

**Construction Specification**

**PART 1 - GENERAL**

**1.01 SCOPE OF WORK**

- A. Include all labor, materials and appliances, and perform all operations in connection with the installation slabs on ground, and all related work incidental to the completion thereof, as shown on the structural drawings and as specified herein. Work includes subgrade preparation, formwork, reinforcing, inserts, sleeves, accessories, miscellaneous embedded items, and cast-in-place concrete.
- B. Related work specified elsewhere includes but may not be limited to:
  - 1. Section 01411 - Testing and Inspection
  - 2. Section 02520 - Portland Cement Concrete Paving (As noted on the Civil Drawings)
  - 3. Section 03150 - Slab on Ground Joint Reinforcing
  - 4. Section 03300 - Cast-In-Place Concrete
  - 5. Section 07901 - Joint Sealers/Fillers

**1.02 RELATED DOCUMENTS**

- A. Unless otherwise shown or specified, the work shall conform to the following standards of the American Association of State Highway and Transportation Officials (AASHTO):
  - 1. AASHTO T318: Standard Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying
- B. Unless otherwise shown or specified, the work shall conform to the following standards and recommendations of the American Concrete Institute (ACI):
  - 1. ACI 117: Standard Tolerances for Concrete Construction and Materials.
  - 2. ACI 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
  - 3. ACI 301: Specifications for Structural Concrete.
  - 4. ACI 306.1: Standard Specification for Cold Weather Concreting.
  - 5. ACI 308.1: Standard Specification for Curing Concrete
  - 6. ACI 318: Building Code Requirements for Structural Concrete.
  - 7. ACI 350: Environmental Engineering Concrete Structures.
  - 8. ACI SP-66: ACI Detailing Manual.
- C. Unless otherwise shown or specified, the work shall conform to the following standards of the American Society for Testing and Materials (ASTM):
  - 1. ASTM A 615: Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 2. ASTM A 706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
  - 3. ASTM C 31: Making and Curing Concrete Test Specimens in the Field.
  - 4. ASTM C 33: Concrete Aggregates.
  - 5. ASTM C 39: Concrete Specimens, Compressive Strength of.
  - 6. ASTM C 94: Ready-Mixed Concrete.
  - 7. ASTM C 136: Sieve Analysis of Fine and Coarse Aggregates.
  - 8. ASTM C 150: Portland Cement.
  - 9. ASTM C 171: Sheet Materials for Curing Concrete.
  - 10. ASTM C 260: Air-Entraining Admixtures for Concrete.
  - 11. ASTM C 494: Chemical Admixtures for Concrete.
  - 12. ASTM C 702: Reducing Field Samples of Aggregate to Testing Size.
  - 13. ASTM C 1315: Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
  - 14. ASTM D 75: Sampling Aggregates.
  - 15. ASTM D 448: Aggregate for Road and Bridge Construction.
  - 16. ASTM D 698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))
  - 17. ASTM D 1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>))
  - 18. ASTM D 1751: Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
  - 19. ASTM D1752: Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
  - 20. ASTM D3575: Standard Test Methods for Flexible Cellular Materials Made From Olefin Polymers
  - 21. ASTM E 1155: Standard Test Method for Determining Floor Flatness and Levelness Using the "F Number" System.
- D. Unless otherwise shown or specified, the work shall conform to the following standards of the Concrete Reinforcing Steel Institute (CRSI):
  - 1. CRSI: Manual of Standard Practice.
  - 2. CRSI: Placing Reinforcing Bars.
- E. Unless otherwise shown or specified, the work shall conform to the following standards of the Federal Specifications (FS):
  - FS TT-S-00230c (2): Sealing Compound; Elastomeric Type, Single Component (for Caulking, Sealing, and Glazing in Buildings and Other Structures).

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- F. Unless otherwise shown or specified, the work shall conform to the following standards of the American Plywood Association (APA): APA: Grading Rules.
- G. Unless otherwise shown or specified, the work shall conform to the following standards of the Portland Cement Association (PCA): Design and Control of Concrete Mixtures.
- H. Unless otherwise shown or specified, the work shall conform to the following standards of the National Concrete Ready-Mix Association: NCRMA Inspection Standards.

**1.03 SUBMITTALS TO ARCHITECT OF RECORD**

- A. Concrete Supplier(s) and Certifications: Name and address of each proposed concrete supplier and their National Concrete Ready-Mix Concrete Association Plant Certification Checklist.
- B. Concrete Mix Design: All mix designs shall be proportioned in accordance with ACI 318  
Include the following for each mix:
  - 1. The Boeringer Ingelheim location.
  - 2. The submittals shall state which areas and items are to be used for each design mix.
  - 3. Separate sieve analyses reports, conducted within 3 months prior to mix design submittal of percentages passing and retained for fine and coarse aggregates, including fineness modulus. Include following sieve sizes: 2 inch, 1-1/2-inch, 1 inch, 3/4-inch, 1/2-inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200. Provide sieve analysis of percentage retained for combined coarse and fine aggregates.
  - 4. Type of fine aggregate, whether natural or manufactured.
  - 5. Ensure the aggregate supplier reports if aggregate is possibly reactive, based on tests or past service.
  - 6. Ensure aggregate supplier reports if aggregate can possibly cause pop-outs, "D" cracking, or other disruptions due to moisture gain, freezing, or other mechanisms, based on tests or past service.
- C. Reinforcing Bar Shop Drawings:
  - 1. Complete information for installing reinforcing, including placement plans, bar bending diagrams, splice lengths and locations, bar spacing, concrete cover, support devices, and accessories.
  - 2. Conform to ACI SP-66, CRSI, and ACI 318.
- D. Product Data: Brand name, chemical composition, installation directions, and certificate of compliance with required standards for the following products 21 days minimum prior to use. The Contractor shall allow two weeks for the review of the submittal.
  - 1. Air-entraining admixture.
  - 2. Low-range water-reducing admixture.
  - 3. Mid-range water-reducing admixture.
  - 4. Retarding admixture.
  - 5. Accelerating admixture.
  - 6. Sheet materials for curing concrete.
  - 7. Liquid membrane curing and sealing compound (limited use).
- E. Joint Types and Locations:
  - 1. Proposed joint types and locations for joints not shown on Drawings.
  - 2. Submit 21 days minimum prior to placing concrete in area concerned.
- F. Hot Weather Concreting Procedures:
  - 1. Submit procedures and changes proposed to facilitate hot weather concreting.
  - 2. Submit 21 days prior to implementation. For developer prepared "pad ready" sites, the submittal shall occur as soon as possible after the Owner has given the Contractor a Notification to Proceed. The Contractor shall allow two weeks for the review of the submittal.

**SUBMITTALS TO OWNER**

- A. Delivery Tickets:
  - 1. Copies of delivery tickets for each load of concrete delivered to site.
  - 2. Indicate on each ticket all information required by ASTM C 94. Including the quantity of water that can be added at the site without exceeding the maximum water-cement ratio specified.
  - 3. Mix identification number on ticket to match number on submitted and approved mix design noted above.
  - 4. Submit copies to the Owner on same day as concrete delivery.
  - 5. Indicate number of drum revolutions from when water is added until concrete is discharged.
- B. Coarse Aggregate Base:
  - 1. Sieve analysis of coarse aggregate base.
  - 2. Submit to the Owner.

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3. Submit 14 days minimum prior to use. For developer prepared "pad ready" sites, the submittal shall occur as soon as possible after the Owner has given the Contractor a Notification to Proceed. The Contractor shall allow two weeks for the review of the submittal.
- C. Fine Aggregate Base:
1. Sieve analysis of fine aggregate base.
  2. Submit to the Owner.
  3. Submit 14 days minimum prior to use. For developer prepared "pad ready" sites, the submittal shall occur as soon as possible after the Owner has given the Contractor a Notification to Proceed. The Contractor shall allow two weeks for the review of the submittal.
- D. Pump Hoses:
1. Method of operating pump hoses so as to prevent displacement of reinforcing steel, dowels, forms, and aggregate base.
  2. Pump hose sizes.
  3. Submit to the Owner.
  4. Submit 14 days minimum prior to first operation. For developer prepared "pad ready" sites, the submittal shall occur as soon as possible after the Owner has given the Contractor a Notification to Proceed. The Contractor shall allow two weeks for the review of the submittal.

**1.04 QUALITY ASSURANCE**

- A. It shall be the responsibility of the Contractor to produce concrete slabs of the strength, durability, workability and specified finish.
- B. Concrete materials and operations shall be tested and inspected as the work progresses. Failure by the inspector to detect any defective work or material shall not in any way prevent later rejection (when such defect is discovered) nor shall it obligate the Owner for final acceptance.
- C. Allowable Tolerances:
1. Formwork: Conform to most stringent requirements of ACI 117 and ACI 301, except as specified herein.
  2. Slab on ground shall conform to ACI 117, unless noted otherwise.
  3. Slab on Ground Base Fine Grade: +0 inch, -3/4 inch, with transition no greater than 3/4 inch vertically to 8 inches horizontally for level slab.
  4. Average slab on ground thickness tolerance: -0 inch
  5. Minimum slab on ground thickness tolerance: -3/4 inch
  6. Ensure at least 85% of the slab on ground area will have a thickness that exceeds the thickness shown on the drawings minus 1/2 inch. Thickness samples are to be randomly located from each slab placement and not exceed 1000 square feet of slab surface area.
  7. Floor Finished Surface Flatness and Levelness:
    - a. All slabs shall conform to the following tolerances as measured in accordance with ASTM E 1155.

| Area     | Overall |       | Local |       |
|----------|---------|-------|-------|-------|
|          | $F_E$   | $F_L$ | $F_E$ | $F_L$ |
| Interior | 50      | 35    | 35    | 24    |

    - i. Bound individual floor sections for testing purposes by the following that provide the smallest sections: construction joints, contraction joints, or column and half-column lines.
    - ii. Additional Requirements:
      - a) Conform to F-numbers specified for floor areas within 2 feet of construction and isolation joints, in lieu of ASTM E 1155 requirements excluding these areas.
      - b) Limit to 1/4-inch maximum elevation change that may occur within 2 feet of vertical elements (such as columns or walls) that pass-through slab surface.
    - b. Remedies for Out-of-Tolerance Work:
      - i. Remove and replace slabs-on-ground measuring below either (or both) of specified minimum local F-numbers, unless approved by Owner. If allowed to stay in place, remedy out-of-tolerance work as required by Owner.
      - ii. If entire project floor, when completed, fails to meet or exceed either (or both) of specified overall F-numbers, then remedy entire floor as required by Owner.
    - c. Elevation Envelope: Provide top of entire slab-on-ground within  $\pm 3/4$  of an inch of finished floor elevation shown on Drawings.
    - d. Cost Responsibility: Costs for corrective work and extra testing required by defective work borne by Contractor.
  8. Anchor Bolt and Other Embedment Placements:
    - a. 1/8-inch center to center of any 2 anchor bolts or other embedment's within group.
    - b. 1/4-inch center to center of adjacent groups.
    - c. 1/4 inch within specified elevation.
  9. Slab on Ground Dowels:
    - a. 0.075 inch maximum in dowel straightness.
    - b. Plus, or minus 1/8 inch in dowel alignment in vertical and horizontal planes.
- D. Workmanship:

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1. If results of strength tests reveal deficiencies in concrete, meet requirements of ACI 318 and ACI 301.

E. Test placements:

1. Unless otherwise allowed, prior to installation of slabs, make a minimum of 1 to 2 test placements as directed by the Owner's Representative. Test placements are to be in an area designated by the Owner's Representative.
2. Test placement shall be a minimum size of 12 ft x 20 ft x 6 in thick, placed on the same substrate indicated for the interior building slab in the construction documents.
3. Test placements will be temporary, unless it meets all of the specified criteria for its location and allowed by the Owner's Representative.
4. Determine if slab concrete mix is adequate to meet specified requirements.

- F. Notification of Owner's inspector for Observation of Installed Formwork and Reinforcement: Notify Owner's inspector 3 working days minimum prior to placing concrete to allow time for observation of installed formwork and reinforcing.

1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged items in manufacturer's container with seals intact.
- B. Mark reinforcing, accessories, and embedded items for proper identification and placement location.
- C. Store materials, except aggregate, off ground and protect from moisture and contamination.
- D. Stockpile aggregate in manner to prevent contamination with other materials or with other sizes of aggregates. Conduct tests for determining conformance to requirements at point of batching. Do not use bottom 6 inches of aggregate piles in contact with ground. Allow sand to drain until it has reached uniform moisture content before it is used.
- E. Store admixtures in manner to prevent contamination. Protect admixtures from extreme temperatures that would adversely affect their characteristics.

1.06 ENVIRONMENTAL CONDITIONS

A. Concreting in Hot, Dry and/or Windy Weather:

1. Employ methods to avoid cracking when the concrete rate of evaporation exceeds 0.2 pounds per square foot per hour or when any combination of concrete materials and weather conditions are favorable for the formation of plastic shrinkage cracks.
2. Maintain an accurate thermometer at the job site to check temperature of concrete
3. Unless otherwise allowed, reject concrete if its temperature before placement is over 90°F.
4. Unless otherwise allowed, during hot weather mixing and delivery (discharge) time to be shorter than specified in ASTM C 94 as follows:
  - a. When air temperature is between 85°F and 90°F, reduce allowable mixing and delivery time from 90 minutes to 75 minutes.
  - b. When air temperature is over 90°F, reduce allowable mixing and delivery time to 60 minutes.
5. Do not place concrete when forms, subgrade, base, or reinforcing bars are more than 120°F or more than 10°F hotter than ambient air temperature.
6. Cool with water or water-soaked burlap as necessary, but allow no standing water on surface on which concrete is placed.

- B. Precipitation Protection: Protect surfaces of exposed concrete from precipitation until adequate strength is gained to prevent damage.

1.07 PROTECTION OF WORK

- A. Wheeled construction equipment is prohibited from any slab on ground until the completion of curing period.
- B. Wheeled construction equipment used on any slab shall have tires that will not leave skid marks.
- C. Wheeled Equipment shall be diapered to prevent oil or other fluid leaks from staining the slab. Additionally, drop cloths shall be placed below any equipment that is parked on the slab on ground.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement:

1. The cement type shall be as indicated on the Structural Drawings.
2. Unless otherwise allowed, use only 1 brand throughout project.

B. Aggregates:

1. ASTM C 33, with following requirements:

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- a. Consider concrete not covered by building materials or soil to be subject to abrasion and in severe weathering region.
  - b. Unless otherwise allowed, allow no coal or lignite in concrete that will not be covered by building materials or soil.
  2. Do not use manufactured sand for slabs unless blended with natural sand or otherwise allowed.
  3. Conform to following, unless otherwise allowed:
    - a. Of total combined coarse and fine aggregates per mix design, do not allow material retained on any 1 sieve to be less than 6% nor more than 24% of total by weight, except:
      - i. Largest coarse aggregate size to be #4 stone, unless otherwise noted. Retain 1% to 8% of total combined aggregates per mix design on largest sieve with retained aggregate.
      - ii. Maintain 6% to 15% of total combined aggregates per mix design retained on each of Nos. 30 and 50 sieves.
      - iii. Maintain 3% to 7% of total combined aggregates per mix design passing the No. 50 sieve.
    - b. Gradation requirement of ASTM C 33 may be waived in order to meet ranges specified.
- C. Water: Potable.
- D. Admixtures:
1. General:
    - a. No admixture to contain more than 0.05% chloride ions. Submit certificate of compliance to this requirement.
  2. Types:
    - a. Air-entraining: ASTM C 260.
    - b. Water-reducing: ASTM C 494, Type A.
    - c. Retarding: ASTM C 494, Type B or D.
    - d. Accelerating: ASTM C 494, Type C or E. Non-chloride.
- E. Fly Ash or Slag: Not permitted, unless Type V cement is unavailable, or is insufficient to mitigate by itself, when it is required to resist severe sulfate exposure or unless it is needed as a means of mitigation against potential aggregate reactivity. See Section 03300 for additional information.
- F. Reinforcing Bars:
1. ASTM A 615, deformed, Grade 60.
  2. ASTM A 706, deformed, Grade 60.
- G. Reinforcing Support Devices:
1. CRSI's "Manual of Standard Practice".
  2. Over fine or coarse aggregate base, use precast concrete chairs (blocks) with properly embedded tie wires or other type of supports acceptable to Owner's Representative to prevent penetration of substrate. Plastic chairs shall not be used.
  3. Do not use wood, brick, and other such devices that can expand due to moisture gain.
  4. Precast concrete chairs (blocks) to have minimum compressive strength of 4000 psi.
- H. Aggregate Base Materials:
1. General
    - a. Aggregate base materials must meet the minimum requirements of the State Department of Transportation.
    - b. Base materials shall have negligible sulfate content with less than 0.1% soluble concentration by weight or less than 150 ppm in water.
  2. Course Aggregate Base
    - a. Unless not available or otherwise recommended by Owner's Geotechnical Engineer, use crusher run road base with rock fines. Otherwise follow Owner's Geotechnical Engineer's recommendations.
  3. Fine Aggregate Base:
    - a. Clean granular fill with less than 3% clay and/or friable particles.
    - b. Provide gradation per ASTM D 448 No. 10 with 6% to 12% passing No. 200 sieve or following table:
- | <u>Std. Sieve Size</u> | <u>% Passing</u> |
|------------------------|------------------|
|                        | 100              |
| No. 4                  | 85-100           |
| No. 8                  | 75-95            |
| No. 16                 | 55-75            |
| No. 50                 | 25-45            |
| No. 100                | 10-30            |
| No. 200                | 6-12             |
- I. Formwork:
1. Plywood for Concrete Surfaces Not to be Exposed After Construction is Complete:
    - a. APA B-B Plyform exterior grade or better, Class I, with straight, sealed edges and 5/8-inch minimum thickness.
    - b. HDO Plyform is acceptable.
  2. Plywood for Concrete Surfaces to be Exposed After Construction is Complete:
    - a. APA HDO Plyform, exterior grade or better, Class I, with straight, sealed edges and 5/8-inch minimum thickness.

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3. Lumber: Dressed, tongue and grooved, free from loose knots.
  4. Metal: Smooth, clean, corrosion-free, without dents or holes, with closely matching edges.
  5. Fiberglass: Smooth, clean, without dents or holes, with closely matching edges.
  6. Partial depth forms made from wood, steel or foam are not permitted.
- J. Form Release Agents:
1. Type acceptable to cement manufacturer, will not cause surface imperfections, non-staining, and compatible with field applied paints, curing compounds, and other coatings.
  2. Use same brand form release agent for all forms.
- K. Form Accessories:
1. Form ties, anchors and hangers of sufficient strength to completely resist displacement of forms due to construction loads and depositing of concrete.
  2. Provide ties and spreader form ties designed so no metal will be within 1 inch of surface when forms are removed.
  3. Where concrete surfaces are exposed to view, use form ties that will leave a depression not more than 1 inch in diameter when removed.
  4. Provide form sealants and gaskets as necessary to provide tight forms.
- L. Evaporation Retardant:
1. Water-based polymer, sprayable.
  2. A minimum of 5 gallons is to be on site at the time of concrete placement.
  3. Acceptable Products and Manufacturers:
    - a. Edoco: Burke Film Finishing Aid
    - b. Euclid Chemical Company: "Euco-bar"
    - c. MBT Protection and Repair Products (Degussa Building Systems): "Confilm"
    - d. White Cap Construction Supply: W.C. Finishing Aid (RTU)
- M. Screed Chairs: Metal; wood not permitted.
- N. Firm Preformed Joint Filler: See Section 07901 – Joint Sealers/Fillers
- O. Soft Preformed Joint Filler: See Section 07901 – Joint Sealers/Fillers
- P. Elastomeric Joint Materials: See Section 07901 – Joint Sealers/Fillers
- Q. Semi-Rigid Joint Filler: See Section 07901 – Joint Sealers/Fillers
- R. Sheet Materials for Moist Curing Concrete Slabs: ASTM C 171.
1. Synthetic Fiber/Plastic Sheet, Single use sheets:
    - a. White synthetic fiber matting securely attached to white plastic sheet backing.
    - b. Ensure sheets are new and have never been used before.
    - c. Acceptable Product and Manufacturer:
      - i. PNA Construction Technologies: "HydraCure - S16"
- S. Slab Vertical Edge Liquid Membrane Curing Compound
1. Conform to ASTM C 1315, Type I.
  2. 25% minimum solids content.
  3. Acceptable Products and Manufacturers:
    - a. Edoco: Burke 1315 Cure Seal
    - b. Euclid Chemical Company: Super Rez-Seal
    - c. Sonneborn (Degussa Building Systems): Kure-N-Seal 30
  4. Acceptable VOC compliant Products and Manufacturers (use only where local VOC restrictions prohibit the products listed above, confirm compliance with local authorities):
    - a. Edoco: Burke 1315 Cure Seal WB
    - b. Euclid Chemical Company: Super Aqua-Cure VOX
- T. Liquid Surface Treatment (See Section 03360 – Special Concrete Floor Finishes)
- U. Abrasive Aggregate: Aluminum oxide or other approved material, factory-graded, packaged, rust-proof, non-glazing and not affected by moisture.
- V. Slab on Ground Joint Reinforcing: See Section 03150 – (FBO) Slab on Ground Joint Reinforcing
- W. Vapor Retarder (when required):
1. Provide a flexible, preformed sheet membrane having a water-vapor permeance rate no greater than 0.3 0.04 perms when tested in accordance with ASTM E154, Section 7, resistant to decay when tested by ASTM E154, Section 13 with minimum permeance of 0.06 perms and meeting or exceeding all other requirements of ASTM E1745 Class A.
    - a. Provide 15 mil minimum membrane when concrete is to be placed by truck or buggy.

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- i. Acceptable products and manufacturers
  - a) Stego Industries, LLC: "Stego Wrap 15 mil Class A"
  - b) Reef Industries: "Griffolyn 15 mil Green"
  - c) Raven Industries: "Vapor Block 15 mil"

Or

- b. Provide 10 mil minimum membrane when concrete is to be placed by pump or conveyor.
  - i. Acceptable products and manufacturers
    - a) Stego Industries, LLC: "Stego Wrap 10 mil Class A"
    - b) Reef Industries: "Griffolyn 10 mil Green"
    - c) Raven Industries: "Vapor Block 10 mil"

**2.02 PROPORTIONS**

- A. General:
  - 1. Use only materials and their proportions included on Concrete Mix Design Submittal Forms approved for this Project.
  - 2. Measure and mix ingredients in accordance with most stringent requirements of ACI 211.1, ACI 301, and ASTM C 94.
- B. Strength: Specified on Drawings.
- C. Workability: Must have proper consistency to be worked readily into forms and around reinforcement without segregation, voids or, excessive bleeding.
- D. Minimum Cementitious Materials Content for all slabs on ground:

**MINIMUM CEMENTITIOUS MATERIALS CONTENT FOR FLOORS**

| Nominal Maximum Size<br>Aggregate (in.) | Cementitious Materials<br>Content (lb/yd <sup>3</sup> ) |
|---|---|
| 1 1/2                                   | 470   |
| 1                                       | 520   |
| 3/4                                     | 540   |
| 1/2                                     | 590   |
| 3/8                                     | 610   |

- E. Water/Cement Ratio:
  - 1. Interior building slab, maximum w/cm = 0.55
  - 2. Exterior slabs subject to freezing and thawing and/or deicing chemicals, maximum w/cm = 0.45
  - 3. All other exterior slabs, maximum w/cm = 0.50.
- F. Air-Entraining Admixture:
  - 1. In cold weather climates, where the coldest average daily low temperature is 32° F or below, concrete exposed to weather in service shall be air-entrained. Air content shall be as indicated in the table below.

**Total Air Content for Frost Resistant Concrete**

| Nominal Maximum<br>Aggregate Size (in) | Air Content* % |
|--|----------------|
| 3/8                                    | 7.5            |
| 1/2                                    | 7              |
| 3/4                                    | 6              |
| 1                                      | 6              |
| 1 1/2                                  | 5.5            |
| 2                                      | 5              |
| 3                                      | 4.5            |

\* The tolerance on air content as delivered shall be ± 1.5 percent.

- 2. Do not air-entrain interior floor slabs with troweled finish. The maximum air content of trowel finished interior slabs shall be 3%.
- G. Slump:
  - 1. Unless otherwise allowed, proportion concrete so slump without adding water-reducing admixtures would be a maximum of 4" ± 1" tolerance. The slump of the concrete prior to the addition of water-reducing admixture shall be between 2" and 3". The slump of the concrete containing water-reducing admixture shall not exceed 8". The slump of the concrete shall be determined prior to the addition of the water-reducer and at the point of discharge.
- H. Admixtures:
  - 1. Water-reducing admixture may be added to improve workability and reduce water content.

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2. Mid-range water-reducing admixture may be added to improve workability or pumpability.
3. Provide an air-entraining admixture only where air-entrainment is specified.
4. Other admixtures may be used only with written approval of Owner's Representative.
5. Do not use calcium chloride as an additive or in admixtures.
6. Use admixtures in accordance with manufacturer's recommendations.

**2.03 MIXING**

**A. Ready-Mixed Concrete:**

1. Mix and transport in accordance with ASTM C 94 and ACI 301, except as specified.
2. Reset drum revolution counter to zero on ready-mix concrete truck when water is added to drum.

**B. Site-Mixed Concrete:**

1. Conform to ACI 301.
2. Use central-mix type batch plant, unless otherwise allowed.

**2.04 FABRICATION**

**A. Reinforcing:**

1. Fabricate reinforcing in accordance with ACI SP-66. Do not heat reinforcing bars for bending purposes, unless otherwise allowed by Owner's Representative.
2. Tie reinforcing bars in bundles and tag with non-rusting tags showing Shop Drawing numbers.
3. When welding of reinforcement is specified or permitted, comply with AWS D1.4. Do not tack-weld crossing bars for assembly of reinforcement, supports or embedded items, unless otherwise allowed.

**PART 3 - EXECUTION**

**3.01 GENERAL**

- A. Design, construct, erect, support, and remove formwork and related items in accordance with most stringent requirements of ACI 117, 301, and 318.
- B. Place reinforcing in accordance with most stringent requirements of ACI 117, 301 and 318 and CRSI Manual of Standard Practice and Placing Reinforcing Bars.
- C. Unless otherwise specified, place concrete in accordance with ACI 301. If proportioning design mix on basis of laboratory trial batches, do not place concrete until Owner's inspector has reviewed results of design mix 7-day test breaks and permission is given to proceed.
- D. Ensure that all work is properly coordinated:
  1. Structural Drawings and Specifications with those of other disciplines.
  2. Use final corrected Shop Drawings and placing Drawings.
- E. Provide for concrete supplier to have quality control representative at site for concrete placements for slabs.
- F. Conform to manufacturer's printed instructions for materials and equipment.
- G. During concreting operations, protect adjacent placements from concrete splatter and spillage, scratches, scrapes and any other surface damage that will affect aesthetics.

**3.02 PREPARATORY WORK**

- A. Pre-placement Inspection: Ensure all trades and other participants involved signify that all preparations are in conformance with Contract Documents. Use approved sign-off forms.
- B. Coarse Aggregate Base:
  1. Unless otherwise allowed, install coarse aggregate base where shown on Drawings.
  2. Compact to final thickness shown in layers not exceeding 6 inches, with minimum of 2 passes per layer with vibratory compactor.
  3. Compact fill to 95% of aggregate's Modified Proctor as determined by Method D of ASTM D 1557.
  4. Choke-off top surface with fine aggregate base material (see below).
  5. Provide dry, smooth, flat, dense surface.
- C. Cleaning Equipment: Remove hardened concrete and foreign materials from mixing and conveying equipment.
- D. Formwork:
  1. Unless otherwise noted on Drawings, form vertical surfaces of concrete work.



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2. Formwork for concrete surfaces to be painted or exposed to view after completion of project to meet following requirements:
    - a. No dents, holes, or patches.
    - b. Individual formwork elements are as large as possible.
    - c. Position individual formwork elements in regular, uniform pattern with all joints aligned.
    - d. Construct forms for removal without hammering or prying against concrete.
  3. Clean all formwork.
  4. Remove rust from steel formwork.
  5. Solidly butt joints and provide backup at joints as required to prevent leakage of cement paste.
  6. Before placing reinforcing steel, thoroughly coat contact surfaces of forms with an approved form release agent, if it is to be used.
  7. Apply form release agent evenly without excess drip.
  8. Do not allow form release agent to come into contact with concrete surfaces against which fresh concrete will be placed, unless noted otherwise.
  9. Moisten wood forms immediately before placing concrete where form release agents are not used.
  10. Just before placing concrete, clean forms and adjacent surfaces again as necessary. Remove wood, sawdust, chips, dirt and other debris.
  11. Provide slab side forms such that by placing a 10-foot straightedge anywhere on side of form hitting 2 points, gap at any point between straightedge and form does not exceed 1/8 inch.
- E. Fine Aggregate Base:
1. Compact to final thickness noted with 2 passes minimum with vibratory compactor to produce smooth, flat, dense surface.
  2. Unless otherwise allowed, fine aggregate to be dry immediately before placing concrete.
  3. Prior to placing concrete, the base shall be proof-rolled with a fully loaded dump truck, or other acceptable means.
  4. The Owner inspector shall monitor the proof rolling. The properly prepared subgrade will depress a maximum of a 1/2" under a fully loaded dump truck. If the base depresses more than a 1/2", the Contractor shall notify the Owner's Representative for direction on how to proceed.
- F. Vapor Retarder (when required)
1. Place vapor retarder below slab on ground where identified on the drawings.
  2. Follow manufacturer's recommendations and details, unless otherwise noted.
  3. Unroll vapor retarder in a continuous manner to minimize the occurrence of end laps below the slab.
  4. Overlap sides and ends of adjoining sheets a minimum of 6 inches.
  5. Tape all sheet laps to seal. Clean adhesion area as required prior to taping to ensure proper seal.
  6. All penetrations are to be sealed prior to placing concrete.
  7. Repair all damaged sheets by cutting out damaged area and placing additional sheet material over cutout. The patch shall overlap the cutout area by 6 inches on all sides. Tape overlapping edges of repair area to seal.
- G. Slab Reinforcing:
1. See Section 03150 for Joint Reinforcing
  2. Accurately place and secure reinforcement against displacement by firmly wiring at intersections and splices with not less than No. 18 U.S. Standard Gage annealed wire, or by use of clipping devices permitted by Owner's Representative.
  3. Turn tie wire ends away from concrete exterior.
  4. Ensure reinforcing is clean, free from defects and kinks, loose mill or rust scale or coatings that will reduce bond.
  5. Protect exposed reinforcing bars, inserts and plates intended for bonding with future expansion from corrosion by approved means.
  6. When welding of reinforcement is specified or permitted, comply with AWS D1.4. Do not tack-weld crossing bars for assembly of reinforcement, supports or embedded items, unless otherwise allowed.
- H. Miscellaneous Items:
1. Accurately place and secure against displacement miscellaneous steel, pipe sleeves, inserts, anchors, preformed joint fillers, and miscellaneous embedded items.
  2. Unless noted otherwise on Drawings, ensure corner protection bars and other similar embedded metal items are continuous between concrete joints. If shorter lengths are required for metal items, connect the ends by butt-welding entire joint and grinding smooth exposed surface. Ensure embedded metal items are discontinued at construction, contraction and isolation joints.
  3. Temporarily fill voids in sleeves and inserts with easily removable materials.
  4. Before placing concrete on ground, piping and other utilities under concrete to be inspected and tested and excavations backfilled and properly compacted to solid bearing, as specified.
- I. Joints:
1. Provide construction, isolation and contraction joints as indicated on Drawings and as noted below.
  2. For bulkheads for construction joints use 1-1/2 inch minimum thick lumber; do not use preformed metal bulkheads that will stay in place, unless approved by Owner's Representative.
  3. Provide bulkheads full depth of member.
  4. Space joints to allow 1 continuous placement between bulkheads.
  5. Do not locate longitudinal construction joints in main aisles.

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6. Unless otherwise shown or approved by Owner's Representative, maximum spacing between joints to be lesser of following:
  - a. Contraction, construction, or isolation joints in slabs on ground: 15 feet and with length-to-width ratio less than 1.5:1, but preferably less than 1.25:1.

J. Embedment:

1. Accurately position and securely anchor steel shapes, anchor bolts, casings, conduit, sleeves, and other materials embedded in concrete.
2. Thicken concrete slabs as required to maintain the intended slab thickness at embedded items.
3. Secure embedment to formwork when possible, not only tied or welded to reinforcement.
4. Install clean embedment. After concrete placement, clean embedment exposed surfaces of concrete splatter and other foreign substances.

3.03 CONVEYING

- A. General: Handle concrete from mixer to place of final deposit as rapidly as practicable and in manner, which will assure obtaining specified quality of concrete.
- B. Retempering: Discard concrete which has already begun to set; do not retemper with water.
- C. Equipment: Provide mixing and conveying equipment of proper size and design to ensure a continuous flow of concrete to delivery end. Provide conveying equipment subject to Owner's Representative's review. Do not use aluminum pipe or equipment in contact with concrete.
  1. Mixers, agitators and non-agitating units: Conform to ASTM C 94 and current certification requirements of Department of Transportation in state where concrete plant is located.
  2. Belt Conveyors:
    - a. Use only types that will not cause segregation.
    - b. Discharge runs over 30 feet into a hopper.
  3. Chutes: Metal or metal lined installed at slopes not exceeding 1 vertical to 3 horizontal. Ensure chutes with greater slopes or chutes over 20 feet in length discharge into a hopper.
  4. Runways:
    - a. Provide runways or other means above finished concrete level for wheeled conveying equipment.
    - b. Do not support runways on reinforcing.
    - c. Do not wheel equipment directly over reinforcing or metal deck.
  5. Pumps:
    - a. Submit to Owner's Representative for review all changes in concrete mix to necessitate pumping.
    - b. Use pump hoses and other slickline components with 5-inch minimum inside diameter, unless otherwise allowed by Owner's Representative.
    - c. For slickline reducers ensure reduction in diameter is no more than 1 inch over 5-foot length.
    - d. Submit to Owner's Representative method of operating pump hoses so as to prevent displacement of reinforcing steel, dowels, form, and aggregate base.

3.04 DEPOSITING

- A. Placing:
  1. The location of all construction and contraction joints shall be as indicated on the Foundation Plan, and no deviations shall be allowed. In no case shall the contractor place more concrete than can be properly and completely finished and saw cut in one day. The size of each placement shall not exceed 28,000 square feet, unless approved by the Owner's representative.
  2. General:
    - a. Do not deposit concrete that has partially hardened or has been contaminated by foreign matter.
    - b. Deposit concrete continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause seams or planes of weakness.
    - c. Between construction joints place concrete in a continuous operation such that concrete is plastic at all times and flows readily into spaces between reinforcement
    - d. Do not subject concrete to procedures that will cause segregation.
    - e. Deposit concrete as near as possible to its final position.
  3. Do Not:
    - a. Place concrete over standing water, mud, frost, ice or snow.
    - b. Do not use wet screeds unless permitted by Owner's Representative.
- B. Consolidation:
  1. General:
    - a. Consolidate concrete by vibrating, spading or rodding so that concrete is thoroughly worked around reinforcing, and embedded items and into the corners of forms.
    - b. Consolidate each layer of concrete with previously placed layers in manner that will eliminate air or stone pockets that may cause honeycombing, pitting or places of weakness.
    - c. Do not insert vibrator into portions of concrete that have begun to set unless allowed by Owner's Representative.
    - d. Do not use vibrators to transport concrete
    - e. Keep spare vibrator on job site during concrete operations.

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2. Formed Elements: Use internal vibrators, not form vibrators, unless allowed by Owner's Representative.
3. Slabs:
  - a. Consolidate slabs with laser screed, vibrating bridge screed or other means allowed by Owner's Representative.
  - b. Use internal vibration along construction joints.
  - c. If bar reinforcing is used, use internal vibration around bars.
  - d. Do not use grate tampers, jitterbugs or mesh rollers, unless allowed by Owner's Representative.
  - e. Move vibrating screed, if used, steadily and as fast as practicable, keeping an adequate surcharge of concrete at forward edge of screed.
  - f. Vibrate under all plate dowels. Mark forms before concreting to properly locate dowels after concreting.
- C. Formwork: After concrete placement, adjust forms and bracing as necessary to maintain proper alignment and eliminate leakage of cement paste.

**3.05 FLOOR SLAB FINISHING PROCEDURES**

**A. General:**

1. Unless otherwise allowed, do not add water to any slab surface during finishing operations.
2. Do not add plain, dry cement to any slab surface during finishing operations.
3. Unless otherwise allowed, perform no finishing operation while water is present on slab surface.
4. If concrete is firm enough for floating but substantial amount of bleed water is still on surface, water may be removed by dragging a rubber hose slowly over surface 1 time, without disturbing or damaging surface.

**B. Initial Leveling:**

1. Complete all bull floating, darbying, and straight edging before any bleed water is present on slab surface.
2. Use highway straightedge 10 feet wide minimum for initial and later leveling instead of bull float where overall floor tolerances specified are greater than  $F_T/20/F_L/15$ .

**C. Hand and Power Floating:**

1. Do not start floating until following conditions are met:
  - a. Bleeding is finished.
  - b. Bleed water is gone, including water sheen on slab surface.
  - c. Concrete will sustain weight of an average man with no more than a 1/8 to 1/4-inch indentation.
  - d. Mortar is not thrown by rotating blades of power float.
2. Do not use following tools for floating:
  - a. Power troweling machine with trowel or finishing blades.
  - b. Fresno or other type of wide metal trowel.
  - c. Power floating machine with water attachment for wetting concrete.
3. Float 3 times minimum, with each floating at right angles to previous floating and final pass at 45 degrees to previous pass.

**D. Troweled Finish**

1. Ensure floor is hand or power floated before starting to trowel.
2. Trowel 3 times minimum, with each troweling at right angles to previous troweling.
  - a. For first troweling, keep blade as flat as possible and use low speed, minimizing "washboard" or "chatter marks" and "pitting".
  - b. Trowel two times minimum with first two troweling at right angles. Some burn marks are acceptable. Refer to test slab. Cease troweling before trowel blades scratch surface.
3. Allow time between troweling for concrete to stiffen and water sheen to disappear.
4. Final troweling shall continue until the slab has achieved a hard-burnished surface with no defects. Differences in the finish of the surface are not acceptable and are critical to the Owner's requirement for a defect free, high sheen final finished surface.
5. Do not ride trowels on existing slabs. Trowels shall be carried off from slab surfaces. When parking power trowels on fresh concrete, place on top of plywood or spray area with evaporation retarder before placing trowel on top of slab.

**E. Broom Finishes**

1. General
  - a. The Contractor shall prepare a sample for each of the broom finishes listed below. The Owner's representative shall approve the samples prior to their use on any concrete placement.
  - b. Broom texture to be in the direction to facilitate drainage.
2. Light Broom Finish
  - a. The surface shall first be given a single float finish as specified above. Immediately after initial floating, it shall be given a light transverse texture by drawing a broom across the surface.
3. Medium Broom Finish
  - a. The surface shall first be given a single float finish as specified above. Immediately after initial floating, it shall be given a medium transverse texture by drawing a broom across the surface.
4. Rough Broom Finish
  - a. The surface shall first be given a single float finish as specified above. Immediately after initial floating, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.

**3.06 EXTERIOR SLABS/PAVEMENTS, STAIRS, APRONS, ETC.**

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- A. Exterior stairs, sidewalks, and the Building Apron Slab shall receive a light broom finish.
- B. All other exterior slabs/pavements shall receive a rough broom finish.

**3.07 NON-SLIP FINISH**

- A. Where directed by Architect of Record, make all exterior ramps, curb cuts, step treads and landings non-slip by application of abrasive aggregate during concrete finishing process. Sprinkle abrasive aggregate by hand at the rate of not less than 1/4 lb. of aggregate per square foot. Sprinkle as soon as the freshly placed concrete will support the weight of workmen. Float into surface, and trowel.

**3.08 FLOOR SLAB JOINTS**

- A. General: Construction and contraction joints shall match the joint layout provided on the drawings. No exceptions.
  - 1. Construction Joints: Shall be located at the discretion of the Contractor except they are not to be located longitudinally in main aisles. and observing the placement limits previously established.
- B. Sawed Joints:
  - 1. Use saws, blades, skid plates, and accessories from Soff-Cut International, Inc.
  - 2. Have two "Soff-Cut" saws minimum on site, with blades capable of achieving the required depth of saw cut.
  - 3. Start cutting sawed joints as soon as concrete has hardened sufficiently to prevent raveling or dislodging of aggregates.
  - 4. For "Soff-Cut" saw, this will typically be from 1 hour in hot weather to 4 hours in cold weather after completing finishing of slab in that joint location.
  - 5. Capability: Employ sufficient number of saws and workers to complete cutting sawed joints before the time noted above and before shrinkage produces cracking.
  - 6. See Drawings for additional requirements.
- C. Saw-Cut Control Joint Dust Collection
  - 1. Connect a dust collection system directly to each Soff-Cut saw being used.
  - 2. Dust Collection System:
    - a. ProVac Dust Collection System PVG-55 by Glad Tech Inc.
    - b. SoffVac V-1000 by Soff-Cut International, Inc.
  - 3. Remove all saw debris, either loose or compacted, from slab surface and joints prior to curing cover installation.

**3.09 CONCRETE CURING**

- A. General:
  - 1. Cure concrete in accordance with ACI 301 and ACI 308.1, except as noted.
  - 2. Start curing as soon as curing operations will not damage concrete surface.
  - 3. Continuously moist cure concrete slabs, for at least 7 consecutive days, except as follows: For tilt-up wall buildings, the interior building slab at the tilt up wall panel locations shall be moist cured for at least 5 consecutive days, all other areas to be moist cured 7 consecutive days. Ensure the casting area is coated with bond breaker prior to constructing tilt panel forms.
  - 4. During curing period, do not allow any part of concrete to become dry.
  - 5. Do not use plain polyethylene sheets on exposed interior floors.
  - 6. If using forms for curing, keep forms in contact with concrete wet during curing period unless type of form is impervious to water, such as metal or fiberglass.
  - 7. If forms are removed before curing period is complete, continue curing immediately with other approved methods.
- B. Methods of Curing: Cure concrete surfaces with following materials and methods:
  - 1. Moisten exposed surfaces of concrete after completing finishing and then apply sheet smoothly with no wrinkles or folds, pre-wetted, with edges lapped 6 inches minimum and sealed and secured in such manner as to prevent moisture escaping from concrete from laps or edges. Keep sheet moist during curing period.
  - 2. Liquid curing compounds sprayed or rolled uniformly on vertical slab edges only immediately following form removal operation.
    - a. Apply curing compound in accordance with manufacturer's recommendations.
    - b. Immediately recoat, at the rate specified above, surfaces subjected to rainfall within 3 hours after compound has been applied or surfaces damaged by subsequent construction operations within the curing period.
- C. Concrete Protection:
  - 1. Barricade concrete surfaces immediately after finishing.
  - 2. Do not allow light traffic, except for curing purposes, on concrete surfaces until concrete has obtained 1800 psi compressive strength.
  - 3. Do not allow heavy traffic on concrete surfaces until concrete has obtained its design strength noted on Drawings, by test.
  - 4. Adequately protect concrete inserts and other embedded items from movement, mechanical injury or from damage by elements.

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5. During concreting operations, protect adjacent placements from concrete splatter and spillage, scratches, scrapes and any other surface damage that will affect aesthetics.

3.10 FORM REMOVAL

A. General:

1. Do not remove forms until concrete has hardened sufficiently to support its own weight and imposed construction loads.
2. Remove forms in manner to avoid damage to concrete.

3.11 BONDING NEW CONCRETE TO EXISTING CONCRETE

A. Use this bonding procedure for bonding new concrete pads to existing concrete and as noted on Drawings.

B. Install as follows:

1. Roughen joint until coarse aggregate is exposed.
2. Clean surface.
3. Immediately before placing concrete, clean surface again as necessary, dampen surface, and remove free water.
4. Brush surface to be bonded with bonding grout.
5. Proportion grout to consist of 1 to 1 mixture of Portland cement and sand passing the No. 8 sieve and mixed with sufficient water to give thick paint-like consistency.

3.12 JOINT SEALING/FILLING: See Section 07901 – Joint Sealers/Fillers

3.13 LIQUID SURFACE TREATMENT

A. See Section 03360 - Special Concrete Finishes for detailed information.

1. The General Contractor is to keep the areas that the liquid surface treatment and polished finish is being installed clear of other work and disturbances and must coordinate the work so as not to delay other work in progress.

END OF SECTION