

SECTION 03 30 00.01 - CONCRETE FORM WORK

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

- 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 SECTION INCLUDES

- A. Provide formwork for cast-in-place concrete work not specified in other Divisions.
  - 1. Work includes design and engineering of formwork.
  - 2. Do not use earth cuts as forms for vertical surfaces, except as specifically reviewed by Engineer.
  - 3. Earth forms may be used for footings if banks are stable.

1.3 RELATED SECTIONS

- A. Section 32 13 13: Concrete Paving.
- B. Section 03 30 00: Cast-in-Place Concrete.

1.4 REFERENCE STANDARDS

- A. ACI American Concrete Institute:
  - 1. 318 Building Code Requirements for Reinforced Concrete.
  - 2. 347 Recommended Practice for Concrete Formwork.
- B. ASTM American Society for Testing and Materials:
  - 1. ASTM Standard Specifications and Test Methods referenced in Part 2 - Products and Part 3 - Execution.

1.5 SUBMITTALS

- A. Product Data: Submit data for formwork materials and accessories, as requested by Engineer.

## 1.6 REGULATORY REQUIREMENTS

- A. Comply with the applicable provisions of codes, standards and specifications referenced in this section.

## PART 2 – PRODUCTS

### 2.1 FORM MATERIALS

- A. Forms for Exposed Concrete: Except where special formwork is required to produce surface characteristics indicated or specified, construct with plywood, metal, metal framed plywood or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Provide material with sufficient thickness to withstand pressure of newly-placed concrete without bow or deflection.
  - 1. Plywood: Comply with U.S. Product Standard PS-1 "B-B (Concrete Form) Plywood", Class I and II, Exterior Grade, not less than 5/8 inch thick, mill-oiled and edge-sealed, with each piece bearing legible trademark of an approved inspection agency.
- B. Forms for Unexposed Concrete: Plywood, lumber, metal or other acceptable material. Where lumber used, it shall be nominal 1 inch x 6 inches or 1 inch x 8 inches, dressed on 2 edges and one side for tight fit.

### 2.2 FORMWORK ACCESSORIES

- A. Form Release Agents: Use commercial formulation compounds that cannot bond with, stain nor adversely affect concrete surfaces, and cannot impair subsequent treatments of concrete surfaces.
  - 1. Reference Product:
    - a. "Formshield" by W.R. Grace Co.
    - b. Substitution: Make substitution under provisions of appropriate Division 01 Section.
- B. Form Ties: Snap-off metal, adjustable-length, cone type, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal.
  - 1. Provide ties with 1-1/2 inches breakback dimension, with a maximum hole size of 7/8 inch diameter in concrete surface.
- C. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required; of strength and character to maintain formwork in place while placing concrete.

## PART 3 – EXECUTION

### 3.1 DESIGN AND ERECTION

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads until such loads can be supported by concrete structure. Construct formwork so concrete members are of correct size, shape, alignment, elevation and position as shown, and within tolerances permitted by ACI 301.
- B. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent materials. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.
- C. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work.
- D. Use selected materials to obtain required finishes. Solidly butt and back-up joints to prevent leakage of cement paste.
- E. Chamfer exposed corners and edges when both surfaces are exposed in the finished work, using wood, metal, PVC or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

### 3.2 OPENINGS, INSERTS, AND EMBEDDED WORK

- A. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection, and for placement of concrete. Securely brace temporary openings and set tight to forms to prevent loss of concrete mortar. Locate temporary openings at inconspicuous locations.
- B. Provide openings in formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such items. Accurately place and securely support items built into forms.
- C. Set and build in to formwork anchorage devices, reglets, and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete.

### 3.3 JOINTS

- A. Locate and install as indicated; if not indicated, locate so as not to impair strength and appearance of the structure, and as reviewed by Engineer.
  - 1. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints.

### 3.4 PREPARATION OF FORM SURFACES

- A. Clean re-used forms of concrete matrix residue; repair and patch as required to return forms to acceptable surface condition.
- B. **Cleaning and Tightening:** Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt and other debris just before concrete is placed. Retighten forms and bracing after concrete placement if required to eliminate mortar leaks and to maintain proper alignment.
- C. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms, unless formwork and construction are within heated enclosure; use compressed air to remove foreign matter.
- D. Coat contact surfaces of forms with form release agent before reinforcement is placed. Apply in accordance with manufacturer's directions.
  - 1. Do not allow excess form release agent to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete shall be placed.
  - 2. Coat steel forms with a non-staining, rust-preventive form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

### 3.5 FORM REMOVAL

- A. Remove formwork only after both the following minimum concrete ages and percentages of design strength have been reached, and as further specified below:

ELEMENT	AGE	STRENGTH
Vertical Surfaces	6 days	60 percent
Footings	2 days	35 percent
Other work	When concrete is self-supporting.	

- B. **Time Reduction:** When high early strength concrete is used, specified time periods may be reduced when a written review has been sent to the Engineer.
- C. **Vertical Surfaces:** Formwork not supporting weight of concrete may be removed in specified time only if cumulative curing time at not less than 50 degrees F is not less than 24 hours; and provided concrete has sufficiently hardened to prevent damaged by form removal operations, and provided curing and protection operations are maintained.

END OF SECTION 03 30 00.01

SECTION 03 30 00.02 – CONCRETE REINFORCEMENT

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 SECTION INCLUDES

- A. Provide reinforcing for cast-in-place concrete work.
- B. Provide inspection and testing related to reinforcing.

1.3 RELATED SECTIONS

- A. Section 32 13 13: Reinforcing for concrete paving and walks.
- B. Section 03 30 00.01: Concrete Formwork.
- C. Section 03 30 00: Cast-in-Place Concrete.

1.4 REFERENCED STANDARDS

- A. ACI American Concrete Institute:
  - 1. 301 - Specifications for Structural Concrete for Buildings.
  - 2. 315 - Manual of Standard Practices for Detailing Reinforced Concrete Structures.
  - 3. 318 - Building Code Requirements for Reinforced Concrete.
- B. CRSI Concrete Reinforcing Steel Institute:
  - 1. Manual of Standard Practice.
- C. ASTM American Society for Testing and Materials:
  - 1. Standard Specifications and Test Methods referenced in PART 2 - PRODUCTS and PART 3 - EXECUTION.

1.5 SUBMITTALS

- A. Product Data: Submit data for reinforcement accessories, as requested by Architect.

- B. Compliance: Submit material certifications, signed by manufacturer and Contractor, that each material item complies with or exceeds specified requirements.
- C. Shop Drawings: Submit shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315. Show bar schedules, stirrup spacing, bending details, and arrangement of reinforcement. Include special reinforcement required at openings through concrete work.
  - 1. Shop drawings shall be sufficiently complete to enable reinforcing to be placed according to, but without reference to, the Construction Drawings, and shall identify and clearly show supports. Include details showing complicated reinforcing arrangements at 1/4 inch to 1'-0" scale or larger.

#### 1.6 QUALITY ASSURANCE

- A. Identification: Each reinforcing bar shall have an embossed identifying symbol indicating that steel is of the grade specified. Steel without such a symbol shall be rejected.
- B. Inspection: Reinforcing shall be inspected and approved by an independent testing and inspection agency before concrete is placed.

#### 1.7 REGULATORY REQUIREMENTS

- A. Comply with the applicable provisions of codes, standards and specifications referenced in this section.

#### 1.8 PRODUCT HANDLING

- A. Ship reinforcing steel to the job site in standard bundles, tagged with embossed zinc shipping and marking tags, prepared in accordance with CRSI "Manual of Standard Practice".
- B. Sort reinforcement upon delivery to the site; store to avoid contact with the ground, and in a location protected from vehicular traffic.
- C. Cover reinforcement remaining in storage on the site for more than one month, to protect it from the weather.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide listed products of one of the manufacturers listed for each product type.

## 2.2 MATERIALS

- A. Reinforcing Bars: ASTM A615, Grade 60, deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A775.
- C. Welded Wire Fabric: ASTM A185, fabricated from ASTM A82, plain cold-drawn steel wire. Sizes as shown, but not lighter than 6 x 6-W1.4 x W1.4. Deliver in flat sheets, not rolls.
- D. Supports for Reinforcement: Provide bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Supports shall be sized and spaced to prevent cover loss during construction. Use wire bar type supports complying with CRSI specifications.
  - 1. For exposed-to-view concrete surfaces, support legs in contact with forms shall be plastic, plastic protected (CRSI, Class 1), or stainless steel protected (CRSI, Class 2).
- E. Tie Wire: Black annealed wire, 16 gage or heavier.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Comply with CRSI "Recommended Practice for Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as specified.
- B. Clean reinforcement before placing, to remove loose rust and mill scale, earth, ice, and other materials which reduce or destroy bond with concrete. Remove and replace reinforcement reduced in section by rust or damage.
- C. Accurately position, support and secure reinforcement against displacement by construction or concrete placement and consolidation operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers; and by wire tying at intersection. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- D. Place reinforcement to provide concrete coverages not less than those specified by ACI, and greater coverages if shown or specified.
- E. Do not bend or straighten reinforcement in a manner injurious to the material. Do not install bars with kinks or bends not shown on Drawings. Heating of reinforcement for bending or straightening is not permitted.
- F. Install reinforcing in the forms before concrete is placed. No reinforcing bars shall be driven or forced into concrete after the concrete has attained its initial set.
- G. Scheduling: Place reinforcement sufficiently in advance of placing concrete to permit inspection, and correction if required. Do not place top layer of deck reinforcing until concealed horizontal conduits and piping are in place.

- H. Use bars of single length, except where the length required is greater than stock length, or where the Architect gives permission for shorter lengths. Lap necessary splices as shown on the Drawings sufficiently to develop the strength of the bars by bond. Lap splices shall be in accordance with ACI 318. No splices shall be made unless shown on the Engineering Drawings and Architect's reviewed shop drawings. Where continuous bars are called for lap splices shall be a minimum of 36 diameters.
- I. Exercise care in placing reinforcing so as not to displace sleeves, boxing, or other embedded items.
- J. Welding shall conform to the AWS "Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction".
- K. Install welded wire fabric in longest lengths practicable. Lap adjoining pieces not less than 6 inches and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.
- L. Avoid cutting or puncturing vapor retarder during reinforcement placement and concreting operations.

### 3.2 INSTALLATION DETAILS

- A. At wall intersections, extend horizontal rods at inner face to the far face of the wall, and bend horizontal rods at the outer face thirty-six (36) bar diameters around the corner unless otherwise shown on the Drawings. Lapping "L" shaped corner bars may be substituted at the other face unless prohibited by notation on the Drawings.
- B. At openings, provide additional reinforcing equal to the interrupted bars, placed equally on each side of the opening.
- C. At footings, provide dowels equal in size, spacing and number to the reinforcing in the columns, pedestals or walls which they support.
- D. Details of reinforcement not specified or shown on the Drawings shall be in accordance with ACI 318 and ACI 315.
- E. Reinforcement used as dowels at doorways shall be pinned into the building foundation to prevent differential settlement and frost heave. The dowel set into the adjacent concrete slab shall be de-bonded to allow for thermal expansion of the slab. One acceptable method of de-bonding is to slip a section of galvanized pipe over the rebar within the concrete slab before pouring same

END OF SECTION 03 30 00.02



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-1 Specification sections, apply to work of this section.

1.2 SUMMARY

- A. Extent of concrete work is shown on drawings.
- B. Concrete paving and walks are specified in Division 2.

1.3 SUBMITTALS

- A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds and others as required by Architect.
- B. Samples: Submit samples of materials as requested by Architect, including names, sources and descriptions.
- C. Laboratory Test Reports: Submit laboratory test reports for concrete materials and mix design test.
- D. Materials Certificates: Provide materials certificates in lieu of materials laboratory test reports when permitted by Architect. Materials certificates shall be signed by manufacturer and Contractor, certifying that each material item complies with, or exceeds, specified requirements. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
- E. Shop Drawings: Reinforcement: Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing diagrams of bent bars, arrangement of concrete reinforcement.

1.4 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of following codes, specifications and standards, except where more stringent requirements are shown or specified:
  - 1. ACI 301 "Specifications for Structural Concrete for Buildings".
  - 2. ACI 318 "Building Code Requirements for Reinforced Concrete".
  - 3. Concrete Reinforcing Steel Institute (CRSI), "Manual of Standard Practice".

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- B. Concrete Testing Service: Engage a testing laboratory acceptable to Architect to perform material evaluation tests and to design concrete mixes.
- C. Materials and installed work may require testing and retesting at anytime during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.
- D. Preinstallation Conference: Conduct conference at a Project site to comply with requirements in Division 01 Section "Project Management and Coordination".
  - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring 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. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete subcontractor.
      - i. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold and hot weather concreting procedures, curing procedures, construction contraction and isolation joints and joint filler strips, semirigid joint fillers, forms and form removal limitations, vapor retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures and concrete protection.

## PART 2 - PRODUCTS

### 2.1 FORM MATERIALS

- A. Forms for Exposed Finish Concrete: Plywood, metal, metal-framed plywood faced, or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings.
- B. Forms for Unexposed Finish Concrete: Plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least 2 edges and one side for tight fit.
- C. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

### 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615, Grade 60, deformed.
- B. Steel Wire: ASTM A 82, plain, cold-drawn steel.
- C. Welded Wire Fabric: ASTM A 185, welded steel wire fabric.
- D. Welded Deformed Steel Wire Fabric: ASTM A 497.
- E. Supports for Reinforcement: Bolsters, chairs, spacers and other devices for spacing, supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI specifications.

### 2.3 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or Type II.
  - 1. Use one brand of cement throughout project, unless otherwise acceptable to Architect.
- B. Normal Weight Aggregates: ASTM C 33, and as herein specified. Provide aggregates from a single source for exposed concrete.
- C. Light Weight Aggregates: ASTM C330 and as herein specified, coarse shale, slate or slag aggregate, free from expanded clay
- D. Water: Drinkable.
- E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Air-Mix"; Euclid Chemical Co.
    - b. "Sika Aer"; Sika Corp.
    - c. "MB-VR or MB-AE"; Master Builders.
    - d. "Darex AEA" or "Daravair"; W.R. Grace.
- F. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.05 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "WRDA" Hycol"; W.R.Grace.
    - b. "Eucon WR-75" or "Eucon WR-89"; Euclid Chemical Co.

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- c. "Pozzolith 322N"; Master Builders.
- G. High-Range Water-Reducing Admixture (Super Plasticizer) ASTM C 494, Type F or Type G and containing not more than 0.05 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Daracem 100" or "WRDA-19"; W.R. Grace.
    - b. "Eucon 37"; Euclid Chemical Co.
    - c. "Rheobuild 1000"; Master Builders.
    - d. "Sika 86"; Sika Corporation.
- H. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.024 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Accelguard 80"; Euclid Chemical Co.
    - b. "Daraset"; W.R. Grace
    - c. "Plastocrete 161FL" or "SikaSet NC"; Sika Corporation
- I. Water-Reducing, Retarding Admixture: ASTM C 494, Type D and containing not more than 0.05 percent chloride ions.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. "Pozzolith Retarder"; Master Builders.
    - b. "Eucon Retarder 75"; Euclid Chemical Co.
    - c. "Daratard 17"; W.R. Grace.
    - d. "Plastocrete 161R"; Sika Corporation.
- J. Prohibited Admixtures: Calcium chloride thiocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

## 2.4 RELATED MATERIALS

- A. Extruded Polystyrene Board Insulation: Rigid closed-cell extruded, expanded polystyrene insulation board with integral high-density skin, complying with ASTM C-578 Type IV: min. 25 psi compressive strength ASTM D 1621: k value of 0.20 ASTM C 518: 0.30% maximum water absorption ASTM C272: 1.1 perm/inch max water vapor transmission: manufacturer's standard length and widths.
  - 1. Manufacturer: Subject to compliance with requirements, provide products of one of the following or an approved equal:

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- a. Dow Chemical Co: Midland MI
  - b. VC Industries/V.5 Gypsum: Chicago, IL.
  - c. GreenGuard XPS: Pactive LLC: Austin, TX
- B. Non-Shrink Grout: CRD-C 621, factory pre-mixed grout.
1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
  2. Products: Subject to compliance with requirements provide one of the following:
  3. Non-metallic
    - a. "Euco-NS"; Euclid Chemical Co.
    - b. "Duragrout"; L&M Construction Chemicals, Inc.
    - c. "Masterflow 713"; Master Builders
    - d. "Five Star Grout"; U.S. Grout Corporation.
- C. Absorptive Cover: Burlap cloth made from jute or kenaf weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- D. Moisture-Retaining Cover: One of the following, complying with ASTM C 171.
1. Waterproof paper.
  2. Polyethylene film.
  3. Polyethylene-coated burlap.
- E. Clear curing and sealing compound (VOC Compliant): The compound shall have 30% solids content minimum, and will not yellow under ultraviolet light after 500 hours of test in accordance with ASTM C-1315 and will have test data from an independent testing laboratory indicating a maximum moisture loss of 0.039 grams per sq. cm. when applied at a rate of 300 sq. ft. per gallon. Sodium silicate compounds are not permitted.
1. Product: "Super Aqua-Cure VOX" by Euclid Chemical Co.
  2. Product: "Dress & Seal WB30" by L&M Construction Chemicals, Inc
  3. Product: "Kure-n-Seal 30 VOC" by Sonneborne
  4. Or approved equal.
- F. Vapor Barrier: Provide vapor barrier which conforms to ASTM E1745, Class A. The membrane shall have a water-vapor transmission rate no greater than 0.01 gr./ft<sup>2</sup>/hr/inch Hg when tested in accordance with ASTM E96. The vapor barrier shall be placed over prepared base material where indicated below slabs on grade. Vapor barrier shall be no less than 15 mil thick. Installation of vapor barrier to comply with ASTM E1643.
1. Product: Stego Wrap (15 mil) Vapor Barrier by Stego Industries LLC
  2. Product: VaporBlock (15 mil) by Raven Industries
  3. Product: Zero Perm by Alumiseal
  4. Product: Premoulded Membrane with PLASMATIC CORE by W.R. Meadows.

2.5 PROPORTIONING AND DESIGN OF MIXES

- A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to Architect for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing.
- B. Submit written reports to Architect and Structural Engineer of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until mixes have been reviewed by Architect.
- C. Design mixes to provide normal weight concrete with the following properties, as indicated on drawings and schedules:
- D. For normal weight aggregate mixes: 3000 psi 28-day compressive strength; W/C ratio, 0.51 maximum, 3500 psi 28-day compressive strength W/C ratio, 0.47 maximum.
- E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results or other circumstances warrant; at no additional cost to Owner and as accepted by Architect. Laboratory test data for revised mix design and strength results must be admitted to and accepted by Architect before using in work.
- F. Admixtures:
  - 1. Use water-reducing admixture or high range water-reducing admixture (super plasticizer) in concrete as required for placement and workability.
  - 2. Use high-range water-reducing admixture in pumped concrete, concrete for industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight and concrete with water/cement ratios below 0.50.
  - 3. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.
  - 4. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having air content within following limits.
    - a. 5% for maximum 2" aggregate
    - b. 6% for maximum 3/4" aggregate
    - c. 7% for maximum 1/2" aggregate
- G. Slump Limits: Proportion and design mixes to result in concrete slump at point of placement as follows:
  - 1. Ramps, slabs and sloping surfaces: Not more than 3".

2. Reinforced foundation systems: Not less than 1" and not more than 3".
3. Concrete containing HRWR admixture (super-plasticizer): Not more than 8" after addition of HRWR to site-verified 2"-3" slump concrete.
4. Other concrete: Not less than 1" nor more than 4"

## 2.6 CONCRETE MIXING

- A. Ready-Mix Concrete: Comply with requirements of ASTM C94, and as herein specified.
- B. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94 may be required.

## PART 3 - EXECUTION

### 3.1 FORMS

- A. Design, erect, support, brace and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete members and structure are of correct size, shape, alignment, elevations and position.
- B. Construct forms to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished structures. Provide for openings, offsets, sinkages, keywarp, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features, required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide back-up at joints to prevent leakage of cement paste.

### 3.2 PLACING REINFORCEMENT

- A. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports, and as herein specified.
  1. Avoiding cutting or puncturing vapor retarder during reinforcement placement and concreting operations.
- B. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.
- C. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers, as required.
- 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 wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

- E. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

### 3.3 JOINTS

- A. Construction Joints: Locate and install construction joints as indicated or, if not indicated, locate at a maximum spacing of 90 feet, so as not to impair strength and appearance of the structure, as acceptable to Architect.
- B. Control Joints: Locate and install control joints as indicated or at a maximum spacing of 30 feet. Locate at a spacing which does not impair appearance of the structure as acceptable to Architect. Use "SOFFCUT" saw to cut joints in slab. Joint to be cut the same day as the pour.
- C. Joint filler and sealant materials are specified in Division-7 sections of these specifications.

### 3.4 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions and directions provided by suppliers of items to be attached thereto.
- B. Edge Forms and Screed Strips for Slabs: Set edge forms, or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

### 3.5 CONCRETE PLACEMENT

- A. Preplacement inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used.
  - 1. Apply temporary protective covering to lower 2' of finished walls adjacent to poured floor slabs and similar conditions, and guard against spattering during placement.
- B. General: Comply with ACI 304R "Guide for Measuring, Mixing, Transporting and Placing Concrete", and as herein specified.



- C. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.
- D. **Placing Concrete Slabs:** Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
- E. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
- F. Bring slab surfaces to correct level with straightedge and strikeoff. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
- G. Maintain reinforcing in proper position during concrete placement operations.
- H. **Cold Weather Placing:** Protect concrete work from physical damage or reduced strength which would be caused by frost, freezing actions or low temperatures, in compliance with ACI 306R.
- I. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- J. **Hot Weather Placing:** When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305R.

### 3.6 MONOLITHIC SLAB FINISHES

- A. **Float Finish:** Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo, and as otherwise indicated.
- B. After screeding, consolidating and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to tolerances of Ff18 - F115. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.

- C. Trowel Finish: Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile, paint, or other thin film finish coating system.
- D. After floating, begin first trowel finish operation using a power driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff20 - Ff17. Grind smooth surface defects which would telegraph through supplied floor covering system.
- E. Non-Slip Broom Finish: Apply non-slip broom finish to exterior concrete platforms, steps and ramps and elsewhere as indicated.

### 3.7 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 7 days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.
- D. Curing Methods: Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing and by combinations thereof, as herein specified.
- E. Provide moisture curing by following methods.
  - 1. Keep concrete surface continuously wet by covering with water.
  - 2. Continuous water-fog spray.
  - 3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
- F. Provide moisture-cover curing as follows:
  - 1. Cover concrete surfaces with moisture-retaining cover for curing concrete, place in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

- G. Do not use membrane curing 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, glue-down carpet), painting and other coatings and finish materials, unless otherwise acceptable to Architect.
- H. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.
- I. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture retaining cover, unless otherwise directed.

### 3.8 MISCELLANEOUS CONCRETE ITEMS

- A. Equipment Bases and Foundations: Provide machine and equipment bases and foundations, as shown on drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of manufacturer furnishing machines and equipment.
- B. Grout base plates and foundations as indicated, using specified non-shrink grout. Use non-metallic grout for exposed conditions, unless otherwise indicated.

### 3.9 CONCRETE SURFACE REPAIRS

- A. Repair of Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface plane to tolerances specified for each surface and finish. Correct low and high areas as herein specified. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness using a template having required slope.
- B. Repair finished unformed surfaces that contain defects which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01" wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets and other objectionable conditions.
- C. Correct high areas in unformed surfaces by grinding, after concrete has cured at least 14 days.
- D. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to Architect.
- E. Underlayment Application: Leveling of floors for subsequent finishes may be achieved by use of specified underlayment material.

### 3.10 QUALITY CONTROL TESTING DURING CONSTRUCTION

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- A. The owner will employ a testing laboratory to perform the following tests, inspect formwork and reinforcement placement and to submit test reports.
- B. Sampling and testing for quality control during placement of concrete may include the following, as directed by Architect.
- C. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
  - 1. Slump: ASTM C 143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
  - 2. Air Content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
- D. Compression Test Specimen: ASTM C 31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
- E. Compressive Strength Tests: ASTM C 39; one set for each day's pour exceeding 5 cu. yds. plus additional sets for each 50 cu. yds. over and above the first 25 cu. yds. of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
- F. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
- G. Test results will be reported in writing to Architect, Structural Engineer and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- H. Nondestructive Testing: Impact hammer, sonoscope or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
- I. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests when unacceptable concrete is verified.

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END OF SECTION 033000

SECTION 033543 - POLISHED CONCRETE FINISHING

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 polished concrete finishing
  - 1. Concrete for polished concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, initial finishing, and curing is specified in Section 033000 "Cast-in-Place Concrete."
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for concrete not designated as polished concrete.

1.3 DEFINITIONS

- A. Design Reference Sample: Sample designated by Architect in the Contract Documents that reflects acceptable surface quality and appearance of polished concrete.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Polishing Schedule: Submit plan showing polished concrete surfaces and schedule of polishing operations for each area of polished concrete before start of polishing operations. Include locations of all joints, including construction joints.
- C. Samples for Initial Selection: For each type of product requiring color selection.
- D. Samples for Verification: For each type of exposed color.

## 1.5 QUALITY ASSURANCE

- A. Field Sample Panels: After approval of verification sample and before casting concrete, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of panels, approximately 12 by 12 inches minimum, to demonstrate the expected range of finish, color, and appearance variations.
1. Locate panels as indicated or, if not indicated, as directed by Architect.
  2. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
  3. Demolish and remove field sample panels when directed.

## 1.6 FIELD CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Water Repellant Sealer: Thin coat, liquid applied, hydrophobic, impregnating water-repellent clear sealer consisting of a silane/siloxane designed for use on concrete or masonry substrates with 0.5% maximum water absorption with 48 hrs exposure as tested in accordance with ASTM C642.
- B. Manufacturer: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
1. KreteTek Industries Inc. – Ghostshield Siloxa-Tek 8510 (Basis of Design)
  2. Or approved Equal.

## PART 3 - EXECUTION

### 3.1 GENERAL WORKMANSHIP FOR WATER-REPELLENT SEALER

- A. Comply with all recommendations of the manufacturer of the water-repellent sealer for surface preparation and installation of the sealer.
- B. Perform a test application on each type of surface prior to full-scale application to determine suitability and final appearance.
- C. Measure and record site conditions immediately before (as applicable) and periodically during the installation of the water-repellent sealer. Measurements must include air and substrate

temperatures, air and substrate relative humidities, application rate, and record general notes on product uptake and performance.

### 3.2 PREPARATION OF CONCRETE OR MASONRY SURFACES FOR WATER REPELLENT

- A. Check concrete or masonry surfaces to ensure that they are suitable for application of water-repellent sealer. Treat unsuitable surfaces (too smooth, too rough, not dry, or contaminated by dirt, oil or any coating or other impurities) as required to make them suitable for application of sealer.
  - 1. Remove all dirt, dust, or other foreign matter from the surface of the concrete or masonry prior to the application of the water-repellent sealer using methods described in this section and approved by Architect based on surface preparation mockups.
  - 2. After cleaning, if a wet method such as power washing is used, the concrete or masonry surface must be allowed to dry for not less than 24 hrs before the application of the water-repellent sealer. If good weather conditions conducive to drying are not present, a longer drying time should be allowed and the sealer should not be applied until the concrete or masonry is completely dry as described in this section. Use a moisture meter if necessary to monitor drying of the concrete or masonry.
- B. Concrete or masonry substrates must be structurally sound, thoroughly dry, clean, and cured at least twenty-eight days.
- C. If acid or chemical cleaning agent is used to clean the concrete, make sure to neutralize before sealing.

### 3.3 WATER-REPELLENT SEALER APPLICATION

- A. Apply water-repellent sealer to prepared substrates within three days after completion of the surface preparation.
- B. Stir and mix materials thoroughly to ensure uniformity and in accordance with the manufacturer's recommendations. Do not dilute or thin product.
- C. Apply water-repellent sealer with a roller.
  - 1. Application rate depends on the density of the concrete or masonry and the depth of penetration required. Apply the sealer, liberally to the surface of the concrete or masonry to achieve high penetration depth but no more than what can stay on the surface without run off.
  - 2. For typical first coat applications, apply one coat of sealer at a rate of approximately 300 sq ft per gallon; application rate specific to the project determined by the mockup.
  - 3. Apply a second coat wet-on-wet, or immediately after the first coat. Take care to avoid the product running or dripping off the substrate. Broom out puddles until they soak in. Do not over apply.



- D. It may take up to 2 or more hours for the sealer to completely penetrate if the substrate is of high density. The treated surface may remain dark for up to twenty-four hours before it returns to normal appearance.
- E. Do NOT apply the sealer to concrete or masonry surfaces:
  - 1. That are damp or have damp repairs. If rain suddenly begins during installation, immediately stop application of sealer and cover the newly impregnated areas.
  - 2. If the conditions (e.g.; weather or surface conditions) do not meet the requirements of Para. 1.06 above or are not expected to meet the requirements for any time within a 24 hr period after installation.
- F. Do not disturb sealed surfaces for a minimum of 6 hrs after the application of the product. Early water repellence will be developed after 24 hrs; however, full curing of the sealer may take up to seven days or longer. Do not install concrete or masonry repairs for a minimum of 72 hrs after application of the sealer.

END OF SECTION 033543

## SECTION 035416 - HYDRAULIC CEMENT UNDERLAYMENT

### 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 hydraulic-cement-based, polymer-modified, self-leveling underlayment for application below interior floor coverings.
- B. Related Sections include the following:
  - 1. Division 09 Sections for patching and leveling compounds applied with floor coverings.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: Signed by manufacturers of underlayment and floor-covering systems certifying that products are compatible.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installer who is approved by manufacturer for application of underlayment products required for this Project.
- B. Product Compatibility: Manufacturers of underlayment and floor-covering systems certify in writing that products are compatible.
- C. Fire-Resistance Ratings: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for fire resistance per ASTM E 119 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- D. Sound Transmission Characteristics: Where indicated, provide hydraulic-cement underlayment systems identical to those of assemblies tested for STC and IIC ratings per ASTM E 90 and ASTM E 492 by a qualified testing agency.

- E. Pre-installation Conference: Conduct conference at Project site.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to comply with manufacturer's written instructions to prevent deterioration from moisture or other detrimental effects.

#### 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with manufacturer's written instructions for substrate temperature, ventilation, ambient temperature and humidity, and other conditions affecting underlayment performance.
  - 1. Place hydraulic-cement-based underlayments only when ambient temperature and temperature of substrates are between 50 and 80 deg F.

#### 1.7 COORDINATION

- A. Coordinate application of underlayment with requirements of floor-covering products and adhesives, to ensure compatibility of products.

### PART 2 - PRODUCTS

#### 2.1 HYDRAULIC-CEMENT-BASED UNDERLAYMENTS

- A. Underlayment: Hydraulic-cement-based, polymer-modified, self-leveling product that can be applied in minimum uniform thickness of 1/4 inch and that can be feathered at edges to match adjacent floor elevations.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Ardex; K-15 Self-Leveling Underlayment Concrete (Basis of Design)
    - b. Sakrete; Self Leveling Underlayment
    - c. MAPEI Corporation; PlaniLevel 560
    - d. USG Corporation; Levelrock 4500
  - 2. Cement Binder: ASTM C 150, portland cement, or hydraulic or blended hydraulic cement as defined by ASTM C 219.
  - 3. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C 109/C 109M.
  - 4. Underlayment Additive: Resilient-emulsion product of underlayment manufacturer, formulated for use with underlayment when applied to substrate and conditions indicated.

- B. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch; or coarse sand as recommended by underlayment manufacturer.
  - 1. Provide aggregate when recommended in writing by underlayment manufacturer for underlayment thickness required.
- C. Water: Potable and at a temperature of not more than 70 deg F.
- D. Reinforcement: For underlayment applied to wood substrates, provide galvanized metal lath or other corrosion-resistant reinforcement recommended in writing by underlayment manufacturer.
- E. Primer: Product of underlayment manufacturer recommended in writing for substrate, conditions, and application indicated.
- F. Corrosion-Resistant Coating: Recommended in writing by underlayment manufacturer for metal substrates.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for conditions affecting performance.
  - 1. Proceed with application only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. General: Prepare and clean substrate according to manufacturer's written instructions.
  - 1. Treat nonmoving substrate cracks according to manufacturer's written instructions to prevent cracks from telegraphing (reflecting) through underlayment.
  - 2. Fill substrate voids to prevent underlayment from leaking.
- B. Concrete Substrates: Mechanically remove, according to manufacturer's written instructions, laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants that might impair underlayment bond.
  - 1. Moisture Testing: Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates do not exceed a maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
- C. Adhesion Tests: After substrate preparation, test substrate for adhesion with underlayment according to manufacturer's written instructions.

### 3.3 APPLICATION

- A. General: Mix and apply underlayment components according to manufacturer's written instructions.
  - 1. Close areas to traffic during underlayment application and for time period after application recommended in writing by manufacturer.
  - 2. Coordinate application of components to provide optimum underlayment-to-substrate and intercoat adhesion.
  - 3. At substrate expansion, isolation, and other moving joints, allow joint of same width to continue through underlayment.
- B. Apply primer over prepared substrate at manufacturer's recommended spreading rate.
- C. Apply underlayment to produce uniform, level surface.
  - 1. Apply a final layer without aggregate to product surface.
  - 2. Feather edges to match adjacent floor elevations.
- D. Cure underlayment according to manufacturer's written instructions. Prevent contamination during application and curing processes.
- E. Do not install floor coverings over underlayment until after time period recommended in writing by underlayment manufacturer.
- F. Remove and replace underlayment areas that evidence lack of bond with substrate, including areas that emit a "hollow" sound when tapped.

### 3.4 PROTECTION

- A. Protect underlayment from concentrated and rolling loads for remainder of construction period.

END OF SECTION 035416