1. **GENERAL**
   1. **WORK INCLUDED**
      1. Provisions of Division 01 apply to this section.
      2. Sections Includes:
2. Cast-in-place normal weight and lightweight concrete, placement and finishing.
   * 1. Related Sections:
3. Section 03 10 00: Concrete Forming and Accessories.
4. Section 03 20 00: Concrete Reinforcing.
   1. **REFERENCES**
      1. American Concrete Institute (ACI) Publication:
5. ACI 117-Specifications for Tolerances for Concrete Construction and Materials.
6. ACI 301-Specifications for Structural Concrete.
7. ACI 302.1R-Guide for Concrete Floor and Slab Construction.  
   ACI 302.2R-Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials
8. ACI 305.1-Specifiction for Hot Weather Concreting.
9. ACI 306.1-Standard Specification for Cold Weather Concreting.
10. ACI 318-Building Code Requirements for Structural Concrete, as modified by CBC Sections 1903A and 1908A.
    * 1. American Society for Testing and Materials (ASTM) Standards:
11. ASTM C31-Standard Specification for Making and Curing Concrete Test Specimens in the Field.
12. ASTM C33-Standard Specification for Concrete Aggregates.
13. ASTM C39-Standard test Method for Compressive Strength of Cylindrical Concrete Specimens.
14. ASTM C42-Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
15. ASTM C88-Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.
16. ASTM C94-Standard Specification for Ready-Mixed Concrete.
17. ASTM C143-Standard Test Method for Slump of Hydraulic Cement Concrete.
18. ASTM C150-Standard Specification for Portland Cement.
19. ASTM C171 –Standard Specification for Sheet Materials for Curing Concrete.
20. ASTM C172-Standard Practice for Sampling Freshly Mixed Concrete.
21. ASTM C173-Standard Test Method for Air Content for Freshly Mixed Concrete by the Volumetric Method.
22. ASTM C260-Standard Specification for Air-Entraining Admixtures for Concrete.
23. ASTM C289-Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
24. ASTM C309 - Liquid Membrane - Forming compounds for Curing Concrete.
25. ASTM C330-Standard Specification for Lightweight Aggregates for Structural Concrete.
26. ASTM C494-Standard Specification for Chemical Admixtures for Concrete.
27. ASTM C567-Standard Test Method for Determining Density of Structural Lightweight Concrete.
28. ASTM C618-Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
29. ASTM C845-Standard Specification for Expansive Hydraulic Cement.
30. ASTM C856 - Practice for Petrographic Examination of Hardened Concrete.
31. ASTM C989-Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
32. ASTM C1064-Standard Test Method from Temperature of Freshly Mixed Hydraulic-Cement Concrete.
33. ASTM C1107-Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
34. ASTM C1240-Standard Specification for Silica Fume Used in Cementitious Mixtures.
35. ASTM C1567-Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combination of Cementitous Materials and Aggregate. (Accelerated Mortar-Bar Method)
36. ASTM D1751-Standard Test Method for Performed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types).
37. ASTM E96-Standard Test Methods for Water Vapor Transmission of Materials.  
    ASTM F1249-Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
38. ASTM E1155-Standard Test Method for Determining Floor Flatness and Floor Levelness Numbers.
39. ASTM E1643-Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill under Concrete Slabs.
40. ASTM E1745-Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs.
    1. **SUBMITTALS**
       1. Shop Drawings: Submit shop Drawings indication locations of cast-in-place concrete work and accessory items such as vapor barriers. Include details and location of reinforcing, embedded items, and interfacing with other Work.
       2. Submit vapor barrier manufacturer’s installation instructions for placement, seaming, penetration prevention and repair, and perimeter seal per ASTM E1643.
       3. Mix Design Data: Submit concrete mix designs as specified herein and in Article 2.02.
41. Submit name, address and telephone number of the concrete production facility which the contractor intends to engage to design the concrete mixes. Submit name and qualifications of the proposed concrete technologist.
42. Mix Design: Submit a concrete mix design for each strength and type of concrete indicated in the drawings or specified. Include water/cement ratio, source, slump and amount of coarse aggregate and admixtures. Predict minimum compressive strength, maximum slump and air content percentage. Clearly indicate locations where each mix design will be used.  
    Test Reports: Submit Copies of test reports showing that the proposed mixes produce concrete with the strengths and properties specified. Include tests for cement, aggregates and admixtures. Provide gradation analysis.

* + 1. Material Samples: Submit Samples illustrating concrete finishes, hardeners, and vapor barrier, minimum 12 X 12 inches in size.
    2. Submit vapor barrier manufacturer’s product warranty that warrants in writing (a) compliance with the designated ASTM E1745 classification, and (b) no manufacturing defects in the product for, at least, the Life of the Building.
    3. Certificates: Submit certification that each of the following conforms to the standards indicated:

1. Portland cement: ASTM C150
2. Normal weight concrete aggregates: ASTM C33.
3. Lightweight concrete aggregates: ASTM C330
4. Aggregates: Submit evidence that the aggregate is not reactive in the presence of cement alkalis. In the absence of evidence, aggregate shall be tested per ASTM C289. If results of test are other than innocuous, aggregates shall be tested per ASTM C1567 as required by CBC, Section 1903A.
5. Curing materials: ASTM C171.
6. Vapor Barrier: Provide a summary of test results per paragraph 9.3 of ASTM E1745, including third party documentation that all testing was performed on a single production roll per ASTM E1745 Section 8.1.

E. Admixtures: Submit product data for proposed concrete admixtures.

* 1. **Quality Assurance**
     1. Continuous inspection shall be provided at the batch plant and for transit-mixed concrete to run check sieve analysis of aggregate, check moisture content of fine aggregate, check design of mix, check cement being used with test reports, check loading of mixer trucks, and certify to quantities of materials placed in each mixer truck.
     2. Inspection shall be performed by a representative of a DSA approved testing laboratory selected by the Owner. Owner will pay for inspection costs. Notify the laboratory 24 hours in advance of time concrete is to be mixed. Notify the laboratory of postponement or cancellation of mixing within at least 24 hours of scheduling time.
     3. Contractor shall assist the testing laboratory in obtaining and handling samples at the project site and at the source of materials.
     4. Continuous batch plant inspection requirement may be waived in accordance with CBC Section 1704A4.4. Waiver shall be in writing, including DSA approval. When batch plant inspection is waived by DSA, the following requirements shall be met:

1. Approved inspector of the testing laboratory shall check the first batching at the start of work and furnish mix proportions to the licensed weightmaster.
2. Licensed weighmaster shall positively identify materials as to quantity and certify to each load by a ticket.
3. Tickets shall be transmitted to the PI by a truck driver with load identified thereon. The PI will not accept the load without a load ticket identifying the mix and will keep a daily record of placements, identifying each truck, its load and time of receipt and approximate location of deposit in the structure and will transit a copy of the daily record to DSA.
4. At the end of the project, the weightmaster shall furnish an affidavit to DSA certifying that all concrete furnishes conforms in every particular to proportions established by mix designs.
   * 1. Special Inspections and Test shall be in accordance with CBC Chapter 17A, CBC Section 1916A and Specification Section 01 45 23.
     2. Contact vapor barrier manufacturer to schedule a pre-construction meeting and to coordinate a review, in-person or digital, of the vapor barrier installation.
   1. **DELIVERY, STORAGE AND HANDLING**
      1. Store cement and aggregate materials so as to prevent their deterioration or intrusion by foreign matter, Deteriorated or contaminated materials shall not be furnished.
      2. Packaged materials shall bear the manufacturers and brand name label, and shall be stored in their original unbroken package in a weather tight place until ready for use in the work
   2. **PROJECT CONDITIONS**
      1. Cold Weather Requirements: Batching, mixing, delivering and placing of concrete in cold weather shall comply with the applicable requirements of ACI 306.1.
5. Hot Weather Requirements: Batching, Mixing, delivering and placing of concrete in hot weather shall comply with the applicable requirements of ACI 305R.
6. Concrete temperature of freshly mixed concrete shall be determined per ASTM C1064.
7. **PRODUCTS**
   1. **MATERIALS**
      1. Cement: ASTM C150, Type I or Type II Portland cement; low alkali; grey color.
      2. Aggregates: Conform to the following standards:
8. Normal weight concrete: ASTM C33
9. Lightweight concrete: ASTM C330, with fine aggregates per ASTM C33.

3. Aggregate shall be tested for Potential Alkali Reactivity of Cement-Aggregate Combinations per ASTM C289.

4. Nominal maximum size of course aggregate shall be no larger than:

a. 1/5th the narrowest dimension between sides of forms, nor

b. 1/3rd the depth of slabs, nor

c. ¾ the clear spacing between individual reinforcing bars or wires, bundles of bars, individual tendons, or ducts.

d. Contractor may request the Architect and DSA waiver of the above limitations per ACI 318, Section 26.4.2.1(5), provided that the workability and methods of consolidation are such that the concrete can be placed without honeycombs or voids.

* + 1. Water: Water for concrete mixes, curing and cleaning shall be potable and free from deleterious matter.

D**.** Admixtures: Shall be shown capable of maintaining essentially the same composition and performance throughout the work as the product used in establishing concrete proportions in accordance with ACI 318, Section 26.4.1.5.

1. Admixtures containing chlorides or sulfides are not permitted.

2. Air-entering admixtures shall comply with ASTM C260, Air-entrained admixtures shall not be used for floor slabs to receive steel trowel finish.

3. Admixtures for water reduction and setting time modification shall conform to ASTM C494.

4. Admixtures for producing flowing concrete shall conform to ASTM C1017.

|  |
| --- |
| **Note to Specifier:** Use of fly ash and blast-furnace slag is encouraged to reduce the impact of cement manufacture. Determine if the use of fly ash and blast-furnace slag is acceptable, available at a competitive price, and would not result in inadequate bid competition. If not used, delete article 5 below. If used, verify percentage of Portland cement replacement and indicate amount in space provided below, and delete the brackets. If not used throughout project, clearly indicate areas where it will be used. |

5. Fly ash, pozzolan and ground granulated blast-furnace slag: Modify ACI 318 Sections 26.4 as follows:

Fly ash or other pozzolan used as a partial substitution for ASTM C150 Portland cement shall meet the following requirements:

1) Shall conform to ASTM C618 for Class N or F materials (Class C is not permitted).

2) [ ] percent by weight of fly ash or other pozzolans shall substitute for ASTM C150 Portland Cement Provided the mix design is proportioned per ACI 318, Section 26.4.2.2 and the durability requirements of Section 1904A are met.

b. Ground-granulated blast-furnace slag used as a partial substitution for ASTM C150 Portland cement shall meet the following requirements:

6. Admixtures containing ASTM C845 expansive cements shall be compatible with the cement and produce no deleterious effects.

7. Silica fumes used as an admixture shall conform to ASTM C1240.

E. Reinforcement Fibers: Chop strands of alkali-resistant polypropylene or nylon fibers added to the concrete mix for protection against shrinkage cracks.

F. Expansion Joint Fillers: Performed strips, non-extruding and resilient bituminous type, of thickness indicated, conforming to ASTM D1751.

G. Curing Paper: Shall conform to ASTM C171 and consist of two sheets of kraft paper cemented together with a bituminous material in which are embedded cords or strands of fiber running in both directions. The paper shall be light in color, shall be free of visible defects, with uniform appearance.

H. Floor Hardener: Water soluble, inorganic, silicate-based curing, hardening, sealing and dustproofing compound. Aquaseal W20 by Monopole Inc., Kure-N-Harden by BASF, Chem Hard by L&M, Liqui-Hard by W. R. Meadows, or equal.

I. Underlayment: Two component latex underlayment for filling low spots in concrete for both interior and exterior applications, from featheredge to maximum of 3/8th inch in thickness. Underlayment shall be non-shrink and suitable for repairing exposed coverings. La\_O\_Test by Tex Rite, Underlay C or RS by Mer-Krete Systems, Underlayment 962 by C-Cure, or equal.

J. Vapor Barrier: Polyolefin-based 15 mils minimum thickness, meeting or exceeding ASTM E1745, 10 feet minimum width. Permeance shall be less than 0.01 perms [grain/(ft2\*hr\*inHg] as determined by ASTM E96 or ASTM F1249 and after mandatory conditioning test per ASTM E154 Sections 8, 11, 12, & 13. Include manufacturer’s recommended sealing accessories for sealing seams, penetrations, and termianted edges in accordance with ASTM E1643-18a. Stego Wrap by Stego Industries LLC<Perminator by W.R. Meadows, Ecoshield-E by Epro, or equal.

K. Stairs Strips and Nosing:

1. Fabricated from 6063-T5 extruded aluminum, mill finish, Anti-slip filler shall contain at least 60 percent virgin grain aluminum oxide abrasive. Binder shall be fully cured resilient type epoxy, with binder-to filler ratio of 13 percent. The epoxy-abrasive filler shall extend over the curved front edge of the nosing and shall be securely bonded to the extruded aluminum base.

2. Manufactured by Wooster Products Inc. American Safety Tread Co. Inc., or equal.

3. Nosing and strips for concrete casting shall be provided with Sure-Hold Anchors, chevron shaped continuous full length of nosing or strip.

4. Nosing and anchors for attachments to hydrated concrete stairs and wood stairs shall be similar to those specified below, except they shall be provided with countersunk holes for screws and fasteners.

5. Colors: As selected by Architect to contrast with stair color. Colors shall extend uniformly through the filler.

6. Strip and Nosing Types:

a. Nosings for sloped riser steel pan stairs Type WP4J, 4-1/16th inches wide, 3/8th inch thick.

b. Nosings for new concrete stairs: Type WP4C, 4-1/16th inches wide, 3/8th inch thick, nose projects down ¼ inch.

c. Nosings for square edge steel pan stairs: Type WP4SP, 4-1/16th inches wide, 3/8th inch thick nose.

d. Strips for recessing into concrete stairs: Type WP1A, except 2-1/4 inches wide, 3/8 inch thick. American Safety Tread Co., Type 24, or equal.

e. Strips for adhering to existing or hydrated concrete: Flex-Tred anti-safety strips, minimum 2-1/4 inches wide. Cut from rolls and round corners.

f. Strips for anchoring into wood or stone: American Safety Tread Co., Type t-24H, or equal, with holes for fasteners, 2-1/4 inches wide.

L. Grout: ASTM C1107, non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 7,000 psi at 7 days; of consistency suitable for application and a 30 minute working time.

* 1. **CONCRETE MIX**
     1. Mix shall be signed and sealed by a Civil or Structural Engineer currently registered in the State of California.

B. Strength of Concrete: Strengths and types of concretes shall be as indicated in the Drawings. Unless otherwise indicated or specified, concrete shall be provided with a minimum 28-day strength of 3000 psi (fc).

C. The required strength and durability of concrete shall be determined by compliance with the proportioning, testing, mixing and placing provisions of CBC Sections 1903 and 1904. Concrete mix shall meet the durability requirements of ACI 318, Section 19.3.

D. Concrete proportioning shall be determined on the basis of field experience and/or trial mixtures shall in accordance with ACI 318, Section 26.4.3. Proportions of materials shall provide workability and consistency to ermit concrete to be placed readily into forms and around reinforcement under conditions of placement to be employed, without segregation or excessive bleeding.

E. Ready-Mixed Concrete: Mix and deliver in accordance with requirements of ASTM C94.

1. **EXECUTION**
   1. **GENERAL** 
      1. Surfaces to receive concrete shall be free of debris, standing water, and any other deleterious substances before start of concrete placing.
      2. Time of Placing: Do not place concrete until reinforcement, conduits, outlet boxes, anchors, hanger, sleeves, bolts, and other embedded materials are securely fastened in place. Contact the PI at least 24 hours before placing concrete; do not place concrete until inspected by PI.
      3. Pouring Record: a record shall be kept on the Project site of time and date of placing concrete in each portion of structure. Such record shall be maintained on the Project site until Substantial Completion and shall be available for examination by the Architect and DSA.

**3.02 TOLERANCES**

A. Concrete construction tolerances shall be as specified in ACI 117 and as modified herein.

B. Floor Flatness (FF) and Floor Levelness (FL) shall be indicated below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Specified Overall Value | | Minimum Local Value | |
|  | FF | FL | FF | FL |
| Slabs on Ground: mechanical and electrical rooms, parking structures and mortar bed set tile and quarry flooring. | 20 | 15 | 15 | 10 |
| Slab on ground: carpet. | 25 | 20 | 17 | 15 |
| Slab on Ground: thinset tile and resilient flooring | 35 | 25 | 24 | 17 |
| Suspend slabs: mechanical and electrical rooms, parking structures and mortar bed set tile and quarry flooring. | 20 | 15 | N/A | N/A |
| Suspend slabs: carpet. | 25 | 20 | N/A | N/A |
| Suspend slabs: thinset tile and resilient flooring. | 35 | 20 | N/A | N/A |

C.Refer to ACI 302.1R, Tables 8.1 and 8.2 Slab on Ground and Suspend Flatness/Levelness Construction Guide, for recommended concrete placing and finishing methods.

* + 1. Floor Flatness and Floor Levelness shall be tested in accordance to ASTM E1155. Floor measurements shall be made within 48 hours after slab installation, and shall precede removal of shores and forms.

**3.03**  **PREPARATION**

A. Vapor Barrier: Before Installation of screeds and slab reinforcement, install vapor barrier under slabs on grade, as indicated in the drawings.

1. Install in accordance to ASTM E1643.

1. Unroll vapor barrier with the longest dimension parallel with the direction of the concrete placement and face laps away from the expected direction of the placement whenever possible.
2. Extend vapor barrier to the perimeter of the slab. If practicable, terminate it at the top of the slab, otherwise (a) at a point acceptable to the structural engineer or (b) where obstructed by impediments, such as dowels, water stops, or any other site condition requiring early termination of the vapor barrier. At the point of termination, seal vapor barrier to the foundation wall, grade beam or slab itself.
   1. Seal vapor barrier to the entire slab perimeter using manufacturer’s textured tape with a surface that creates a mechanical seal to freshly placed concrete, per manufacturer's instructions.

OR

* 1. Seal vapor barrier to the entire perimeter wall or footing/grade beam with manufacturer’s double-sided tape, or both termination bar and double-sided tape, per manufacturer’s instructions. Ensure the concrete is clean and dry prior to adhering tape.

1. Overlap joints 6 inches and seal with manufacturer’s seam tape.
2. Apply seam tape/textured tape/double-sided tape to a clean and dry vapor barrier
3. Seal all penetrations (including pipes) per manufacturer’s instructions.
4. Avoid the use of stakes driven through vapor barrier by utilizing screed and forming systems that will not puncture the vapor barrier.
5. Repair damaged areas with vapor barrier material of similar (or better) permeance, puncture, and tensile.
6. Utilize vapor barrier sealing accessories from the same manufacturer as the vapor barrier membrane.

B. Reglets and Rebates:

1. Form reglets and rebates in concrete to receive flashing, frames and other equipment as detailed and required. Coordinate dimensions and locations required with other related Work.

2. If concrete slabs on grade adjoin a wall or other perpendicular concrete surface, form a reglet in wall to receive and carry horizontal concrete Work. Reglet shall be full thickness of the slab and shall be ¾ inch wide, unless otherwise indicated. Requirement does not apply to exterior walks, unless specifically indicated.

C. Anchor Slots: Embedded anchor slots in concrete walls to receive masonry veneer shall be set vertically in forms, 24 inches maximum on centers measured horizontally; Anchor slots shall be No. 24 gage galvanized sheet steel with removable fiber filler to prevent seepage of cement in slot.

D. Screeds: Install screeds accurately and maintain in required grade or slab elevations after steel reinforcement has been installed, but before starting to place concrete. Install screeds adjacent to walls and in parallel rows not to exceed 8 feet on centers.

**3.04 INSTALLATION**

1. Conveying and Placing:
2. Concrete shall be placed only under direct observation of the PI. Do not place concrete outside of regular working hours, unless the PI has been notified at least 48 hours in advance.

2. Concrete shall be conveyed from mixer to location of final placement by methods that will prevent separation or loss of materials.

3. Concrete shall be placed as nearly as practicable to its final position to avoid segregation due to re-handling or flowing. No concrete that has partially hydrated or has been contaminated by foreign materials shall be placed, nor shall re-tempered concrete or concrete which has been remixed after initial set be placed.

4. In placing concrete in columns, walls or thin sections, provide openings in forms, elephant trunks, tremies or other recognized devices, to prevent segregation and accumulation of partially hydrated concrete on forms or metal reinforcement above level of concrete being placed. Such devices shall be installed so that concrete will be dropped vertically. Unconfined vertical drop of concrete from end of such devices to final placement surface shall not exceed 6 feet.

5. Concrete shall be placed as a continuous operation until placing of panel or section is completed. Top surfaces of vertically formed lifts shall be level.

6. Concrete shall be thoroughly consolidated by suitable means during placement, and shall be thoroughly worked around reinforcement and embedded fixtures and into corners of forms.

7. Where conditions make consolidation difficult or where reinforcement is congested, batches of mortar containing some proportions of cement, sand, and water as provided in the concrete, shall first be deposited in the forms to a depth of at least one inch.

B. Cold Weather:

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. All ground with which concrete is to come in contact shall be free from frost. No frozen materials or materials containing ice shall be used.

2. The temperature of concrete at the time of placement shall not below the minimum temperatures given in Table 5.1 of ACI 306.1.

3. Concrete shall be maintained at a temperature of at least 50°F. for not less than 72 hours after placing or until it has thoroughly hardened. Cover concrete and provide sufficient heat as required. When necessary, aggregates shall be heated before mixing. Special precautions shall be taken for protection of transit-mixed concrete.

C. Hot Weather:

1. Concrete to be placed during hot weather shall comply with the requirements of ACI 318, Section 26.5.5.

2. Maintain concrete temperatures indicated in Section 3 of ACI 305.1 to prevent the evaporation rate from exceeding 0.2 pound of water per square feet of exposed concrete per hour.

3. Cool Concrete using methods indicated in ACI 305R Appendix B.

4. Place and cure concrete as specified in ACI 305R Chapter 6.

D. Compaction and Screeding:

1. Tamp freshly placed concrete with a heavy tamper until at least 3/8 inch of mortar is brought to surface. Concrete shall then be tamped with a light tamper and screeded with a heavy straightedge until depressions and irregularities are eliminated, and surface is true to finish grades or elevations. Remove excess water and debris.

2. Where slabs are to receive separate cement finish or mortar setting bed, continued tamping to raise mortar to surface is not performed. Laitance shall be removed by brushing with a stiff brush or by light sandblasting to expose clean top surface of course aggregate.

E. Floating and Troweling:

1. When concrete has hydrated sufficiently, it shall be floated to a compact and smooth surface. After floating, wait until concrete has reached proper consistency before troweling. Top surfaces shall receive at least 2 troweling operations with steel hand trowel. Prior to and during final troweling, apply a fine mist of water frequently with an atomizing type fog sprayer. Omit troweling for slabs to receive a separate cement finish.

2. For interior finish slabs, final troweling shall provide a hard, impervious, and non-slip surfaces, free from defects and blemishes. Finished surface shall be within tolerances indicated in Article 3.02. Avoid burnishing. Do not add cement or sand to absorb excess moisture.

a. Floor of Walk-In Refrigerator: Finish as specified above, to a smooth finish.

b. Floor of Gymnasium Locker Rooms: After floating, and while the surface is still plastic, provide a fine textured finish by drawing a fine fiber bristle broom uniformly over the surface in one direction only. Floors sloped for drainage should be brushed in the direction of flow.

3. Exterior Paving and Cement Walks: Finish as specified above, except surface shall be given a non-slip broom finish to match Sample reviewed by the Architect.

4. Vertical concrete surfaces shall be finished smooth and free from marks or other surface defects.

F. Curing:

1. Length of Time, temperature and moisture conditions for curing concrete shall be in accordance with ACI 318, Section 26.5.3.

2. Forms containing concrete, top of concrete between forms, and exposed concrete surfaces after removal of forms shall be maintained in a thoroughly wet condition for at least 7 consecutive days after placing.

3. If weather is hot or surface has dried out, spray surface of concrete slabs and paving with a fine mist of water, starting not later than 2 hours after final troweling and continuing until sunset. Surface of finish shall be kept continuously wet until curing medium has been installed.

4. Immediately after finishing, monolithic floor slabs shall be covered with curing paper. Paper shall be lapped 4 inches at joints and sealed with waterproof sealer. Edges shall be cemented to finish. Repair or replace paper damaged during construction operations.

G. Filling, Leveling and Patching:

1. Concrete slabs exhibiting high or low spots and indicated to receive resilient floor covering or soft floor covering, shall have surfaces repaired. High spots shall be honed, or ground with power-driven machines to required tolerances. Low spots shall be filled with latex underlayment, installed in strict accordance with manufacturer’s written recommendations.

2. Holes resulting from form ties or sleeve nuts shall be solidly packed, through exterior walls, by pressure grouting with cement grout, as specified. Grouted holes on exposed surfaces shall be screeded flush and finished to match adjoining surfaces.

H. Cement Base: Cement base shall be of the height, thickness, and shape detailed. Base shall be reinforced with on inch mesh, 18 gage, zinc-coated wire fabric. Base finish mixture shall be one part Portland cement, 2 parts of fine aggregate and on part pea gravel. Colored cement base shall include a chemically inert mineral oxide pigment in the mix.

**3.05 FINISHING**

A. Soda and Acid Wash: Concrete surfaces to receive plaster, paint or other finish, and which have been formed by oil coated forms, shall be scrubbed with a solution of 1-1/2 pounds of caustic soda to one gallon of water. Surfaces where smooth wood or waste molds have furnished shall be scrubbed with a solution of 20 percent muriatic acid. Wash with clean water after scrubbing.

B. Sacking: exposed concrete curbs, walls, and other surfaces shall be sacked by an application of Portland cement grout, floated, and rubbed. Sacking shall not be performed until patching and filling of holes has been completed. Entire sacking operation for any continuous area shall be started and completed within the same day.

1. Mix one part Portland cement and 1-1/2 parts fine sand with sufficient water to produce a grout having a consistency of thick paint. Wet surface of concrete sufficiently to prevent absorption of water from the grout. Apply grout uniformly with a brush or spray gun, then immediately float surface with a cork or other suitable float, scouring wall vigorously.

2. While grout is still plastic, finish surface with a sponge-rubber float, removing excess grout. Allow surface to dry thoroughly, and then rub vigorously with dry burlap to completely remove dried grout. No visible file or grout shall remain after rubbing with burlap.

C. Sandblasting; Exterior concrete surfaces to receive stucco dash coat finish, where ply wood or other smooth forms have been furnished, shall be uniformly sandblasted with sharp quartez sand under sufficient air pressure to remove dirt, form oil and other foreign materials, and roughen surface to provide a proper bond. Such surfaces shall be thoroughly washed with clean water after sandblasting.

D. Abrasive: Concrete stair treads, landings, ramps and steps on interior and exterior of buildings, and interior exposed concrete floors in shop buildings shall receive an abrasive finish.

* + 1. Floor Hardener: Exposed interior concrete floors throughout shall be treated with floor hardener.

1. Protect adjacent surfaces. Clean surfaces to receive treatment in accordance with manufacturer’s instructions, ensuring that all stains, oil, grease, form release agents, laitance, dust and dirt are removed prior to application.

2. Apply hardener in accordance with manufacturer’s instructions as soon as concrete is firm enough to work on after final troweling.

* + 1. Cement Grout and Dry-Pack Concrete: Cement grout shall be mixed at the Project site and shall be composed of one volume of Portland cement and 2-1/2 volumes of fine aggregate. Materials shall be mixed dry with sufficient water added to make mixture flow under is own weight. When grout is used as a dry pack concrete, add sufficient water to provide a stiff mixture, which can be molded into a sphere.

G. Broom Finish: Exterior stair treads and landing shall be provided with a non-slip groom finish in addition to abrasive finish specified.

H. Abrasive Stair Nosing: Nosing shall be installed according to manufacturer’s written recommendations.

**3.06 EXPANSION AND CONSTRUCTION JOINTS**

A. Construction Joints: Details and proposed location of Construction joints shall be indicated on the Drawings, located to least impair strength of structure, in accordance with the following:

1. Thoroughly clean contact surface by sand blasting entire surface not earlier than 5 days after initial placement.

2. A mix containing same proportion of sand and cement provided in concrete plus a maximum of 50 percent of coarse aggregate shall be placed to a depth of at least one inch on horizontal joints. Vertical joints shall be wetted and coated with a neat cement grout immediately before placing of new concrete.

3. Should contact surface become coated with earth, sawdust, or deleterious material of any kind after being cleaned, entire surface shall be re-cleaned before applying mix.

B. Expansion Joints: Provide expansion joint where indicted in walks and exterior slabs. Space approximately 20 feet apart, unless otherwise indicated. Joints shall extend entirely through slab with joint filler in one piece for width of walk or slab. Joint filler shall be 3/8 inch thick, unless otherwise indicated.

C. Tooled Joints: Slabs, walks and paving shall be marked into areas as indicated with markings made with a V-grooving tool. Marks shall be round-edged, free from burrs or obstructions, with clean cut angles and shall be straight and true. Walks, if not indicated, shall be marked off into rectangles of not more than 12 square feet and shall have a center marking where more than 5 feet wide.

**3.07 TESTING**

A. Molded Cylinder Tests:

1. Testing lab personnel will prepare cylinders and perform slump tests. Samples for concrete strength shall be taken in accordance to ASTM C172. Each cylinder shall be dated, given a number, point in structure form which sample was obtained, mix design number, mix design strength and result of accompanying slump test noted.

2. Separate tests of molded concrete cylinders obtained at same place and time shall be made at age of 3 days, 7 days, and 28 days. A strength test shall be the average of the compressive strength of 2 cylinders, obtained from the same sample of concrete and tested at 28 days or at test age designed for determination of fc.

3. Test cylinders shall be prepared at the Project site and stored in testing laboratory in accordance with ASTM C31, and tested in accordance with ASTM C39.

B. Core Test: At request of the Architect, cores of hardened concrete shall be cut from portions of hydrated structures for testing, in accordance with CBC and ASTM C42.

1. Provide 4 inch diameter cores at representative places throughout the structure as designated by the Architect.

2. In general, provide sufficient cores to represent concrete placed with at least one core for each 4,000 square feet of building area, and at least 3 cores total for each Project.

3. Where cores have been removed, fill voids with drypack, and patch the finish to match the adjacent existing surfaces.

C. Concrete Consistency: Measure consistency according to ASTM C143. Test twice each day or partial day’s run of the mixer.

D. Adjustment of Mix: If the strength of any grade of concrete for any portion of Work, as indicated by molded test cylinders, falls below minimum 28 days compressive strength specified or indicated, adjust mix design for remaining portion of construction so that resulting concrete meets minimum strength requirements.

E. Air Content Testing: Measure in accordance ASTM C173 or ASTM C231, for each composite sample taken in accordance to ASTM C172.

F. Defective Concrete:

1. Should strength or any grade of concrete, for any portion of Work indicated by test of molded cylinders and core tests, fall below minimum 28 days strength specified or indicated, concrete will be deemed defective Work and shall be replaced or adequately strengthened I a manner acceptable to the Architect, DSA and Owner.

2. Concrete Work that is not formed as indicated, is not true within 1/250 of span, not true to intended alignment, not plumb or level where so intended, not true to intended grades and levels, contains sawdust shavings, wood or embedded debris, or does not fully conform to the Contract provisions, shall be deemed to be defective Work and shall be removed and replaced.

G. Concrete for Equipment Pads, Mechanical and Electrical Work: Unless otherwise indicated, strength shall have a minimum fc=3000 psi. Exposed concrete shall be provided with a hand trowel finish and with radius corners and edges. Form and place concrete where necessary as described in Section 03 10 00: Concrete Forming and Accessories, and reinforced as described in Section 03 20 00: Concrete reinforcing. Calcium chloride shall not be furnished in any concrete mix provided for the installation of underground electrical conduits. For concrete encasement of more than one conduit, furnish ¾ inch maximum aggregate.

**3.08 CLEAN UP**

A. Remove rubbish, debris and waste materials and legally dispose of off the Project site.

**3.09 PROTECTION**

1. Protect the Work of this section until Substantial Completion.
2. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
3. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

**END OF SECTION**