DIVISION 3 – CONCRETE

03 30 00 CAST-IN-PLACE CONCRETE

1) Concrete Work Definitions and Applications:
   a. Exposed exterior flatwork shall be defined as the following:
      i. Sidewalks, curb, gutter, driveways, paving, landings, aprons, stairs, etc., and which are
         exposed to exterior freeze/thaw conditions, heavy deicer use and heavy snow removal
         equipment.
      ii. Use Concrete Mix Type 1 or 2 for these applications.
   b. Unexposed exterior flatwork shall be defined as the following:
      i. Flatwork exposed to ice and snow but not exposed to heavy deicer use or heavy snow
         removal equipment.
      ii. Use Concrete Mix Type 1, omitting waterproofing admixture, OR use Type 2 for these
          applications.
   c. Suspended slabs shall be defined as follows:
      i. All suspended concrete slabs or slabs on metal deck exposed to rain, snow, and ice, exterior
         freeze/thaw conditions, and/or deicer use, such as parking terraces, stairways, landings,
         bridges, etc.
      ii. Use Concrete Mix Type 1 for these applications. At contractor’s option, fiber reinforcing
          may be omitted.
   d. Buried tunnel section work shall be defined as follows:
      i. All cast-in-place buried tunnel sections, which shall include floor slabs, walls, and top slabs.
      ii. Use Concrete Mix Type 1 for these applications. At contractor’s option, fiber reinforcing
          may be omitted.

2) Submittals:
   a. Contractor shall submit concrete mix design(s), certifications, and all other required product spec
      sheets to engineer for review prior to any construction. Allow one (1) week for engineering review.
   b. No concrete shall be poured without prior written approval of all submittals.

3) Aggregate:
   a. General:
      i. Aggregates for all concrete shall come from a quarry that is DOT approved and meets or
         exceeds durability Class I aggregate. The quarry shall submit a letter to USU FPD&C that
         certifies that all aggregate complies with DOT requirements for durability. Aggregate not
         meeting DOT durability requirements shall not be used.
   b. Cleanliness:
      i. The concrete supplier shall submit written certification by an independent testing agency
         demonstrating that aggregates supplied meet this requirement.
         1. All fine aggregates shall have a Sand Equivalent (SE) value of not less than 80
            according to ASTM D2419 and/or AASHTO T176.
         2. All coarse aggregates shall have a Cleanliness Value (CV) of not less than 80
            according to California Department of Transportation Test 227.
c. Coarse Aggregate:
   i. 1” minus and well-graded crushed aggregate meeting ASTM C33. Aggregate shall be free of deleterious coatings and other materials and/or aggregate types causing pop outs, discoloration, staining, alkaline reactions or other defects within the concrete. The concrete supplier shall submit written certification by an independent testing source of aggregate testing and soundness in accordance with ASTM C33 with all concrete mix designs.

d. Fine Aggregate:
   i. Natural sand or blend of natural sand and crushed sand meeting ASTM C33. Crushed sand shall be less than 50% of the total sand by dry weight.

4) Cement:
   a. Portland Type I or Type II (Do not use Type I-A or II-A).

5) Pozzolans:
   a. Fly Ash: Type F meeting ASTM C618
   b. Silica Fume: Silica fume (or microsilica) meeting ASTM C1240 and/or AASHTO M307

6) Concrete Waterproofing Admixtures:
   a. Approved products:
      i. Penetron Admix as manufactured by Penetron International, Ltd.
      ii. Xypex Admix C-500 as manufactured by Xypex Chemical Corporation.
   b. Comply with all manufacturer’s instructions and recommendations.

7) Fiber Reinforcing:
   a. Approved products:
      i. ‘RSC15’ polyvinyl alcohol (PVA) fibers as manufactured by Nycon at a dosage rate not less than two (2) lbs. per cubic yard.
      ii. ‘Fibermesh 300’ polypropylene fibrillated fibers as manufactured by Fibermesh at a dosage rate not less than 1.5 lbs. per cubic yard.
      iii. ‘Econo-Net’ polypropylene fibrillated fibers as manufactured by Forta Corporation at a dosage rate not less than 1.5 lbs. per cubic yard.
      iv. Approved equals
   b. Comply with all manufacturer’s instructions and recommendations.

8) Compressive Strength:
   a. 4500 psi, minimum, at twenty-eight (28) days.

9) Water/Cement Ratio:
   a. As noted for each individual mix
   b. No additional water shall be permitted either in transit or on site.

10) Air Entrainment:
    a. As noted for each individual mix.
    b. Air-entraining admixtures shall conform to ASTM C260.
11) Slump:
   a. As noted for each individual mix.
   b. For high slump concrete, water reducing admixtures meeting ASTM C494 shall be used.

12) Surface Preparation:
   a. Remove all water, debris, dirt clods, etc., from space where concrete is to be placed.
   b. Unless noted otherwise, all exterior concrete flatwork shall be installed with six inches (6”) minimum, of washed, crushed gravel beneath it (1” minus).
   c. Gravel shall be well compacted and pre-wetted as per ACI standards prior to concrete installation.

13) Special Techniques:
   a. Cold Weather Concreting Procedures:
      i. General Requirements:
         1. Although the schedules of building projects may necessitate it, the installation of exterior concrete flatwork is NOT recommended before April 1st or after October 1st, due to Cache Valley climate.
         2. Materials and equipment required for heating and protection of concrete shall be approved and available at project site before beginning cold weather concreting.
         3. Forms, reinforcement, metallic embedments, and fillers shall be free from snow, ice, and frost. Surfaces that will be in contact with newly placed concrete, including sub-grade materials, shall be 35 deg F (2 deg C) minimum at time of concrete placement.
         4. Thaw sub-grade 6 inches (150 mm) deep minimum before beginning concrete placement. If necessary, re-compact all thawed material.
         5. Use no frozen materials or materials containing ice.
         6. Requirements When Average twenty four (24) Hour Temperature, midnight to midnight, Is Below 40 deg F (4 deg C):
            a. Temperature of concrete as placed and maintained shall be 55 deg F (13 deg C) minimum and 75 deg F (27 deg C) maximum.
            b. Heat concrete for seventy two (72) hours minimum after placing if regular cement is used; for 48 hours if high early strength cement is used; or longer if determined necessary by USU FPD&C.
               i. During this period, maintain concrete surface temperature between 55 and 75 deg F (13 and 27 deg C).
            c. Vent flue gases from combustion heating units to outside of enclosure to prevent carbonation of concrete surface.
            d. Prevent concrete from drying during heating period. Maintain housing, insulation, covering, and other protection twenty four (24) hours after heat is discontinued.
            e. After heating period, if temperature falls below 32 deg F (0 deg C), protect concrete from freezing until strength of 2000 psi minimum is achieved.
               i. Protect flatwork exposed to melting snow or rain during day and freezing during night from freezing until strength of 3500 psi minimum is achieved.
         7. Requirements When Average twenty four (24) Hour Temperature, midnight to midnight, Is Above 40 deg F (4 deg C), but when temperature falls below 32 deg F (0 deg C):
a. Protect concrete from freezing for seventy two (72) hours after placing, or until strength of 2000 psi is achieved, whichever is longer.
b. Protect flatwork exposed to melting snow or rain during day and freezing during night from freezing until strength of 3500 psi minimum is achieved.

b. Hot Weather Concreting Procedures:
   i. Maximum concrete temperature allowed is 90 deg F (32 deg C) in hot weather.
   ii. Cool aggregate and subgrades by sprinkling with water.
   iii. Avoid cement over 140 deg F (60 deg C).
   iv. Use cold mixing water or ice.
   v. Use fog spray or evaporation retardant to lessen rapid evaporation from concrete surface.

14) Finishing of Exterior Concrete:
   a. All concrete sidewalks and other flatwork shall have a cross-slope of not greater than 2% but not less than 0.5% toward the curb or street to provide positive drainage.
   b. Use of steel floats/trowels, power screeds and vibrators for the finishing of exterior, air-entrained concrete is not permitted and shall be cause for rejection of any or all work.
   c. Bull floating and/or darbying shall follow promptly after initial screeding using magnesium tools only.
   d. No finishing operations shall be performed with bleed water present on the surface of the concrete. Any dusting of cement powder onto the surface to absorb bleed water or the working of bleed water back into the surface of the concrete is not permitted.
   e. All concrete slabs shall be edged according to current ACI standards.
   f. Sprinkling of water on the surface of the concrete to re-temper it during any finishing process is not permitted.
   g. Trowelling of concrete shall be limited to a single, light pass before final finish using a magnesium trowel only.
   h. All concrete shall have slip resistant finishes. The standard finish, unless noted otherwise, shall be a coarse broomed finish. Finishes shall be applied to the surface before the concrete has thoroughly hardened but yet sufficiently hardened to retain the scoring impressions.

15) Concrete Curing:
   a. Curing procedures shall begin immediately after the final finishing process is complete and the surface sheen is gone.
   b. Contractor shall provide proper curing of concrete by employing initial and final curing methods as indicated in ACI 308R-01.
   c. Final curing shall be achieved by providing and/or installing the following:
      i. Moist curing methods that maintain a continuously wet surface such as ponding, sprinkling, plastic sheeting, or wet burlap sheets for a minimum period of 7 days. Moist curing is the curing method of choice for all exterior concrete on USU campus.
      ii. As an alternate, liquid membrane-forming curing compound(s) conforming to ASTM C-309 or ASTM C-1315, applied according to manufacturer’s recommendations and with the following additional requirements:
         1. Curing agent shall be applied in two (2) applications at right angles to each other to ensure uniform and complete coverage.
         2. Curing agent shall contain a fugitive dye or white pigmentation which allows an inspector to see that the agent has been adequately applied.
3. Contractor shall provide evidence of the amount of curing agent used for the project.
4. The use of sprayed curing compounds is NOT recommended before April 1st or after October 1st due to Cache Valley climate.
   d. Contractor shall make every effort to allow concrete to air dry for at least 30 days after the curing process is complete before exposing it to freeze/thaw conditions.

16) Joints:
   a. All exterior concrete shall have expansion and control joints installed according to current ACI standards.
   b. Expansion Joints:
      i. Joint material shall be Re-Flex rubber expansion joint material as manufactured by the J.D. Russell Company or approved equal.
      ii. Joints shall be sealed using a self-leveling sealer installed as per manufacturer’s recommendations. Approved sealers are: MasterSeal SL1, Novalink SL or approved equal.
   c. Control Joints:
      i. Joints shall be installed using one of two methods:
         1. Saw cutting using a beveled blade that provides a 3/8” beveled profile. Straight, unbeveled saw cuts are discouraged due to damage by snow removal equipment.
         2. Tooled joints that provide a maximum 3/8” radius (rounded) profile.

17) Colored Concrete:
   a. Colored concrete shall have an integrated color (color throughout) within the concrete and shall not be surface applied.

18) Field Tests and Inspections:
   a. Testing Agency shall provide testing and inspection for concrete as per ASTM C1077.
   b. Testing Agency will sample and test for quality control during placement of concrete as directed by USU FPD&C.
   c. Testing and inspections, if performed, will include the following:
      i. Periodic inspection verifying use of required design mix.
      ii. Inspection at time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine temperature of concrete.
      iii. Inspection of concrete placement for proper application techniques.
      iv. Periodic inspection of curing materials and techniques.
      v. Periodic inspection of formwork for configuration, location, and dimensions of concrete member being formed.
      vi. Slope of concrete members.
   d. Testing Agency will sample and test during placement of concrete as directed by USU FPD&C and may include the following:
      i. Sampling Fresh Concrete: ASTM C172, except as modified for slump to comply with ASTM C94:
         1. Slump: ASTM C143. Test each time a set of compressive test specimens are made.
         2. Air Content: ASTM C173. Volumetric method for normal weight concrete each time a set of compression test specimens is made.
         3. Concrete Temperature: Test each time a set of compressive test specimens is made.
4. Unit Weight: ASTM C567. Test each time a set of compressive test specimens is made.

ii. Compression Test Specimens: ASTM C31. One (1) set of four (4) standard cylinders for each compressive strength test, unless otherwise directed.

iii. Compressive Strength Tests: ASTM C39.:
   1. Obtain one (1) composite sample for each day’s pour of each concrete mixture exceeding 5 cu. Yd., but less than 50 cu. Yd., plus one (1) set for each additional 50 cu. Yd. or fraction thereof.
   2. One (1) specimen tested at seven (7) days, two (2) specimens tested at twenty eight (28) days, and one (1) specimen retained in reserve for later testing if required.
   3. If strength of field-cured cylinders is less than eighty-five (85) percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing in-place concrete.
   4. Strength level of concrete will be considered satisfactory if averages of sets of three (3) consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

19) Protection:
   a. Protect concrete that has not received its initial set from pedestrian traffic and from precipitation to avoid excess water in the mix and an unsatisfactory surface finish.
   b. Do not allow materials resulting from construction activities, which will affect concrete, to come in contact with concrete slabs.

20) Warranty:
   a. Contractor shall provide a two-year written guarantee of concrete materials and workmanship commencing on the date of substantial completion to promptly remove and/or repair all defective concrete (i.e., pitting, scaling, flaking, cracking, honeycombing, etc.).

21) Concrete Mix Types
   a. Type 1:
      i. 611 lb. / cu. yd. total cementitious material, min.
      ii. Water/Cementitious Ratio: 0.43
      iii. Slump: 3” – 6” using water reducing admixture
      iv. Waterproofing admixture: Penetron or Xypex
      v. Fiber reinforced
      vi. Air Entrainment: 6.5%, +/-1.5%
   b. Type 2:
      i. 611 lb. / cu. yd. total cementitious material, min.
      ii. Water/Cementitious Ratio: 0.40
      iii. Slump: 8” – 9” using mid and high range water reducing admixtures
      iv. Waterproofing admixture: None
      v. Fiber reinforced
      vi. Air Entrainment: 6.5%, +/-1.5%