.
- K. Self-leveling, Polymer Modified Industrial Topping
- 1. Material shall be compatible with floor sealer.
 - 2. Material shall be used on exposed concrete floors.

3. Standards:
 - a. MasterTop Topping 112, by Master Builders Solutions.
 - b. Thin Top/Thin Top Supreme by The Euclid Chemical Co.

- L. Industrial Floor Joint Filler *(Option #1)*
 1. Flexible epoxy joint filler with 100 percent solids.
 2. Minimum Shore D hardness of 50.
 3. Use to fill control joints and construction joints in slabs on grade. Apply filler a minimum of 3 months after concrete placement.
 - a. The Contractor that installs the joint filler shall return to the project six months after occupancy and shall fill in the separations or cracks that have occurred at the control joints and the construction joints with the same material or with an approved companion material by the same manufacturer.

 4. Standards:
 - a. Euco 700 by The Euclid Chemical Co.
 - b. MM-80 by Metzger/McGuire.

- M. Industrial Floor Joint Filler * (Option #2)*
 1. Flexible multi-part urethane sealant.
 2. Non-sag or self-leveling.
 3. Use to fill control joints and construction joints in slabs on grade.
 4. Standards:
 - a. Eucolastic II by The Euclid Chemical Co.
 - b. THC-900 or THC-901 by Tremco Inc.

- N. Reinforced Polyethylene Underslab Vapor Retarder: Co-extruded Polyolefin Membrane meeting ASTM E 1745, Class A, single or multi-layer, not less than 15 mils thick. Sheet manufactured in multilayer extrusion process using virgin (non-recycled) polyolefin resins.
 1. Maximum perm rating of 0.02 perms (U.S.) per ASTM E-96 / F-1249, Procedure B.
 2. Puncture resistance of 2200g or greater per ASTM D-1709,B.
 3. Include manufacturer's recommended adhesive or pressure-sensitive joint tape and include manufacturer's proprietary penetration flashing for all thru slab penetrations.
 4. Products: Subject to compliance with above requirements, provide one of the following:
 - a. Fortifiber Building Systems Group; Moistop Ultra 15.

- b. [Insulation Solutions, Inc.](#); Viper Vaporcheck II, 15 mils.
- c. [Raven Industries, Inc.](#); Vapor Block 15.
- d. [Reef Industries, Inc.](#); Griffolyn 15 mil.
- e. W. R. Meadows, Inc.; Perminator 15.

2.5 PROPORTIONING CONCRETE MIXES

- A. Establish concrete proportions to produce homogeneous, durable mixes with the required average strength based on the appropriate amount of overdesign as required by Section 5.3 of ACI 318.
- B. Proportion concrete mixes to provide workability and consistency to permit concrete to be worked readily into the corners and angles of the forms and around reinforcement by the methods of placement and consolidation to be employed, without segregation or excessive bleeding.
- C. Include a water-reducing admixture, a mid-range water reducing admixture, or high range water-reducing admixture, used in strict accordance with manufacturer's instructions, in all mix designs. Specified minimum cement contents are based on the use of such admixtures.
- D. Include an air-entraining admixture in mix designs for all concrete exposed to freezing and thawing during service.
- E. Base mix design on saturated surface dry aggregates. Adjust the amount of mixing water added at the batch plant for the moisture condition of the aggregates.
 - 1. The water-cementitious ratio given for each class of concrete shall be calculated using the amount of Portland Cement plus flyash plus Slag Cement. For Class C flyash, use 100 percent of flyash, and for Class F flyash, use 80 percent of flyash. For Slag Cement, use 100 percent of the Slag Cement.
- F. Flyash may be used as a cement substitute with a maximum 20 percent substitution rate on a pound for pound basis for Class C flyash and a maximum 15 percent substitution rate using 1.25 pounds of flyash for 1.00 pound of cement for Class F flyash.
 - 1. Flyash not permitted in concrete to be polished.
- G. Slag Cement may be used as a substitute for Portland Cement on a pound for pound basis. The maximum substitution rate shall be 50%, except for Class 4ESOG (exterior concrete) the max substitution rate shall be 30%.

- H. When Slag Cement and flyash are used in the same concrete mix, the maximum substitution rates for Slag Cement and flyash shall comply with the following:

Portland Cement/Slag Cement/Flyash Ratio

Exterior concrete (Classes 4ESOG)..... 70%/20%/10%

All other concrete 50%/30%/20%

- I. For concrete to be cast during cold weather, the maximum substitution rate for Slag Cement shall be 30%. If slag Cement and flyash are used in the same concrete mix, the maximum substitution rates shall comply with a ratio of Portland Cement/Slag Cement/Flyash of 70%/20%/10%.

- J. Water Soluble Chloride Ion Content:

1. Maximum percent in concrete by weight of cement:
 - a. Reinforced concrete exposed to earth or weather: 0.15.
 - b. Other reinforced concrete construction: 0.30.

- K. Slump:

1. Mixes containing high range water-reducing admixture: 5 to 8 inches.
2. Mixes containing mid-range water-reducing admixture: 5-6 ½ inches.
3. Mixes containing water-reducing admixture: 5 inches maximum.

- L. Adjustments to the approved mix designs may be requested by the Contractor when job conditions, weather, test results, drying times or other circumstances warrant. These revised concrete mix designs shall be submitted to the Architect/Engineer for approval prior to their use.

- M. Concrete Mix Classes:

1. Class 3 concrete: Footings
 - a. Compressive strength at 28 days: 3000 psi.
 - b. Minimum cement content: 423 lb/cu yd.
 - c. Maximum water-cementitious ratio: 0.58
 - d. Air content: Optional.
 - e. Water-reducing admixture required.
2. Class 4 concrete: Foundation walls and piers
 - a. Compressive strength at 28 days: 4000 psi.
 - b. Minimum cement content: 517 lb/cu yd.

- c. Maximum water-cementitious ratio: 0.48.
 - d. Air content: 0 to 3 percent.
 - e. High range water-reducing admixture required.
3. Class 4SOG concrete: Interior Slabs on grade
- a. Compressive strength at 28 days: 4000 psi.
 - b. Minimum cement content: 517 lb/cu yd.
 - c. Maximum water-cementitious ratio: 0.48.
 - d. Air content: 0 to 3 percent.
 - e. Mid range water-reducing admixture required.
 - f. Synthetic fibers required.
4. Class 4SOG-P concrete: Interior Slabs on grade to be polished
- a. Compressive strength at 28 days: 4000 psi.
 - b. Minimum cement content: 517 lb/cu yd.
 - c. Maximum water-cementitious ratio: 0.48.
 - d. Air content: 0 to 3 percent.
 - e. Mid range water-reducing admixture required.
 - f. Flyash not permitted.
 - g. Aggregate shall be single-source River Rock as approved by the Architect, max. size $\frac{3}{4}$ " nominal.
 - h. No synthetic fibers – reinforce with 6x6-W2.9xW2.9 WWF.
5. Class 4EXT concrete: Exterior exposed concrete including slabs on grade shown on "S" series drawings and concrete with Architectural Finish, per drawings.
- a. Compressive strength at 28 days: 4500 psi.
 - b. Minimum cement content: 564 lb/cu yd.
 - c. Maximum water-cementitious ratio: 0.40.
 - d. Coarse aggregate: Crushed stone.
 - e. Air content: 6+ 1 percent.
 - f. High range water-reducing admixture required.
 - g. Synthetic fibers required.

2.6 BATCHING AND MIXING

- A. Batch and mix concrete in accordance with ASTM C94.
- B. Mix concrete until there is a uniform distribution of materials.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Before forms are constructed, reinforcement is installed, or concrete is placed, inspect the installed work of this and other Sections and verify that all such work is complete.

- B. Verify that forms are constructed in accordance with all pertinent codes and regulations, the referenced standards, and the original design.
- C. Verify that concrete can be placed to the required lines and elevations with required cover for reinforcement.
- D. Prevent groupings of conduits, pipes and sleeves in concrete that would significantly impair the strength of the concrete.
- E. Discrepancies:
 - 1. In the event of discrepancy, immediately notify the Architect/Engineer.
 - 2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved and reviewed by the Engineer.

3.2 CONSTRUCTION OF FORMS

- A. Provide substantial form construction, sufficiently tight to prevent leakage of concrete, and able to prevent excessive deflection when filled with wet concrete.
- B. Layout:
 - 1. Form all required cast-in-place concrete to the shapes, sizes, lines and dimensions indicated on the Drawings. Provide 3/4" chamfers on all exposed corners of concrete except those abutting or aligning with masonry.
 - 2. Layout formwork to eliminate need for cutting of concrete after it is in place.
 - 3. Make proper provisions for all openings, offsets, recesses, anchorage, blocking, and other features of the Work as shown, or required.
 - 4. Perform all forming required for Work of other trades and do all cutting and repairing of forms required to permit such installation.
 - 5. Carefully examine the Drawings and Specifications and consult with other trades as required relative to provisions for openings, reglets, chases and other items in the forms.
- C. Bracing:
 - 1. Properly brace and tie the formwork together to maintain position and shape and to ensure safety of workers.
- D. Construct all formwork straight, true, plumb, level and square within tolerances as specified in ACI 117.
- E. Keep formwork sufficiently wetted to prevent joints opening up before concrete is placed.

- F. Provide holes at bottom of formwork for cleaning and inspection. Close prior to placing concrete.
- G. Forms for concrete surfaces exposed to public view:
 - 1. Lap form facing materials over the concrete or previous placement at construction joints exposed to view. Ensure formwork is placed against hardened concrete so offsets at construction joints attain specified tolerances and minimize loss of mortar.
 - 2. Where seams are acceptable for architecturally exposed formed concrete surfaces, orient as indicated by the Drawings. If not indicated in the Drawings, orient in the least visible position.
 - 3. If necessary, back fasten forms to the supporting members for category to prevent visible blisters on the finished concrete surface at the fastener locations.
 - 4. Where as-cast finishes are required, install forms so that no dressing will be required in the finishing operation.
 - 5. Wall ties: Where embedded ties must be used, lay out in regular pattern approved by Architect. (If ties can be eliminated from concrete for short pours, this is preferable.)
- H. Form footings and pile caps with wood, unless it can be demonstrated to the satisfaction of the independent geotechnical testing and inspection agency that the footing excavation is sufficiently stable to prevent sloughing of the sides of the excavation into the bottom of the excavation.

3.3 FABRICATION AND INSTALLTION OF REINFORCEMENT

- A. Fabrication, including bar bending shall comply with the requirements of ACI 318, ACI 315 and CRSI "Manual of Standard Practice".
- B. Before placing reinforcement and again before placing concrete clean reinforcing of loose rust and mill scale, dirt, ice and other materials that reduce concrete bond.
- C. Installation shall be completed in accordance with reviewed and corrected shop drawings. A set of shop drawings marked accordingly for "Field Use" shall be used during the installation.
- D. All reinforcement and welded wire reinforcement shall be held securely in design position by wiring to supports in accordance with the contract documents, and, in addition, any other supports needed to secure every bar against displacement shall be provided. Provide supports at frequencies in accordance with CRSI manual of Standard Practice, but in no case less than frequencies specified by Contract Drawings. Overhanging tails shall be supported positively. All bars bent and/or displaced during concrete placement shall be straightened and repositioned before they are encased in concrete.
- E. Concrete protection shall comply with the requirements of ACI 318 except as modified on the Structural Drawings.

F. Obstructions:

1. In the event conduits, piping, inserts, sleeves or any other items interfere with placing reinforcement as indicated on the Drawings or as otherwise required, immediately consult the Architect/Engineer and obtain approval of new procedure before placing concrete.
2. Do not field bend or cut reinforcing unless specifically approved by Architect/Engineer.

3.4 PREPARATION FOR CONCRETE PLACEMENT

- A. Install items to be embedded in concrete. Set steel frames, angles, trench drains, bolts, inserts, and other such items required to be anchored in the concrete before the concrete is placed. Position accurately and secure against displacement.
1. Anchor rods shall be installed in accordance with the tolerances indicated in the AISC-303 Code of Standard Practice for Steel Buildings and Bridges, Article 7.5.
 2. Do not embed aluminum items in concrete.
- B. Remove wood scraps, ice, snow, frost, standing water and debris from areas in which concrete will be placed.
- C. Notify the Architect/Engineer when concrete placement is planned. Allow sufficient time for review of formwork, reinforcement and embedded items, and for any required corrective work.
- D. Before fresh concrete is placed against hardened concrete, retighten forms and suitably clean and moisten the surface of the hardened concrete for bond to the fresh concrete.
- E. Thoroughly moisten subgrade on which concrete is to be placed. Do not place concrete on frozen subgrade.
- F. Thoroughly clean conveying and handling equipment.
- G. Installation of vapor barrier beneath slab on grade shall be in accordance with ASTM E1643.
1. Follow manufacturer's instructions for placement (including laps, sealing around penetrations and foundation walls), protection and repair.
 2. Place vapor barrier sheeting with the longest dimension parallel to the direction of the concrete pour.
 3. Do not use reinforcing supports that will puncture the vapor barrier.
 4. Repair all damaged areas.

3.5 PLACING CONCRETE

- A. Addition of water to the concrete during transport or at the site is strictly prohibited. Slump may be adjusted at the site by the addition of high or mid-range water reducer.
- B. Convey concrete by methods and equipment capable of supplying concrete from mixer to place of final deposit without segregation and such that detectable setting of concrete does not occur before adjacent concrete is placed.
- C. Use pumping equipment with sufficient design and pumping capacity to ensure a practically continuous flow of concrete at the point of discharge without segregation.
 - 1. Do not add water or alter the mix design in any way to facilitate pumping.
 - 2. Pumping concrete through aluminum pipe is prohibited.
- D. Concrete may be placed in walls by "free fall" providing a tremie is used to control concrete to fall without hitting the formwork, reinforcing, or any embedded items.
- E. Do not bear concrete conveying equipment on fresh concrete or reinforcement.
- F. After concrete placing has started, provide continuous operation until placement of the section is complete. Do not place a greater section at one time than can be properly finished.
- G. Deposit concrete as nearly as practicable to its final position to avoid segregation due to rehandling or flowing.
- H. Place concrete at a rate such that the concrete is at all times plastic and flows readily between reinforcement and into corners of forms without segregation.
- I. Place concrete in all slabs, mats, and footings for the full depth of the member at one time in such a way as to prevent a horizontal cold joint from occurring.
- J. All concrete shall be discharged into the structure within 90 minutes after batching.
- K. Do not place concrete that has partially hardened, been retempered or contaminated by foreign materials.

3.6 CONSOLIDATION

- A. Thoroughly consolidate concrete with high frequency vibrators, working the concrete thoroughly around reinforcement and embedded items and into corners of forms.
- B. Use a sufficient number of vibrators, of appropriate size and type, to provide complete vibration throughout the concrete at the same rate it is placed.

1. Provide at least one spare vibrator at the site for use in case of breakdown.
- C. Provide properly spaced vibration of duration sufficient to produce complete consolidation, but not long enough to cause segregation. Continue vibration until mortar just begins to puddle at the surface. Remove any excess free water that collects on the surface.
- D. Do not use vibrators to transport concrete within forms.
- E. Supplement internal vibration with manual consolidation methods and external form vibration as required to produce concrete free of voids, honeycomb and rough surfaces.
 1. Vibrate forms in such a way as to avoid form displacement.
- F. For slabs to receive Polished Concrete Finishing, do not consolidate concrete with the use of vibration or tamping. See Section 033543 – Polished Concrete Finishing.

3.7 FINISHING SLABS

A. Tolerances:

1. Finish level slabs to conform to the following minimum F-numbers.

- a. For each slab on grade pour (not polished):

SOFF (specified overall flatness) = 25

MLFF (minimum local flatness) = 17

SOFL (specified overall levelness) = 20

MLFL (minimum local levelness) = 15

- b. For each slab on grade pour (polished concrete):

SOFF (specified overall flatness) = 45

MLFF (minimum local flatness) = 30

SOFL (specified overall levelness) = 25

MLFL (minimum local levelness) = 17

2. Compliance tests shall comply with Field Quality Assurance article.
3. Remedial work in areas of non-compliance may be required at the Owner's request. This work shall be accomplished by grinding and/or using a self-leveling underlayment concrete or by using a self-leveling, polymer modified industrial topping per PART 2 - PRODUCTS - RELATED MATERIALS article.

B. Screeding:

1. Immediately after placing, strike off excess concrete with a straightedge to bring the top surface to proper grade, aligning it to the contours of screeds.
2. Screed off edge forms, intermediate screed strips or pipe set accurately and firmly to the required elevations and contours for the finished surface.
3. Move straightedge across the concrete surface with a sawing motion, advancing forward a short distance with each movement. There should be a surplus of concrete against the front face of the straightedge to fill in low areas as the straightedge passes over the surface.
4. Complete screeding before any excess moisture or bleeding water is present on the surface.

C. Bull Floating or Leveling:

1. Immediately after screeding, bull float the concrete surface, eliminating high and low spots, smoothing the surface and embedding the coarse aggregate.
2. Avoid overworking the concrete. Do not close up or seal the surface of the concrete.
3. Complete bull floating before any excess moisture or bleeding water is present on the surface.

D. Floating:

1. Begin floating operations when bleeding water has disappeared or been removed from the surface and when the surface has stiffened sufficiently to support the operation.
 - a. Do not use dry cement and sand to take up bleeding water.
2. Hand or power float the concrete surface, removing slight imperfections and producing a relatively even and true surface with a uniform, sandy texture prepared for final finishing.
3. Avoid overworking the concrete. Do not close up or seal the surface of the concrete.
4. Surfaces to received Polished Concrete Finishing shall be hand floated only – no power. Apply float finish.

E. Final Finishing:

1. Hard Trowel Finish: All slabs unless otherwise specified.
 - a. Immediately after floating, use power trowel for first trowelling to produce a smooth surface relatively free of defects.
 - b. For first trowelling, use hand trowelling in areas inaccessible to power trowelling.

- c. Use hand trowel and heavy pressure for final trowelling after concrete has become hard enough to produce a ringing sound as the trowel is moved over the surface. Produce a smooth, hard, dense surface, uniform in texture and appearance and free of defects.
2. Broom Finish: Slip-resistant surfaces.
 - a. Immediately after floating, draw a broom across the concrete surface transversely to the main direction of traffic, producing a coarse, scored, slip-resistant texture.

3.8 FORM REMOVAL

- A. Remove formwork in an approved manner under competent supervision to avoid damage to the concrete. Use sufficient care to prevent spalling.
- B. The Contractor shall bear full responsibility for form removal. Concrete damaged by too early removal of supports shall be repaired to the satisfaction of the Architect/Engineer, or replaced.
- C. Do not remove shores and other supports until concrete has attained sufficient strength to support, without objectionable deflections, its own weight plus all anticipated construction loads.
- D. Do not remove formwork for vertical elements (foundation walls and piers) until the day after casting of the concrete. Do not damage concrete surface during form removal.

3.9 FORM MAINTENANCE

- A. Clean and recondition formwork before each use. Repair damage to formwork during placing, removal, or storage. Do not use formwork with repairs or patches which would result in adverse effects to the concrete finish.
- B. Store formwork and form materials in a manner to prevent damage or distortion.

3.10 FINISHING FORMED SURFACES

- A. Rough Form Finish: All formed concrete surfaces not exposed to public view.
 1. After being cleaned and thoroughly dampened, fill tie holes solid with patching mortar matching the color of the surrounding concrete.
 2. Patch defective areas in accordance with REPAIR OF DEFECTIVE SURFACES article below.
 3. Chip or rub off fins and projections as follows:
 - a. Exceeding 1" (Class D per ACI 347) in height unless otherwise noted.

- B. Exposed to Public View Formed Concrete Surface: Architectural Finish (per drawings).
 - 1. Tie holes in a regular pattern that has been approved by the Architect need not be filed.
 - 2. Patch defective areas in accordance with REPAIR OF DEFECTIVE SURFACES article below.
 - 3. Completely remove all fins and projections.
 - 4. Final concrete finish shall be uniform and free from defects. Any areas with defects that cannot be repaired per article 3.11 to the satisfaction of the Architect shall be removed and replaced at no expense to the Owner.

3.11 REPAIR OF DEFECTIVE AREAS

- A. Remove honeycombed and other defective concrete, exposing sound concrete. Cut and chip edges straight and perpendicular to the surface or slightly undercut to a depth of ½". Feathered edges are not permitted.
- B. Dampen areas to be patched and surrounding areas. Patch with patching material according to manufacturer's recommendations. Submit data on patching material to engineer for review prior to starting repair.
- C. After surface water has evaporated from the area to be patched, apply patching material to the surface.
- D. Apply curing to the repaired surface as soon as possible and maintain for a minimum of 3 days.

3.12 CURING

- A. Maintain concrete in a moist condition for at least 5 days at temperatures above 70°F and at least 7 days at temperatures between 40°F and 70°F.
- B. Curing Slabs: Curing compounds, moisture retention covers, or internal curing admixture. (Curing compounds not permitted for polished slabs. Use moisture retention cover.)
 - 1. Apply curing compounds to the concrete surface, immediately after final finishing of the concrete, in accordance with manufacturer's instructions to comply with ASTM C309.
 - a. If it is determined that the curing compound is not compatible with the floor finish after the curing compound has been applied, then the curing compound must be removed by mechanical abrasion.
 - 2. Place moisture retention covers on the concrete surface immediately after final finishing of the concrete. Lap edges 6 inches and seal, creating a moisture barrier that must remain intact for the duration of the curing period.

3. Provide internal curing admixture.

C. Curing Formed Surfaces:

1. Formed surfaces may be cured by leaving forms in place. During hot, dry weather, keep forms moist by sprinkling.
2. When forms are removed before the end of the curing period, apply curing compound to walls and piers.

3.13 POLISHED CONCRETE FINISHING

- A. Where called for on drawings, concrete slabs shall be ground and polished as specified in Section 033543.

3.14 JOINTS

A. Construction Joints:

1. Locate construction joints so as not to impair the strength of the structure.
2. With the exception of slabs on grade, continue reinforcement across construction joints.
3. Thoroughly clean the concrete surface at construction joints and remove laitance before placing adjoining concrete.
4. In slabs on grade with control joints, locate construction joints at control joint locations.

B. Slab on Grade Control Joints:

1. Sawcut Control Joints:

- a. Conventional: Sawcut joints as soon as the blade does not dislodge aggregate and when the edges of the cut do not ravel. For slabs to remain exposed, use a blade that has a triangular arbor configuration to reduce edge releveling or dislodging aggregates. Complete saw-cutting before shrinkage stresses become sufficient to produce cracking. Sawcut joints in straight lines to avoid unsightly joints.
- b. SOFF-CUT System: Saw cut control joints with SOFF-CUT System Model G-2000 or GS-1000, 1/8" wide x 1 3/16" deep joints, within (2) hours after final finish at joint location. Do not disturb final slab finish. Saw cuts shall be made with SOFF-CUT saw as manufactured by SOFF-CUT International, Corona, Calif. Equipment shall be used in accordance with manufacturer's instructions. SOFF-CUT System shall not be used for slabs greater than 6" thick.

2. Hand-Tooled Control Joints: Tool joints with hand groovers in straight lines to avoid unsightly joints.

3.15 HOT WEATHER CONCRETING

- A. Follow the provisions of this Article and ACI 305.1 when the rate of evaporation of surface moisture from the concrete exceeds 0.18 lb/sq ft/hr (Figure 2.1.5, ACI 305.1).
- B. Control concrete setting time with the use of water-reducing & retarding admixtures as required to facilitate placing and finishing operations.
- C. Before placing concrete, spray the subgrade, forms and reinforcement with water to keep them cool and to prevent absorption of water from the concrete.
- D. Transport, place and finish concrete as quickly as practicable. Plan concrete delivery, placing techniques and consolidation methods to avoid cold joints.
- E. Maximum temperature of concrete during placing: 90°F.
 - 1. Exception: At slabs to be polished, max. temperature of concrete during placing: 85°F.
- F. Apply evaporation retardant to the surface of the fresh concrete after screeding and as needed during finishing.
- G. Take additional precautions as necessary to prevent plastic shrinkage cracking.
- H. Start curing the concrete immediately after finishing operations have been completed.

3.16 COLD WEATHER CONCRETING

- A. Follow the provisions of this Article and ACI 306.1 when the average daily temperature (average of the highest and lowest temperature during the period from midnight to midnight) is less than 40°F.
- B. Control concrete setting time with the use of accelerating admixtures and water-reducing accelerating admixtures as required to facilitate placing and finishing operations.
 - 1. Do not use calcium chloride as an accelerating admixture. Only the specified accelerators shall be used.
- C. Temperature of concrete during placing: 55°F to 75°F.
- D. Maintain the temperature at the concrete surface between 55°F and 75°F until the concrete reaches 70 percent of its specified compressive strength by providing heated enclosures and insulated blankets.
 - 1. Construct weathertight enclosures, allowing the heated air to circulate around the outer edges of the concrete.

2. Provide a sufficient number of heaters to assure an even temperature within the enclosure.
 - a. Use indirect-fired heaters vented to the exterior where heat is supplied to the top of fresh concrete to prevent dusting due to carbonation.
 3. Add moisture to the heated air as required to maintain a minimum relative humidity of 40 percent within the enclosure. Do not allow any concrete surface to become dry during the protection period.
 4. Maintain enclosures for 24 hours after heating has been discontinued to allow the concrete to cool gradually.
 5. Lap insulating materials and cover the edges and corners of the concrete to provide complete and adequate protection.
 6. Wrap piers and walls with insulated blankets.
 7. Monitor the temperature of the concrete surface regularly with suitable thermometers throughout the protection period.
- E. Provide insulation or temporary backfill to protect all earth supported concrete from damage due to frost heaving.

3.17 PROTECTION

- A. Protect finished concrete surfaces from damage by construction equipment, materials or methods and by rain or running water.
- B. Do not load any concrete member in such a way as to overstress the concrete.
- C. Protect concrete surfaces to receive Polished Concrete Finishing with floor slab protective covering.

3.18 FIELD QUALITY CONTROL

- A. Testing and Inspection Agency: Contractor shall engage an independent testing and inspection agency to conduct testing and write reports as outlined in this Article under provisions of Division 1.
- B. Reinforcement inspection:
 1. Contractor shall notify the Architect/Engineer and the Testing and Inspection Agency, if applicable, when reinforcement for a pour is nearing completion so that reinforcing steel in place may be reviewed.
 - a. For all slabs and mats; the installation of all reinforcement shall be completed by noon of the day prior to casting the concrete.
 - b. Allow sufficient time for setters to make adjustments or corrections so that reinforcing steel correct in size, shape and position will be in place when concreting is started.

2. The Testing and Inspection Agency shall inspect all in-place reinforcing steel for compliance with the contract documents and approved shop drawings. This inspection shall include, but not necessarily be limited to: bar size, concrete cover, lap lengths mechanical butt splices, and bar supports. Daily inspection reports shall address all areas which have been inspected, and any deficiencies.

C. Strength Tests:

1. During the progress of the work, take samples of concrete for strength tests in accordance with ASTM C172.
2. Make and cure a minimum of 4 cylinders in accordance with ASTM C31 for each of the following:
 - a. Each 100 cubic yards of concrete.
 - b. Each 5000 square feet of surface area for slabs and walls.
 - c. Each class of concrete placed in a day's work.
3. Cylinders may be either 6 x 12 inches or 4 x 8 inches.
4. Test each group of 4 cylinders in accordance with ASTM C39 as follows:
 - a. Two field cured cylinders to be tested at 7 days or just before anticipated time of form removal.
 - b. Two laboratory cured cylinders to be tested at 28 days.
5. A strength test is the average of the strengths of two cylinders made from the same sample of concrete and tested at 28 days.
6. The strength level of an individual class of concrete will be considered satisfactory if each strength test equals or exceeds the specified compressive strength.
7. If the strength level of an individual class of concrete is found to be unsatisfactory, conduct core testing in accordance with ASTM C42, impactometer testing or load testing on the area of concrete in question as required by the Architect/Engineer. If such additional testing does not produce acceptable results, corrective measures will be required to ensure structural adequacy.
 - a. Make appropriate adjustments to the concrete mix designs as required.

D. Slump Tests:

1. Make one slump test in accordance with ASTM C143 with each group of 4 cylinders.
2. When concrete is pumped, make the slump test at the point of placement.
3. Keep a slump cone available at the site for additional testing as required.

- E. Air Content Tests: Make one air content test in accordance with ASTM C173 or ASTM C231 with each group of 4 cylinders for air-entrained concrete mixes at point of discharge.
- F. Rejection of Concrete:
1. Any concrete that does not meet the specified requirements for air-entrainment, concrete temperature, or slump shall not be placed until corrective measures have been taken, and the concrete has been re-tested to indicate compliance.
 2. The Owner or Owner's Construction Representative shall authorize one party to be responsible for rejection of concrete.
- G. Field Quality Control Test Reports:
1. Include the following information in test reports:
 - a. Project identification and portion of structure represented.
 - b. Concrete mix class and specified compressive strength requirements.
 - c. Weather conditions and air temperature.
 - d. Concrete temperature, slump and air content test results.
 - e. Dates of placing and testing.
 - f. Method of curing (field or laboratory).
 - g. Strength test results.
 - h. Technician's name, certification number with expiration date.
- H. Compliance tests for F-numbers shall be performed for all level slabs.
1. Slab measurements and computation of F-numbers shall conform to ASTM E1155.
 2. The maximum area to be considered for minimum local FF and FL numbers shall be 400 square feet.
 3. Compliance tests shall be performed using the Dipstick Floor Profiler or the Face Floor Profileograph.
 4. Compliance tests shall be performed by the Owner's Testing and Inspection Agency.
 5. Compliance tests shall be completed within 72 hours after the final finishing is complete and prior to the removal of any forms and shoring.
 6. If cold weather protection prevents testing, then compliance tests shall be performed immediately after the removal of the protection and prior to the removal of any forms and shoring.
 7. Submit slab finish compliance test reports within one week of testing.

- END -

CLEAR CREEK WELCOME CENTER
DAPW PROJECT NO: 84003001-22-058-C1
FRP NO. 21071.00

CAST-IN-PLACE CONCRETE

SECTION 033000

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SECTION 118129 - FACILITY FALL PROTECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Fall arrest safety anchors.
- B. Related Requirements:
 - 1. Section 051200 "Structural Steel" for steel supporting roof anchors.
 - 2. Section 053100 "Steel Decking" for steel roof deck.
 - 3. Division 07 roofing Section(s) for roof penetration flashing.

1.03 COORDINATION AND MEETINGS

- A. Coordinate installation of anchorages for maintenance equipment. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

1.04 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, rated capacities, operating characteristics, furnished specialties, accessories, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Submit shop drawings showing complete layout and configuration of roof anchor locations and all other components and accessories.
 - 2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Delegated-Design Submittal: For facility fall protection systems permanently attached to the building.

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and professional engineer.

- B. Product Test Reports: Based on evaluation of tests performed by manufacturer and supervised and verified by a qualified independent professional engineer.
- C. Proof of specified liability insurance.

1.06 CLOSEOUT SUBMITTALS

- A. Field Quality Control Reports.
- B. Maintenance Data: For maintenance equipment to include in maintenance manuals.
 - 1. Safety Inspection Log Book with "Initial inspection – Certificate for Use" and "Inspection Sign-off" completed.
 - 2. Two Laminated copies of roof plan, at a convenient scale, showing location of roof anchors to be posted by Owner near exits to roof.

1.07 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: An experienced firm specializing in the design, fabrication and installation of permanent building maintenance equipment with a record of successful in-service installations of equipment similar in design and extent to that proposed for this project.
 - 1. Minimum five years' experience in the design, fabrication and installation of similar maintenance equipment.
- B. Installer Qualifications: Manufacturer of units.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of facility fall protection similar to those indicated for this Project in material, design, and extent.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM E 329 to conduct the testing indicated.
- E. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
- F. Design Standards: Comply with the following:
 - 1. AISC publication S342 with Supplement No. 1 "Load and Resistance Factor Design Specification for Structural Steel Buildings."

1.08 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS AND SYSTEM DESCRIPTIONS

- A. Delegated Design: Engage a qualified professional engineer to design facility fall protection systems permanently attached to the building.
- B. Structural Performance: Provide safety anchorage capable of withstanding design loads within limits and under conditions indicated.
- C. Design system fall arrest safety anchors and equipment supports to AISC S342L (including supplement No.1) and ANSI/IWCA I-14.1, and as follows:
 - 1. Comply with OSHA 1910, Subpart F, Appendix C.
- D. Fall Arrest Safety Anchors:
 - 1. Fall arresting force safety factor of 2 to 1 without permanent deformation: 1800 lbs minimum.
 - 2. Fall arrest force against fracture or detachment: 5,000 lbs minimum.

2.02 MANUFACTURERS

- A. Subject to compliance with requirements, provide the Basis-of-Design products indicated, or approved comparable products.
- B. Other manufactured products meeting this specification may be substituted if approved prior to bidding. Companies, such as miscellaneous metal fabricators, who are not normally engaged in design and manufacture of building maintenance equipment are not acceptable.
- C. Manufacturers:
 - 1. Pro-Bel (Basis-of-Design); (800) 461-0575; <http://www.pro-bel.ca>.
 - 2. FixFast USA Inc.; Contact: Wyatt Lynes, 317-517-8977 cell, 317-769-7710 office.
 - 3. Summit Anchor Company, Inc.; (800) 372-1098; <http://www.summitanchor.com>.
 - 4. Tractel Group; (800) 675-6727 <http://www.tractel.com>.
 - 5. Diversified Fall Protection; 350 Green Oaks Pkwy, P.O. Box 1504, Holly Springs, NC 27540; 866-387-9965; www.fallprotect.com.

2.03 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- C. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
- D. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- E. Steel Tubing: ASTM A 500, cold-formed steel tubing.

- F. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
- G. Mild Steel: Type 300W, hot-dipped galvanized to ASTM A123/A or proprietary polyurethane/polyurea coating system, with yield strength as follows:
 - 1. Hollow steel section piers: 50 ksi.
 - 2. Securement bolts: 44 ksi.
 - 3. Base plates and other sections: 44 ksi.

2.04 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123/A 123M for iron and steel.
 - 2. ASTM A 153/A 153M for iron and steel hardware.

2.05 MISCELLANEOUS MATERIALS

- A. Flashing for Roof Mounted Supports and Anchors: Complying with requirements specified in Division 07 roofing and in accordance with roofing manufacturer's details and instructions.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas, dimensions, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of maintenance equipment.
- B. Verify that structural frame and substrates to which safety anchors are to be attached have adequate bearing surface as indicated on shop drawings and as necessary to ensure 100 percent weld area.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Commencement of Work constitutes Contractor's acceptance of substrates and conditions.

3.02 INSTALLATION

- A. Install building maintenance equipment systems according to approved shop drawings, specifications, manufacturer's instructions and under supervision of professional engineer registered in state in which project is located.

- B. Provide all items to be installed. Provide handling, installation instructions, anchorage information, roughing-in dimensions, templates and service requirements for completion of work of this Section. Assist or supervise, or both, setting of anchorage devices when handled by others. Provide advice and assistance with respect to construction of other work related to products specified in this section.
- C. Install all work true, level, tightly fitted, and flush to adjacent surfaces where required for installation.
- D. Provide anchorage and mounting devices required for installation of each product.
- E. Deform threads of all exposed studs behind nuts after nuts have been tightened.
- F. Where contact is made between dissimilar materials, protect components with bituminous paint or other materials, to prevent corrosion.

3.03 FIELD QUALITY CONTROL

- A. Conduct full live load and operational tests using load cell test apparatus in accordance with manufacturer's recommendations, after completion of the installation, under maximum design live loading conditions over a selected range of the building surfaces, in accord with applicable standards.
- B. At a time mutually agreeable to all parties, allow one (1) full day to conduct operational demonstrations for the Owner and/or the Owner's representative, after completion of the operational tests.
- C. Repair or replace any components and correct all deficiencies observed as a result of these tests and demonstrations, and retest to assure compliance with the Contract Documents.

END OF SECTION 118129