# PART 1 - GENERAL

## 1.1 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes, for the following:

1. Preparation and grading of earth subgrade under concrete.
2. Furnishing, erection, and removal of forms.
3. Furnishing and placing reinforcing for cast-in-place concrete.
4. Finishing and final curing of cast-in-place concrete.
5. Reinforcing bars for masonry.
6. Furnishing and placing reinforcing for precast concrete fabricated at the site.
7. Concrete and reinforcement in piles or caissons.
8. Gravel fill under interior floor slabs.
9. Subslab drainage fill.
10. Insulating concrete.
11. Formed concrete stairs.
12. Grouting of masonry.
13. Metal decking.
14. Furnishing, placing, patching, and initial curing of cast-in-place concrete unless otherwise specified.
15. Grout and drypack, except as otherwise specified.
16. Placing of embedded anchor bolts and inserts.
17. Vapor barrier under interior floor slabs on grade.
18. Waterstops including testing.
19. Miscellaneous concrete work, including but not limited to areaways, cast-in-place valve boxes, pits, splash blocks, equipment bases, rigid foam and other items as shown or required to complete all Work.
20. Slurry concrete.

B. Related Sections include the following:

1. Section 018113 “Sustainable Design Requirements.
2. ”Division 2 Sections "Earthwork" and “Foundation Drainage” for preparation and drainage at foundations and under slabs-on-grade.
3. Division 2 Section “Concrete Walks” for site concrete work.
4. Division 3 Sections “Concrete Formwork” and “Concrete Reinforcement.”
5. Division 5 through 13 Sections for embedded items cast into concrete.
6. Division 7 Section 072616 for waterproofing systems below grade.
7. Division 14, 15, and 16 Sections for embedded items cast into concrete.

## 1.2 SUBMITTALS

A. General: Comply with division 1 section “Shop Drawings, Product Data, and Samples.”

B. LEED Submittals: Credits MRc4 & MRc5. Refer to Section 018113 “Sustainable Design Requirements” for additional submittal requirements.

C. Shop Drawings: Submit shop drawings for all horizontal and vertical concrete showing dimensioned locations of all construction, control, and expansion joints. Show pour sequencing. Show details for constructing construction and expansion joints, and method of keying.

1. The contractor shall also submit a shop drawing showing all locations of embeds, inserts, etc. for review and approval by the University's representative prior to the concrete pour.

D. Samples:
1. Construct minimum 4'-0" by 4'-0" mock-up of each type of smooth-form concrete finish that will be exposed to view, including horizontal (floor) and vertical (wall) surfaces, slab edge (4'-0" long), and stairs (three risers and treads), showing typical form joints, reveals, surface finish, texture, tolerances, and standard of workmanship. Mock-up is required for concrete finish to be exposed, and for concrete finish to be exposed and painted.
2. Comply with requirements specified in Section 013400.

E. Certificates: Certify that materials meet requirements of paragraph "Quality Assurance".

F. Delivery Tickets: With each transit truck, provide delivery ticket, sighed by an authorized representative of the batch plant, containing all information required by ASTM C94, as well as time batched, type and brand of cement, cement content, maximum size of aggregate and total water content.

G. Provide written verification of fly ash content of cement.

1.3 QUALITY ASSURANCE

A. Comply with division 1 section "Quality Control."

B. Compliance with Regulations: All materials shall comply with the Applicable Code Requirements, including, but not limited to, rules regarding volatile organic compounds, and with FDA rules and regulations for dangerous substances in construction products.

C. Concrete Manufacturer: Furnish concrete from licensed commercial ready-mix concrete plants conforming to ASTM C94 and approved by University's Representative. Requirements herein govern when exceeding ASTM C94.

D. Allowable Tolerances: Construct concrete conforming to the tolerances specified in ACI 117 "Recommended Tolerances for Concrete Construction and Materials", as applicable, unless exceeded Applicable Code Requirements or otherwise indicated or specified.

E. Source Quality Control: Refer to the following paragraphs for specific procedures. Concrete materials which, by previous tests or actual service, have shown conformance may be used without testing when so approved by the University's Representative. The University's Testing Laboratory shall perform following conformance testing.
1. Portland Cement: Furnish Mill Certificates, acceptable to University's Representative, showing conformance with requirements specified; otherwise, the Testing Laboratory shall test each 250 barrels of cement in accordance with ASTM C150.
2. Aggregate For Normal Weight Concrete: Test the aggregate before and after concrete mix is designed and whenever character of aggregate varies or source of material is changed. Include a sieve analysis. Obtain samples of aggregates at the dry batching or ready-mix concrete plant in accordance with ASTM D75 and perform tests for the following properties:

| PHYSICAL PROPERTIES | | |
|---|---|---|
| Physical Properties, units | Test Method | Minimum values |
| Sieve analysis | ASTM C136 | |
| Organic impurities | ASTM C40 | Fine aggregate not darker than reference standard color |
| Soundness | ASTM C88 | Loss after 5 cycles not more than 8 percent of coarse aggregate, nor more than 10 percent of fine aggregate |
| Abrasion | ASTM C131 | Weight loss not more than 10.5 percent after 100 revolutions, 42 percent after 500 revolutions |
| Deleterious materials | ASTM C33 | |
| Materials finer than No. 200 sieve | ASTM C117 | Not over 1 percent for gravel, 1.5 percent for crushed aggregate |
| Reactivity potential | ASTM C227, C289, C342 | Ratio of silica released to reduction in alkalinity not to exceed 1.0. |
| Sand equivalent | ASTM D2419 | California sand equivalent values operating range not below 71 percent |

3. Lightweight Aggregates: Test the lightweight aggregates before mix is designed and whenever the character of aggregate varies or source is changed in accordance with ASTM C330. Include a sieve analysis and report on unit weights, deleterious substances, unburned or underburned lumps, loss on ignition, soundness, and staining materials.

1.4 CONCRETE MIX DESIGNS: The University's Testing Laboratory shall design concrete mixes for concrete requiring 28-day compressive strength exceeding 2,000 psi.

A. Strength Requirements: Design mixes for structural concrete for minimum 28-day compressive strengths required by Drawings and Specifications. All mix designs for structural concrete shall be proportioned in accordance with Section 4 of ACI 301. If trial batches are used, the mix design shall be prepared by an independent testing laboratory and shall achieve an average compressive strength 1,200 psi higher than the specified strength. This over-design shall be increased to 1,400 psi when concrete strengths over 5,000 psi are used.

B. Basis of Mix Designs: Design all mixes for workability and durability of concrete. Control mixes in accordance with ACI 301. Make adjustments in water/cement ratios as necessary for required concrete strengths at the Contractor's expense. Calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions are not permitted.

C. Maximum Aggregate Sizes: Not exceeding 3/4 of minimum clear space between bars and between bars and forms, nor larger than 1/5 of least dimensions between the forms. Design the mixes with 3/4" maximum size, except maximum 1-1/2" size for foundations and maximum 3/8" size at congested reinforcing or thin sections, when approved by the University's Representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver all materials in timely manner to ensure uninterrupted progress of the Work

B. Store materials by methods that prevent damage and permit ready access for inspection and identification.

C. General: comply with division 1 section "Material & Equipment."

1.6 PROJECT SITE CONDITIONS

A. Do not place concrete during rain or adverse weather conditions without means to prevent all damage. Conform to requirements specified hereinafter whenever concrete placement is required during cold or hot weather.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Portland cement: Use ASTM C150, Type II cement from one approved source for all other concrete as indicated and approved by the University's Representative.

B. Aggregates:
1. Normal weight aggregates: ASTM C33.

C. Admixtures:
1. Chemical (Water Reducing) Admixture: ASTM C494, Type A, D, or E. Only one brand. When used, are subject to approval of University's Representative, and must reduce the mixing water at least 10 percent without entraining air in excess of 2 percent by volume. If the water reducing agent entrains more than 2 percent air, the water reduction shall be at least 12 percent, but in no case shall the water reducing agent entrain air in excess of 4 percent.
2. Pozzolan: ASTM C618, Class F or C Fly Ash, 100 pounds maximum per cubic yard, containing 1 percent or less carbon. Fly ash shall not be used in excess of 15 percent at foundation and 10 percent at all other locations, measured by percentage weight of total cement quantity.
3. Super-Plasticizers (High Range Water Reducers): ASTM C494, Type F or G. Master Builders "Rheobuild", Euclid "Eucon 37" or equal, capable of producing concrete which can be placed at 8-11 inch slump without segregation, capable of maintaining slump

within 2" of that initially mixed for 2 hours, and of maintaining concrete temperature within 2 degrees F. from time of batching for 2 hours minimum.

D. Water: From potable domestic source.

E. Curing Materials:
1. Liquid Curing compound: ASTM C309, Type I, Class B, W.R. Meadows 1100 Series, Master Builders "Mastercure W", or equal, complying with Rule 1113 of the South Coast Air Quality Management District and Federal Air Quality Regulation 40 CFR 52.254.
2. Curing sheet: ASTM C171, non-staining white types.
3. Evaporation retardant and finishing aid: Master Builders "Confilm", Euclid "Eucobar", or equal.

F. Non-shrink grout: Conform to Corps of Engineers CRD-C 621, and as follows:
1. Metallic for concealed areas: Master Builders "Embeco 885", or equal, non-gas-forming and free of oxidizing catalysts and inorganic accelerators, used as dry or damp pack, or mixed to a 20-second flow (CRC-C 621), without segregation or bleeding at any temperature between 45 degrees F and 100 degrees F. Working time 30 minutes or more.
2. Non-metallic for exposed areas: Master Builders "Masterflow 928", or Euclid "Euco Hi-Flow Grout", or equal. with same characteristics as specified for concealed areas.
3. Epoxy grout where indicated: Multi-component, premeasured, fast-curing combination of thermosetting resins and inert fillers, Master Builders "Ceilcote 648", Sikadur 42 Industrial Group-Pak by Sika Chemical Corporation, or Euclid "Euco High Strength Grout", or equal.

G. Drypack: Field mixture of 1 part Portland cement to 2 parts fine aggregate mixed to a damp consistency such that a ball molded in the hands will stick together and hold its shape. At Contractor's option, the specified admixture may be added for increased workability at lower water/cement ratio. In lieu of field mixing, Contractor may use factory mixed drypack material, such as Master Builders "SetGrout" or Euclid "Euco Dry Pack Grout", or equal.

H. Waterstops: Williams Product Inc. "Efficiency Waterstops", Gates Rubber Co. "Kwik-Seal Waterstops", Electrovert Inc. "Durojoints" or "Duroseal", or equal, neoprene or polyvinyl chloride types shown, joints per manufacturer's directions. For walls, flat ribbed type, minimum 6" width by 3/8" thick at center with minimum 7 ribs each side of each flange. For slabs, ribbed center bulb type, minimum 9" wide by 3/8" thick next to bulb, minimum 9 ribs on each side of each flange, bulb minimum 1/2" ID and 7/8" OD.

I. Expansion Joint Filler: Asphalt impregnated fiber or non extruding foam type, conforming to ASTM D994 and D1751, or D1752.

J. Construction Joint Materials: "Key-Kold" or "Kwik-Joint", or equal, of profiles indicated.

K. Bonding Agent: "Weld-Crete", manufactured by Larsen Products Co., P.O. Box 2127, Rockville, MD 20852, Master Builders "Concresive", or equal.

L. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

M. Rigid Foam: “Insulfoam” Type 1 expanded polystyrene (EPS) foam plastic boards by Premier

Industries, Inc./dba Insulfoam, 1019 Pacific Ave., Ste. 1501, Tacoma, WA 98402, or approved equal.

N. Compressible Foam: Where “compressible foam” or “compressible filler” is specified on the structural drawings, provide “Ceramar” Flexible Foam Expansion Joint by W.R. Meadows, P.O. Box 338, Hampshire, IL 60140, or approved equal meeting the following properties:
   1. Closed cell and water absorption < 0.5% by volume per ASTM D 545
   2. 10% minimum and 25% maximum compressibility at a pressure equal to 3 psi.
   3. Resilience: Deformation recovery > 99%.
   4. Resistant to fungus and bacterial growth.

## 2.2 CONCRETE MIXING

A. Furnish ready-mixed concrete from an approved concrete batch plant. Conform to ASTM C94, except materials, testing, and mix designs as specified herein. Use transit mixer trucks equipped with automatic devices for recording number of revolutions of drum.

B. Admixtures: All approved admixtures shall be introduced into the concrete at the batch plant. Field additions are not acceptable.

C. Slump: Adjust quantity of water so concrete at point and time of placing does not exceed the following slumps when tested according to ASTM C143. Use the minimum water necessary for workability required by part of structure being cast.

| SLUMP AND WATER/CEMENT RATIOS | | |
|---|---|---|
| Part of Structure | Maximum Slump Inches | Maximum Water-Cement Ratio |
| Footings, foundation walls, and mass concrete, not reinforced | 4 +/- 1” | 0.5 |
| Slabs on grade, reinforced and non-reinforced | 4 +/- 1” | 0.45 |
| Reinforced concrete over 8" thick | 4 +/- 1” | 0.5 |
| Reinforced concrete 8" or less thick | 4 +/- 1” | 0.5 |
| All other concrete | 4 +/- 1” | 0.5 |

# PART 3 - EXECUTION

## 3.1 PREPARATION FOR CONCRETE PLACING

A. Remove all free water from forms before concrete is deposited. Remove hardened concrete, debris, and foreign materials from interior surfaces of forms, exposed reinforcing, and from surfaces of mixing and conveying equipment.

B. Wetting: Wet wood forms sufficiently to tighten up cracks. Wet other materials sufficiently to reduce adsorption and to help maintain concrete workability.

C. Earth Subgrade: Dampen 24 hours before placing concrete, but do not muddy. Re-roll where necessary for smoothness and remove loose material.

D. Gravel Fill: Recompact disturbed gravel and bring to correct elevation.

E. Sand Beds or Subslab Drainage Fill: Recompact disturbed material and bring to correct elevation.

F. Vapor Barrier. Install under interior floor slabs on grade. Lap joints 6" in the direction of concrete spreading and tape seal. Seal the joints at walls and around penetrations with tape. Cover barrier with 2" layer of clean damp sand.

G. Screeds: Set screeds at walls and maximum 8-foot centers between. Set to provide level floor. Check with an instrument level, transit, or laser during placing operation to maintain level floor.

H. Screeds Over Vapor Barrier: Use weighted pad or cradle type screeds and do not drive stakes through the vapor barrier. Check with an instrument level, transit, or laser.

I. Metal Floor Decking: Verify that decking joints are sealed and there are no openings or voids that will permit concrete leakage.

J. Composite Steel Beams: Furnish and install shores for tributary construction loads to floor and roof beams as required, or camber the beams as approved by University's Representative.

K. Expansion Joint Filler: Install where slabs abut buildings and elsewhere as indicated. Install full depth of concrete with top level with finished surface of concrete.

## 3.2 CONCRETE PLACING

A. Conveying and Placing: Do not place concrete until the reinforcing steel, forms, including embedded items for work specified in other Sections, or metal decking have been approved. Do not use aluminum tubes or any aluminum equipment for pumping concrete, nor allow concrete to free fall from its point of release at mixer, hoppers, tremies, or conveying equipment more than 6 feet for concealed concrete and 3 feet for exposed concrete. Deposit concrete so that the surface is kept level throughout, a minimum being permitted to flow from one portion to another. Place concrete in horizontal layers not more than 18" thick within 45 minutes after water is first added to the batch. Place concrete by methods that prevent segregation of materials.

1. Where new concrete is placed against or on old or existing concrete, apply bonding agent to properly prepared surface of old concrete prior to placement of new concrete.

B. Joints In Concrete: Locate joints only where approved, and obtain prior approval for points of stoppage of any pour. Clean and roughen the surface of construction joints by removing the entire surface and exposing 1/4" amplitude of clean aggregate solidly embedded in mortar matrix by sandblasting, chipping, use of an approved surface retarder, or equal. Water and keep hardened concrete wet for not less than 24 hours and slush with Portland cement slurry just before placing joining concrete. Cover horizontal surfaces of existing or previously placed and hardened concrete with a 2" thick layer of fresh concrete less 50% of coarse aggregate just before balance of concrete is placed.

1. Exception: When using super-plasticizers, the free fall, horizontal layer thickness and time limitations may be doubled.

C. Compacting: Compact each layer of the concrete as placed with mechanical vibrators or equivalent equipment. Transmit vibration directly to concrete and in no case through the forms unless approved. Accomplish thorough compaction. Supplement by rodding or spading by hand adjacent to forms. Compact concrete into corners and angles of forms and around reinforcement and embedded fixtures. Recompact deep sections with congestion due to reinforcing steel as required.

D. Operation of Vibrators: Do not horizontally transport concrete in forms with vibrators nor allow vibrators to contact forms or reinforcing. Push vibrators vertically into the preceding layers that are still plastic and slowly withdraw, producing maximum obtainable density in concrete without creating voids or segregation. In no case disturb concrete that has partially set. Vibrate at intervals not exceeding two-thirds the effective visible vibration diameter of the submerged vibrator. Avoid excessive vibration that causes segregation. Use and type of vibrators shall conform to ACI 309 "Recommended Practice for Consolidation of Concrete".

E. Correction of Segregation: Before placing next layer of concrete, and at the top of last placement for vertical elements, remove concrete containing excess water or fine aggregate or showing deficiency of coarse aggregate and fill the space with compacted concrete of correct proportions.

F. Waterproof Membranes: Perform work adjacent to waterproof membranes to prevent damage to membranes. Arrange work so that membrane is left unprotected for minimum period of time, as approved. Prior to placing concrete, inspect the membrane and arrange for repair to all damage, which may have occurred.

G. Slabs
1. Float Finish: Place, consolidate, strike off and level concrete slab to proper elevation. Use highway straightedge, bull float or darby. Remove all bleed water. After the concrete has stiffened sufficiently to permit the operation, and water sheen has disappeared, the surface shall be floated, at least twice, to a uniform sandy texture. Remainder of finishing operations shall be as specified in paragraph 3.13 for each type of surface.
2. On-Grade Slabs: Generally locate joints on column lines, exact locations as approved by University’s Representative. Submit joint locations and pour sequence for review and approval by University’s Representative.
3. On-Grade Slab Construction and Contraction Joints: Use types as indicated at column lines intermediate locations.
4. Expansion Joints: Conform to details and approved submittal. Furnish and install expansion joint filler finished flush with slab surface except for those joints shown to be sealed with sealant. Conform to Section 079200 where sealant sealed joints are shown or specified, including the polymer joint filler, backing, and bond breaker.
5. Control Joints: Provide for concrete slabs as indicated. At Contractor's option, "Soff-Cut" saw may be used to depth of 1-1/4" immediately providing spalling or undercutting of the concrete does not occur, and in no case shall slab reinforcement be cut or damaged. Conventional saws shall be used as soon as possible without dislodging aggregate to 1/4 slab thickness. Complete sawing of joints within 12 hours after finishing is completed. If early sawing causes undercutting or washing of the concrete, delay the sawing operation and repair the damaged areas. The saw cut shall not vary more than 1/2 inch from the true joint alignment. Discontinue sawing if a crack develops ahead of a saw cut. Immediately after each joint is sawed, thoroughly clean the saw cut and adjacent concrete surface. Respray surfaces treated with curing compound, which are damaged during the sawing operations as soon as the water disappears. Protect joints in a

manner to prevent the curing compound from entering the joints. Conform to approved submittal.

3.3 COLD WEATHER PROVISIONS

A. Normal Concrete: When the temperature is below 40 degrees F. the temperature of the concrete placed in the forms shall be at least 60 degrees F. When the temperature is below 30 degrees F. the temperature of the concrete as mixed shall be 65 degrees F. In all cases, when the daily average temperature is below 40 degrees F. the concrete shall be kept at 55 degrees F. for the 72 hours and then allowed to drop uniformly to the air temperature over the next 24 hours.
   1. Concrete temperature shall be measured by placing a thermometer 2" from the top of the concrete being placed.

B. No calcium chloride shall be used to accelerate hardening of concrete. Contractor to certify that any additive used does not contain calcium chloride.

C. If low temperature accelerating admixture is proposed, adjust concrete mix as required and obtain approval of University's Representative.

D. All concrete materials, reinforcement, forming materials and ground with which concrete is to come in contact shall be free of frost.

E. The covering or other protection used in connection with the curing shall remain in place and intact for at least 24 hours.

F. The work shall be protected from the elements, flowing water, and defacements of any nature during the construction operations.

G. Conform to the provisions of A.C.I. 306, Recommended Practice for Cold Weather Concreting, except as modified herein.

3.4 HOT WEATHER PROVISIONS

A. Conform to ACI 305R and the following requirements.

B. Take extra care to reduce the temperature of the concrete being placed, and to prevent rapid drying of newly placed concrete. When the outdoor ambient temperature is more than 90 degrees F., shade the fresh concrete as soon as possible after placing, and start curing as soon as the surface of the fresh concrete is sufficiently hard to permit it without damage.

C. Concrete placement temperatures shall be controlled by the Contractor and shall not be limited to:
   1. Shading and cooling the aggregate;
   2. Avoiding use of hot cement;
   3. Cooling mixing water by additions of ice;
   4. Insulating water supply lines and tanks; and
   5. Insulating mixer drums or cooling them with sprays or wet burlap.

3.5 CURING FORMED CONCRETE

A. Keep forms containing concrete in a wet condition until removed. Keep concrete continuously moist for not less than 7 days after placement. Keep concrete moist with a fine fog water spray until protected by curing media.

B. During times of dry or excessive winds, high ambient temperature, low humidity, or other ambient conditions causing rapid drying, use specified evaporation retardant and finishing aid material according to the manufacturer's instructions and cure concrete with a fine fog spray of water, or equal, applied both during and after finishing and continued until final curing operations are started.

C. Use the water curing method, curing sheet material, or a clear liquid membrane-forming curing compound except as otherwise specified.

D. Do not use any type of finishing or curing materials or methods that interfere with the correct application or bonding of subsequent materials; verify exact requirements as they apply to all applicable materials.

## 3.6 PATCHING FORMED CONCRETE

A. Remove fins, projections, and offsets. Cut out rock pockets, honeycomb, and all other defects to sound concrete, with edges of cuts straight and back-beveled. Dampen cut-outs and edges, and scrub with neat Portland cement slurry just before patching, or an apply approved epoxy concrete adhesive.

B. Saturate form tie holes with water and fill voids and patches with flush smooth-finished mortar of same mix as concrete (less coarse aggregate), cure, and dry.

## 3.7 GROUTING AND DRYPACKING

A. Install as indicated or required. Where grouting and drypacking is part of the work of other sections, it shall conform to the following requirements, as applicable.

B. Drypacking: Mix materials thoroughly with minimum amount of water. Install drypack by forcing and rodding to fill voids and provide complete bearing under plates. Finish exposed surfaces smooth and cure with damp burlap or liquid curing compound.

C. Non-Shrink Grouting:
1. Mixing: Mix the approved non-shrink grout material with sufficient water per manufacturer’s recommendations.
2. Application: Surfaces to receive the non-shrink grout shall be clean, and shall be moistened thoroughly immediately before placing the mortar. Before grouting, surfaces to be in contact shall be roughened and cleaned thoroughly, all loose particles shall be removed and the surface flushed thoroughly with neat cement grout immediately before the grouting mortar is placed. Place fluid grout from one side only and puddle, chain, or pump for complete filling of voids; do not remove the dams or forms until grout attains initial set. Finish exposed surfaces smooth, and cure as recommended by grout manufacturer.

## 3.8 SITE CONCRETE WORK

A. Use bituminous type joint filler. Cure all concrete for at least 10 days with liquid curing compound or sheet material except as otherwise specified. Construct all site concrete of 2,000 psi concrete unless otherwise indicated or specified. Furnish and install reinforcing bars or mesh only where indicated. Conform to requirements specified hereinbefore for slab finishing and curing as applicable.

B. Concrete Curbs: Provide 1/2" thick expansion joints, at beginning and at end of curves, intersections, and 20-foot intervals between, set plumb, square, and to same profile as the curbs. Edge curb tops to 1/2" radius and vertical joints to 1/4" radius. Comply with Division 2 Section “Combination Curb and Gutter.”

C. Concrete Gutters: Provide 1/2" thick expansion joints as above for curbs and apply a light broom finish with a 3" wide steel trowel finish at flow line. Comply with Division 2 Section “Combination Curb and Gutter.”

D. Combination Curb and Gutter: As above for curbs and gutters, including expansion joints, 3" troweled flow line at base of curb. Comply with Division 2 Section “Combination Curb and Gutter.”

E. Concrete Walks: Provide 1/2" expansion joints as specified for curbs and where walks abut rigid structures, aligned with joints in curbs where adjoining, comply with and finish according to Division 2 Section “Concrete Walks.”

F. Control Joints: Comply with Division 2 Sections “Combination Curb and Gutter” and “Concrete Walks.”

## 3.9 OFF-SITE CONCRETE WORK

A. Furnish and install new concrete items where indicated, and replace existing items damaged by Contractor's operations. Secure and pay for required permits, inspections, engineering, and surveying.

## 3.10 SLURRY CONCRETE

A. Slurry concrete shall be used as fill or backfill where indicated, and wherever excavations are carried below design depths without approval. Slurry concrete shall be placed within 1 hour after mixing, and shall be placed in manner that will prevent voids in, or segregation of, the concrete.

B. Backfilling over slurry concrete shall not be done less than 4 hours after placing.

## 3.11 INSTALLATION OF WATERSTOPS

A. Heat fuse waterstop joints and connections in accordance with manufacturer's instructions including heating tools and devices. Run waterstops continuous in joints, following offsets and angles in joints until spliced to waterstops at intersecting joints, completely sealing the structure. Align and center waterstops in joints unless otherwise indicated.

B. Tie flanges to reinforcing with 18 gage wire ties spaced at maximum 18" intervals. Test all waterstops, including splices, intersections, and welds, with approved holiday spark detector before concrete is placed.

C. Install approved waterstops in all exterior wall cold joints below the Ground Level.

## 3.12 FIELD QUALITY CONTROL

A. Flatness and Levelness of Floors: Floors shall be measured for levelness and flatness as indicated below. Measurements shall be made within 24 hrs after placement of the slab and shall be reported to the University's Representative as soon as possible and not later than 72 hrs after installation. All tests are to be performed prior to removing shoring. Proposed sectional boundries for taking measurements shall be submitted to the architect for review and approval prior to pouring the slabs. In general, use one-half bay spacings, control and cold joint locations for sectional boundaries.
   1. Concrete Slab Over Metal Deck: Use a minimum Ff value of 20.
   2. Poured in Place and Shored Slabs: Use a minimum Ff/Fl value of 20/17.
   3. Ff and Fl values shall be defined per ACI 302.1R. Where these tolerances are not met it shall be immediately brought to the University Representative's attention. Remedial measures can be conducted with approval of the University's Representative but should remedial measures not be possible, the Contractor shall remove and replace the portions of the slab that are not in conformance at the Contractor's expense.

B. Continuous Inspection: Construct structural concrete exceeding 2,000 psi compressive strength under continuous inspection of Inspector. Obtain inspection and approval of forms and reinforcing by University's Representative as required and by the Inspector before placing structural concrete.

C. Testing of Concrete: University's Testing Laboratory shall perform following tests. Samples for testing shall be obtained in accordance with ASTM C172, and shall be taken from as close to point of placement as possible.
   1. Compressive Strength Tests: Cast one set of three or more cylinders from each day's placing and each 150 cubic yards, or fraction thereof, or not less than once for each 2,000 square feet of surface area for slabs and walls, of each strength of structural concrete. Date cylinders, assign record number, and tag showing the location from which sample was taken. Also record slump test result of sample. Do not make more than two series of tests from any one location or batch of concrete.
   2. Test Cylinders: Samples will be made in accordance with ASTM C172. Cast cylinders according to ASTM C31; 24 hours later, store cylinders under moist curing conditions at about 70 degrees F. Test according to ASTM C39 at 7 and 28-day ages. The remaining cylinder shall be kept in reserve in case tests are unsatisfactory.
   3. Control Test Cylinders: Cast a set of two or more cylinders for each day's placing of concrete for slabs supported on shoring. Place test cylinders on slabs represented by cylinders and cure the same as slabs. Test cylinders to determine proper times for removal of shores and reshoring. A strength test shall be the average of the compressive strengths of 2 cylinders made from the same sample of concrete and tested at 28 days.

D. Core Tests: If tests show the compressive strength of any concrete falls below the required minimum, additional testing of concrete which unsatisfactory tests represent may be required. Make core tests at approved locations according to ASTM C42. Fill core holes with drypack concrete of strength required for concrete. Contractor shall bear cost of tests for below-

strength concrete even if such tests indicate concrete has attained required minimum compressive strength, and all costs for required corrections.

3.13 FINISH OF FORMED SURFACES

A. Rough Form Finish:
   1. Provide rough form finish to all concrete formed surfaces that are to be concealed in the finish Work or by other construction, unless otherwise shown or specified.
   2. Rough form finish shall be the concrete surface having the texture imparted by the form facing material used, with the defective areas repaired and patched as specified, and all fins and other projections exceeding 1/4" in height rubbed down.

B. Smooth Form Finish:
   1. Provide smooth finish for formed concrete surfaces that are to be exposed-to-view or that are to be covered with a coating applied directly to concrete or a covering material bonded to concrete such as waterproofing, dampproofing, painting, or other similar system.
   2. Smooth finish shall be as-cast concrete surface as obtained with the form facing material, with defective areas repaired and patched, and all fins and other projections on the surface completely removed and smoothed.
   3. Fill voids and form tie holes at membranes and where exposed, to produce an even finished appearance consistent with smooth-form finish.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.14 MONOLITHIC SLAB FINISHES

A. Score exterior slabs in pattern as indicated, at least 3/4" deep, not over 3/8" wide, using Goldblatt 06 300 tool, or equal, modified for 1" overall width; provide samples for observation.

B. Float Finish:
   1. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes specified and slab surfaces shown or scheduled for waterproofing, and roofing.
   2. After placing concrete slabs, consolidate the surface with power-driven floats, or by hand-floats, or by hand-floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance of 1/4" in 10'. Cut down high spots and fill all low spots. Immediately after leveling, refloat the surface to a uniform, smooth granular texture, free of voids.

C. Scratch Finish:
   1. Apply scratch finish to monolithic slab surfaces that are to receive mortar setting beds for pavers.
   2. After placing slabs, plane surface to a tolerance not exceeding 1/4 inch in 2 feet when tested with a 2-foot straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set, with stiff brushes, brooms, or rakes.

D. Trowel Finish:

1. Apply trowel finish to interior monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and slab surfaces that are to be covered with resilient flooring, carpet, paint, or other thinfilm finish coating system, including sealer.
2. Consolidate the concrete surface by suitable methods to produce surfaces free of trowel marks, uniform in texture and appearance and with a surface plane tolerance not exceeding 1/8 inch in 10 feet when tested with a 10-foot straightedge. Grind smooth surface defects, which would telegraph through applied floor covering system.

E. Slip-Resistive Finish Broadcast Applied: Before final floating, apply slip resistive aluminum granule finish to Stair 1, 2 and 3 concrete stair treads and landing platforms, the exterior walkway to Stair 2, and where indicated.
1. Uniformly spread 25 lb per 100 sq. ft. of dampened slip-resistive aluminum granujles over surface in one or two applications. Tamp aggregate flush wit surface, but do not force below surface.
2. Immediately after broadcasting and tamping, apply float finish.
3. After curing, lightly work surface with a steel wire brush or an abrasive stone and water to expose slip resistive aluminum granules.

F. Slip-Resistive Broom Finish:
1. Apply slip-resistive broom finish to exposed concrete walking surfaces not indicated to have aggregate finish specified in 3.14(E), ramps, and vehicle traffic areas.
2. Immediately after trowel finishing, roughen the concrete surface by brooming (corrugations not over 1/8 inch deep) in straight lines in direction perpendicular to the main traffic route. Coordinate the required final finish with the University's Representative before application.

G. At electrical and mechanical items in concrete slabs, carefully hand finish at least 24 inches around recessed items so that the top of the fill and the electrical devices are flush after the concrete has set.

## 3.15 WASTE MANAGEMENT

A. Concrete Form Work:
1. Subject to other requirements, reuse formwork where possible, on site or elsewhere.
2. Separate, reuse, and recycle waste materials in accordance with the Waste Management Plan. Subject to other requirements, form lumber may be reused on the job for framing, blocking, etc.
3. Comply with Waste Management provisions of Division 6 Section "Rough Carpentry."

B. Reinforcing Steel: Collect and place in designated area for recycling.

C. Cast-in-Place Concrete:
1. Before concrete pours, designate locations or uses for excess concrete. Any selected options must be approved by the University's Representative.
2. Before concrete pours, designate a location for cleaning out concrete trucks. Options include:
a. Company-owned site for that purpose (which meets environmental standards).
b. On-site area to be paved later in Project.
3. Unused hardened concrete and droppings: Pulverize concrete to maximum 1-1/2-inch size. Recycle, use as fill, or legally dispose of in accordance with the Waste Management Plan.

END OF SECTION