

### **3.2 SITE WORK CONCRETE:**

Test site work concrete including materials for concrete as required in Article CONCRETE of this section.

### **3.3 CONCRETE:**

#### **A. Batch Plant Inspection and Materials Testing:**

1. Perform continuous batch plant inspection until concrete quality is established to satisfaction of COR and perform periodic inspections thereafter as determined by COR.
2. Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to the COR.
3. Sample and test mix ingredients as necessary to insure compliance with specifications.
4. Sample and test aggregates daily and as necessary for moisture content. Test the dry rotted weight of the coarse aggregate whenever a sieve analysis is made and when it appears there has been a change in the aggregate.
5. Certify, in duplicate, ingredients and proportions and amounts of ingredients in concrete conform to approved trial mixes. When concrete is batched or mixed off immediate building site, certify (by signing, initialing or stamping thereon) on delivery slips (duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.

#### **B. Field Inspection and Materials Testing:**

1. Provide a technician at site of placement at all times to perform concrete sampling and testing.
2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least three cylinders for each 40 m<sup>3</sup> (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. After good concrete quality control has been established and maintained as determined by the COR make three cylinders for each 80 m<sup>3</sup> (100 cubic yards) or less of each concrete type and at least three cylinders from any one day's pour for each concrete type. Label each cylinder with an identification number. The COR may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m<sup>3</sup> (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m<sup>3</sup> (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.

6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.
10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations.
  - a. When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
  - b. When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
  - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
  - b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:
  - a. Monitor and record amount of water added at project site.
  - b. Observe minimum and maximum mixing times.
18. Measure concrete flatwork for levelness and flatness as follows:
  - a. Perform Floor Tolerance Measurements  $F_F$  and  $F_L$  in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.
  - b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.

- c. Provide the Contractor and the COR with the results of all profile tests, including a running tabulation of the overall  $F_F$  and  $F_L$  values for all slabs installed to date, within 72 hours after each slab installation.

19. Other inspections:

- a. Grouting under base plates.
- b. Grouting anchor bolts and reinforcing steel in hardened concrete.

C. Laboratory Tests of Field Samples:

1. Test compression test cylinders for strength in accordance with ASTM C39. For each test series, test one cylinder at 7 days and one cylinder at 28 days. Use remaining cylinder as a spare tested as directed by Contracting Officer. Compile laboratory test reports as follows: Compressive strength test shall be result of one cylinder, except when one cylinder shows evidence of improper sampling, molding or testing, in which case it shall be discarded and strength of spare cylinder shall be used.
2. Make weight tests of hardened lightweight structural concrete in accordance with ASTM C567.
3. Furnish certified compression test reports (duplicate) to COR. In test report, indicate the following information:
  - a. Cylinder identification number and date cast.
  - b. Specific location at which test samples were taken.
  - c. Type of concrete, slump, and percent air.
  - d. Compressive strength of concrete in MPa (psi).
  - e. Weight of lightweight structural concrete in  $\text{kg/m}^3$  (pounds per cubic feet).
  - f. Weather conditions during placing.
  - g. Temperature of concrete in each test cylinder when test cylinder was molded.
  - h. Maximum and minimum ambient temperature during placing.
  - i. Ambient temperature when concrete sample in test cylinder was taken.
  - j. Date delivered to laboratory and date tested.

## **D. SECTION 02200**

### **EARTHWORK**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION OF WORK**

- A. This section includes the requirements for earthwork including, but not limited to, the following:
  - 1. Site preparation.
  - 2. Excavation.
  - 3. Foundation Base Aggregate.
  - 4. Filling and backfilling.
  - 5. Grading.
  - 6. Soil Disposal.

##### **1.2 DEFINITIONS**

- A. Borrow Material: Borrow materials are soils generated during excavation operations at the site.
  - 1. Backfill: Backfill shall be obtained from onsite excavation. The material shall be used as indicated on the Construction Drawings. It shall be free of organic matter, debris and other deleterious substances. The material shall contain no particles greater than 3 inches.
- B. Unsatisfactory Materials: Materials that do not comply with the requirements listed above are unsatisfactory. Unsatisfactory materials also include non-engineered fills; trash; refuse; backfills from previous construction; and material classified as satisfactory that contain or are contaminated with unsatisfactory material. The COR shall be notified of any contaminated materials.
- C. Degree of compaction: Degree of compaction is expressed as a percentage of the maximum density obtained by the test procedure presented in ASTM D 698, abbreviated as a percent of laboratory maximum density.
- D. Unauthorized excavation: Removal of materials beyond indicated sub-grade elevations or dimensions without written authorization by the COR. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.

##### **1.3 RELATED WORK**

- A. Protection of existing utilities, fire protection services, existing equipment, roads, and pavements: Section 01010, GENERAL REQUIREMENTS.

##### **1.4 SUBMITTALS**

- A. Unless otherwise noted, submittals shall be made 14 days before commencing the Work specified in this Section. The following shall be submitted in accordance with Section 01334 SAMPLES AND SHOP DRAWINGS.
  - 1. Import Material: The Contractor shall submit the following for each imported material a minimum of 14 days prior to delivery:
    - a. Material source(s);
    - b. Particle size analysis in accordance with ASTM C136

2. **Equipment List:** The Contractor shall submit a list of equipment to be utilized for the work 7 days prior to mobilization. The list shall include equipment make, model, year, tire or track dimensions, weight and other information.
3. **Construction Procedures Plan:** The Contractor shall submit a plan that includes, but not be limited to, material excavation, marker surveying and identification tagging, marker removal, marker collar removal, marker transportation and storage, marker re-installation, backfill processing and placement, equipment use, borrow source utilization, and protection to be provided in the event of rain, wind, heat or other potential cause of damage 14 days prior to material construction.
4. **Record Drawing Information:** Record Drawings including, but not limited to, drawings showing the original and final marker locations, foundation location including measurements and dimensions, shall be prepared by the Contractor and submitted to the COR following completion of the project. The preconstruction survey of the markers will be submitted to the COR in draft form for use during construction.
5. **Cleaning Agent:** The Contractor shall submit manufacturer's spec sheets on proposed cleaning agent(s) for approval.

## 1.5 APPLICABLE PUBLICATIONS

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. American Society for Testing and Materials (ASTM):
 

D698-00 .....	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft <sup>3</sup> (600 kN m/m <sup>3</sup> ))
D1556-00 .....	Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-00 .....	Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2700 kN m/m <sup>3</sup> ))
D2922-01 .....	Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D2940-98 .....	Graded Aggregate Material for Bases or Subbases for Highways or Airports
SS-2630.....	State of Oregon Department of Transportation (ODOT) SS-2630 - (2006) Standard Specifications - Section 2630 - Base Aggregate [use CalTrans equivalent]
SS-2690.....	State of Oregon Department of Transportation (ODOT) SS-2690 - (2006) Standard Specifications - Section 2690 – PCC Aggregates [use CalTrans equivalent]

## 1.6 UTILIZATION OF EXCAVATED MATERIALS

Contractor excavated and stockpiled materials shall be used as fill and backfill materials as specified. Excavated materials shall be stockpiled in designated stockpile areas. No excavated material shall be disposed of to obstruct the flow of any stream or road, endanger a partly finished

structure, impair the efficiency or appearance of any structure, or be detrimental to the completed work in any way.

## **PART 2 – PRODUCTS**

### **2.1 MATERIALS**

- A. Foundation Base Aggregate shall be ¾ inch in conformance to ODOT SS-2630 [or CalTrans equivalent specifications].
- B. Leveling Sand shall be Sand for Mortar in conformance to ODOT SS-2690 [or CalTrans equivalent specifications].

## **PART 3 – EXECUTION**

### **3.1 SITE PREPARATION**

- A. Trees and Shrubs: Protect from damage, existing trees and shrubs which are not shown to be removed in construction area. Immediately repair damage to existing trees and shrubs by trimming, cleaning and painting damaged areas, including roots, in accordance with standard industry horticultural practice for the geographic area and plant species. Do not store building materials closer to trees and shrubs that are to remain, than the farthest extension of their limbs. If the Contractor is obstructed by tree roots within the drip-line of a standing tree that are 2 inches in diameter or greater, the Contractor shall request an inspection by the COR. The COR will inspect and determine if any roots will be pruned.
- B. Stripping Topsoil: Strip topsoil from within limits of earthwork operations as specified. Topsoil shall be a fertile, friable, natural topsoil of loamy character and characteristic of locality. Topsoil shall be capable of growing healthy horticultural crops of grasses. Stockpile topsoil and protect as directed by COR. Eliminate foreign materials, such as weeds, roots, stones, subsoil, frozen clods, and similar foreign materials larger than 0.014 m<sup>3</sup> (1/2 cubic foot) in volume, from soil as it is stockpiled. Remove foreign materials larger than 50 mm (2 inches) in any dimension from topsoil to be used as backfill.
- C. Lines and Grades: With the services of a Registered Professional Land Surveyor or Registered Civil Engineer, specified in Site Survey section, the Contractor shall survey and document existing lines and grades and submit for approval new lines and grades in order to achieve grades that provide a smooth surface free from irregular surface changes. The intent here is not to change the overall contour of the gravesites but rather to eliminate any irregular surface changes. Grading shall comply with compaction requirements and grade cross sections, lines, and elevations indicated by the approved survey. Where spot grades are indicated the grade shall be established based on interpolation of the elevations between the spot grades while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.

### **3.2 EXCAVATION**

- A. The Contractor shall perform excavation of every type of material encountered within the limits of grading to the lines, grades, and elevations indicated and as specified. Grading shall be in conformance with the Site Survey Drawings and the tolerances specified in Paragraph Grade Tolerance. Excavation areas will be cleared of vegetation prior to excavation. Satisfactory excavated materials shall be transported to and placed in fill as indicated. Unsatisfactory materials encountered within the excavation shall be excavated below grade and replaced with

satisfactory materials as directed. Surplus excavated material not required for fill shall be disposed offsite.

- B. Excavation of trenches shall be accomplished by cutting accurately to the dimensions shown on the Construction Drawings. Excessive open trench excavation shall be backfilled with satisfactory, thoroughly compacted, material. Contractor shall maintain excavations free from detrimental quantities of leaves, brush, sticks, trash, and other debris until final acceptance of the work.

### **3.3 SUBGRADE PREPARATION**

- A. Ground surface on which fill is to be placed shall be cleared of vegetation.
- B. The subgrade shall be shaped to lines, grades, and sections shown on the Construction Drawings, and compacted as specified. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Existing low areas and those resulting from removal of unsatisfactory material shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped and compacted as specified.
- C. All subgrade areas shall be moisture conditioned and compacted to not less than 90 percent compaction in accordance with ASTM D2922.
- D. If the Contractor excavates below the lines and grades indicated on the Construction Drawings, the Contractor shall place fill to elevate these areas back to grade at no cost to the Government.
- E. The prepared subgrade surface shall be reasonably smooth, free of holes, depressions greater than 3 inch deep, or protrusion extending above the surface more than 3 inch. No overlying materials shall be placed until the subgrade has been checked and approved. The subgrade surface shall be protected and restored if damaged.

### **3.4 FOUNDATION BASE AGGREGATE**

- A. Aggregate shall be placed in the bottom of the prepared trench subgrade and compacted. All areas shall be moisture conditioned and compacted to not less than 95 percent compaction in accordance with ASTM D2922.
- B. Aggregate finish grades shall be constructed to within plus or minus 0.1 foot of the indicated grades. The finished surface of the aggregate shall be free of depressions and shall be reasonably smooth in accordance with the grade tolerance.

### **3.5 FILL AND BACKFILL**

- A. Fill shall be not be dropped from a height greater than 3 feet nor excessively loaded on markers. The soil shall be placed in the trench and compacted in 4 inch deep loose lifts. The moisture content of fill placed shall be adjusted prior to placement. Each lift shall be rough graded prior to compaction. Equipment shall be operated with careful attention to protection of markers. Fill shall not be constructed on surfaces that are muddy, frozen, or contain frost. Compact soil to not less than 95 percent compaction in accordance with ASTM D2922.

### **3.6 GRADE TOLERANCE**

- A. Excavation and finish grades shall be constructed to within plus or minus 0.1 foot of the indicated grades. The finished surface of the excavations and fills shall be free of depressions and shall be reasonably smooth in accordance with the grade tolerances.

### **3.7 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL**

- A. Remove from site and legally dispose trash and debris.
- B. Remove from site and legally dispose excess soil after all fill and backfill operations are completed.

### **3.8 CLEAN UP**

- A. Upon completion of earthwork operations, clean all work areas within contract limits, remove tools, and equipment. Provide site clear, clean and free of debris. Remove all debris, rubbish, and excess material from Cemetery Property.

## **E. SECTION 03300**

### **CAST-IN-PLACE CONCRETE**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION:**

This section specifies cast-in-place structural concrete and materials and mixes for other concrete.

##### **1.2 RELATED WORK:**

- A. Materials testing and inspection during construction: Section 01410, TESTING LABORATORY SERVICES.

##### **1.3 TESTING AGENCY FOR CONCRETE MIX DESIGN:**

- A. Testing agency retained and reimbursed by the Contractor and approved by the COR.
- B. Testing agency maintaining active participation in Program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology. Accompany request for approval of testing agency with a copy of Report of Latest Inspection of Laboratory Facilities by CCRL.
- C. Testing agency shall furnish equipment and qualified technicians to establish proportions of ingredients for concrete mixes.

##### **1.4 TOLERANCES:**

- A. Formwork: ACI 117, except the elevation tolerance of formed surfaces before removal of shores is +0 mm (+0 inch) and -20 mm (-3/4 inch).
- B. Reinforcement Fabricating and Placing: ACI 117, except that fabrication tolerance for bar sizes Nos. 10, 13, and 16 (Nos. 3, 4, and 5) (Tolerance Symbol 1 in Fig. 2.1(a), ACI, 117) used as column ties or stirrups is +0 mm (+0 inch) and -13 mm (-1/2 inch) where gross bar length is less than 3600 mm (12 feet), or +0 mm (+0 inch) and -20 mm (-3/4 inch) where gross bar length is 3600 mm (12 feet) or more.
- C. Cross-Sectional Dimension: ACI 117, except tolerance for thickness of slabs 12 inches or less is +20 mm (+3/4 inch) and -6 mm (-1/4 inch).

##### **1.5 REGULATORY REQUIREMENTS:**

- A. ACI 315 – Details and Detailing of Concrete Reinforcement.
- B. ACI 318 - Building Code Requirements for Reinforced Concrete.
- C. ACI 301 – Standard Specifications for Structural Concrete.

##### **1.6 SUBMITTALS:**

- A. Testing Agency for Concrete Mix Design: Approval request including qualifications of principals and technicians and evidence of active participation in program of Cement and Concrete Reference Laboratory (CCRL) of National Institute of Standards and Technology and copy of report of latest CCRL, Inspection of Laboratory.
- B. Test Report for Concrete Mix Designs: Trial mixes including water-cement ratio curves, concrete mix ingredients, and admixtures.

**1.7 PRE-CONCRETE CONFERENCE:**

- A. General: At least 15 days prior to submittal of design mixes, conduct a meeting to review proposed methods of concrete construction to achieve the required results.
- B. Agenda: Includes but is not limited to:
  - 1. Submittals.
  - 2. Coordination of work.
  - 3. Availability of material.
  - 4. Concrete mix design including admixtures.
  - 5. Methods of placing, finishing, and curing.
  - 6. Material inspection and testing.
- C. Attendees: Include but not limited to representatives of Contractor; subcontractors involved in supplying, conveying, placing, finishing, and curing concrete; Contracting Officer; COR.

**1.8 APPLICABLE PUBLICATIONS:**

- A. Publications listed below form a part of this specification to extent referenced. Publications are referenced in text by basic designation only.
- B. Federal Specifications (Fed. Spec.):
  - MM-L-751H.....Lumber Softwood
- C. American Concrete Institute (ACI):
  - 117-90 .....Standard Specifications for Tolerances for Concrete Construction and Materials
  - 117R-90.....Commentary on Standard Specifications for Tolerances for Concrete Construction and Materials
  - 211.1-91 .....Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
  - 211.2-98 .....Standard Practice for Selecting Proportions for Structural Lightweight Concrete
  - 214-77 .....Recommended Practice for Evaluation of Strength Test Results of Concrete
  - 301-99 .....Standard Specifications for Structural Concrete
  - 304R-2000.....Guide for Measuring, Mixing, Transporting, and Placing Concrete
  - 305R-99.....Hot Weather Concreting
  - 306R-(R2002) .....Cold Weather Concreting
  - 308-(R1997) .....Standard Practice for Curing Concrete
  - 309R-96.....Guide for Consolidation of Concrete
  - 315-99 .....Details and Detailing of Concrete Reinforcement

- 318/318R-02.....Building Code Requirements for Reinforced Concrete and Commentary
- 347R-(R1999) .....Guide to Formwork for Concrete
- D. American National Standards Institute and American Hardboard Association (ANSI/AHA):
- A135.4-95 .....Basic Hardboard
- E. American Society for Testing and Materials (ASTM):
- A82-02 .....Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
- A185-02 .....Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
- A615/A615M-03 .....Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- A653/A653M-03 .....Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- A706/A706M-03 .....Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
- A767/A767M-00 REV.B .....Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
- A775/A775M-01 .....Standard Specification for Epoxy-Coated Reinforcing Steel Bars
- A820-01 .....Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
- A996/A996M-03 REV.A .....Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
- C31/C31M-03 .....Standard Practice for Making and Curing Concrete Test Specimens in the field
- C33-03.....Standard Specification for Concrete Aggregates
- C39/C39M-01 .....Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C94/C94M-03 .....Standard Specification for Ready-Mixed Concrete
- C143/C143M-00 .....Standard Test Method for Slump of Hydraulic Cement Concrete
- C150-02 REV. A.....Standard Specification for Portland Cement
- C171-03.....Standard Specification for Sheet Materials for Curing Concrete
- C172-99.....Standard Specification for Sampling Freshly Mixed Concrete
- C173-01.....Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
- C192/C192M-02 .....Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory

- C231-97(E1999).....Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
- C260-01.....Standard Specification for Air-Entraining Admixtures for Concrete
- C309-REV. A 98.....Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- C330-03.....Standard Specification for Lightweight Aggregates for Structural Concrete
- C494/C494M-REV. A 99(E2001) Standard Specification for Chemical Admixtures for Concrete
- C496-96.....Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
- C567-00.....Standard Test Method for Density of Structural Lightweight Concrete
- C618-03.....Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- C666-03.....Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
- C881-02.....Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
- C1107-02.....Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
- D6-95(R2000).....Standard Test Method for Loss on Heating of Oil and Asphaltic Compounds
- D297-93(R2002)(E2003).....Standard Test Methods for Rubber Products-Chemical Analysis
- D1751-99.....Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
- D4397-02.....Standard Specification for Polyethylene Sheeting for Construction, Industrial and Agricultural Applications
- E1155-96(R2001).....Standard Test Method for Determining FF
- F. American Welding Society (AWS):
  - D1.4-98.....Structural Welding Code - Reinforcing Steel
- G. Concrete Reinforcing Steel Institute (CRSI):
  - DA4-90.....Manual of Standard Practice
- H. National Cooperative Highway Research Program (NCHRP):
  - Report No. 244-81.....Concrete Sealers for the Protection of Bridge Structures
- I. U. S. Department of Commerce Product Standard (PS):
  - PS 1-83.....Construction and Industrial Plywood

- J. U. S. Army Corps of Engineers Handbook for Concrete and Cement:
  - CRD C513-74 .....Rubber Waterstops
  - CRD C572-74 .....Polyvinyl chloride Waterstops

## **PART 2 – PRODUCTS:**

### **2.1 MATERIALS:**

- A. Portland Cement: ASTM C150 Type I or II.
- B. Coarse Aggregate: ASTM C33.
  - 1. Size 67. Size 467 may be used for footings and walls over 300 mm (12 inches) thick.
  - 2. Coarse aggregate for applied topping, encasement of steel columns, and metal pan stair fill shall be Size 7.
  - 3. Maximum size of coarse aggregates not more than one fifth of narrowest dimension between sides of forms, one third of depth of slabs, nor three fourth of minimum clear spacing between reinforcing bars.
- C. Fine Aggregate: ASTM C33. Fine aggregate for applied concrete floor topping shall pass a 4.75 mm (No. 4) sieve, 10 percent maximum shall pass a 150 µm (No. 100) sieve.
- D. Mixing Water: Fresh, clean, and potable.
- E. Admixtures:
  - 1. Water Reducing Admixture: ASTM C494, Type A and not contain more chloride ions than are present in municipal drinking water.
  - 2. Water Reducing, Retarding Admixture: ASTM C494, Type D and not contain more chloride ions than are present in municipal drinking water.
  - 3. High-Range Water-Reducing Admixture (Super plasticizer): ASTM C494, Type F or G, and not contain more chloride ions than are present in municipal drinking water.
  - 4. Non-Corrosive, Non-Chloride Accelerator: ASTM C494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. Admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory of at least one year duration using an acceptable accelerated corrosion test method such as that using electrical potential measures.
  - 5. Air Entraining Admixture: ASTM C260.
  - 6. Certification: Written conformance to the requirements above and the chloride ion content of the admixture prior to mix design review.
- F. Reinforcing Steel: ASTM A615, or ASTM A996, deformed, grade as shown.
- G. Reinforcing Bars to be Welded: ASTM A706.
- H. Galvanized Reinforcing Bars: ASTM A767.
- I. Supports, Spacers, and Chairs: Types which will hold reinforcement in position shown in accordance with requirements of ACI 318 except as specified.
- J. Sheet Materials for Curing Concrete: ASTM C171.

- K. Liquid Membrane-forming Compounds for Curing Concrete: ASTM C309, Type I, with fugitive dye. Compound shall be compatible with scheduled surface treatment, such as paint and resilient tile, and shall not discolor concrete surface.
- L. Epoxy shall be in conformance to ODOT SS-2070.

**2.2 CONCRETE MIXES:**

- A. Mix Designs: Proportioned in accordance with Section 5.3, "Proportioning on the Basis of Field Experience and/or Trial Mixtures" of ACI 318.
  - 1. If trial mixes are used, make a set of at least 6 cylinders in accordance with ASTM C192 for test purposes from each trial mix; test three for compressive strength at 7 days and three at 28 days.
  - 2. Submit a report of results of each test series, include a detailed listing of the proportions of trial mix or mixes, including cement, admixtures, weight of fine and coarse aggregate per m<sup>3</sup> (cubic yard) measured dry rodded and damp loose, specific gravity, fineness modulus, percentage of moisture, air content, water-cement ratio, and consistency of each cylinder in terms of slump.
  - 3. Prepare a curve showing relationship between water-cement ratio at 7-day and 28-day compressive strengths. Plot each curve using at least three specimens.
  - 4. If the field experience method is used, submit complete standard deviation analysis.
- B. After approval of mixes no substitution in material or change in proportions of approval mixes may be made without additional tests and approval of the COR or as specified. Making and testing of preliminary test cylinders may be carried on pending approval of cement, providing Contractor and manufacturer certify that ingredients used in making test cylinders are the same. The COR may allow Contractor to proceed with depositing concrete for certain portions of work, pending final approval of cement and approval of design mix.
- C. Cement Factor: Maintain minimum cement factors in Table I regardless of compressive strength developed above minimums.

**TABLE I - CEMENT AND WATER FACTORS FOR CONCRETE**

Concrete Strength		Non-Air-Entrained	Air-Entrained	
Min. 28 Day Comp. Str. MPa (psi)	Min. Cement kg/m <sup>3</sup> (lbs/c. yd)		Min. Cement kg/m <sup>3</sup> (lbs/c. yd)	Max. Water Cement Ratio
25 (3000)	300 (500)	*	310 (520)	*

\* Determined by Laboratory in accordance with ACI 211.1 for normal concrete or ACI 211.2 for lightweight structural concrete.

- D. Maximum Slump: Maximum slump, as determined by ASTM C143 with tolerances as established by ASTM C94, for concrete to be vibrated shall be as shown in Table II.

**TABLE II - MAXIMUM SLUMP, MM (INCHES)\***

Type of Construction	Normal Weight Concrete
Reinforced Footings and Substructure Walls	75mm (3 inches)

- \* Slump may be increased by the use of the approved high-range water-reducing admixture (super plasticizer). Tolerances as established by ASTM C94. Concrete containing the high-range-water-reducing admixture may have a maximum slump of 225 mm (9 inches). The concrete shall arrive at the job site at a slump of 50 mm to 75 mm (2 inches to 3 inches), and 75 mm to 100 mm (3 inches to 4 inches) for lightweight concrete. This should be verified, and then the high-range-water-reducing admixture added to increase the slump to the approved level.
- E. Air-Entrainment: Air-entrainment of normal weight concrete shall conform with Table III. Air-entrainment of lightweight structural concrete shall conform with Table IV. Determine air content by either ASTM C173 or ASTM C231.

**TABLE III - TOTAL AIR CONTENT  
FOR VARIOUS SIZES OF COARSE AGGREGATES (NORMAL CONCRETE)**

Nominal Maximum Size of Total Air Content	Coarse Aggregate, mm (Inches) Percentage by Volume
10 mm (3/8 in).6 to 10	13 mm (1/2 in).5 to 9
20 mm (3/4 in).4 to 8	25 mm (1 in).3-1/2 to 6-1/2
40 mm (1 1/2 in).3 to 6	

- F. Enforcing Strength Requirements: Test as specified in Section, TESTING LABORATORY SERVICES, during the progress of the work. Seven-day tests may be used as indicators of 28-day strength. Average of any three 28-day consecutive strength tests of laboratory-cured specimens representing each type of concrete shall be equal to or greater than specified strength. No single test shall be more than 3.5 MPa (500 psi) below specified strength. Interpret field test results in accordance with ACI 214. Should strengths shown by test specimens fall below required values, Contracting Officer may require any one or any combination of the following corrective actions, at no additional cost to the Government:
1. Require changes in mix proportions by selecting one of the other appropriate trial mixes or changing proportions, including cement content, of approved trial mix.
  2. Require additional curing and protection.
  3. If five consecutive tests fall below 95 percent of minimum values given in Table I or if test results are so low as to raise a question as to the safety of the structure, COR may direct Contractor to take cores from portions of the structure. Use results from cores tested by the Contractor retained testing agency to analyze structure.

4. If strength of core drilled specimens falls below 85 percent of minimum value given in Table I, the COR may order load tests, made by the Contractor retained testing agency, on portions of building so affected. Load tests in accordance with ACI 318 and criteria of acceptability of concrete under test as given therein.
5. Concrete work, judged inadequate by structural analysis, by results of load test, or for any reason, shall be reinforced with additional construction or replaced, if directed by the Contracting Officer.

### 2.3 BATCHING AND MIXING:

- A. General: Concrete shall be "Ready-Mixed" and comply with ACI 318 and ASTM C94, except as specified. Batch mixing at the site is permitted. Mixing process and equipment must be approved by the COR. With each batch of concrete, furnish certified delivery tickets listing information in Paragraph 16.1 and 16.2 of ASTM C94. Maximum delivery temperature of concrete is 38°C (100 degrees Fahrenheit). Minimum delivery temperature as follows:

Atmospheric Temperature	Minimum Concrete Temperature
-1. degrees to 4.4 degrees C (30 degrees to 40 degrees F)	15.6 degrees C (60 degrees F.)
-17 degrees C to -1.1 degrees C (0 degrees to 30 degrees F.)	21 degrees C (70 degrees F.)

1. Services of aggregate manufacturer's representative shall be furnished during the design of trial mixes and as requested by the COR for consultation during batching, mixing, and placing operations of lightweight structural concrete. Services will be required until field controls indicate that concrete of required quality is being furnished. Representative shall be thoroughly familiar with the structural lightweight aggregate, adjustment and control of mixes to produce concrete of required quality. Representative shall assist and advise COR.

## PART 3 – EXECUTION

### 3.1 PLACING REINFORCEMENT:

- A. General: Details of concrete reinforcement in accordance with ACI 318 and ACI 315, unless otherwise shown.
- B. Placing: Place reinforcement conforming to CRSI DA4, unless otherwise shown.
  1. Place reinforcing bars accurately and tie securely at intersections and splices with 1.6 mm (16 gauge) black annealed wire. Secure reinforcing bars against displacement during the placing of concrete by spacers, chairs, or other similar supports. Portions of supports, spacers, and chairs in contact with formwork shall be made of plastic in areas that will be exposed when building is occupied. Type, number, and spacing of supports conform to ACI 315.
- C. Spacing: Minimum clear distances between parallel bars, except in columns and multiple layers of bars in beams shall be equal to nominal diameter of bars. Minimum clear spacing is 25 mm (1 inch) or 1-1/3 times maximum size of coarse aggregate.

- D. Splicing: Splices of reinforcement made only as required or shown or specified. Accomplish splicing as follows:
1. Lap splices: Do not use lap splices for bars larger than Number 36 (Number 11).
  2. Welded splices: Splicing by butt-welding of reinforcement permitted providing the weld develops in tension at least 125 percent of the yield strength ( $f_y$ ) for the bars. Welding conform to the requirements of AWS D1.4. Welded reinforcing steel conform to the chemical analysis requirements of AWS D1.4.
    - a. Submit test reports indicating the chemical analysis to establish weldability of reinforcing steel.
    - b. Submit a field quality control procedure to insure proper inspection, materials and welding procedure for welded splices.
    - c. Department of Veterans Affairs retained testing agency shall test a minimum of three splices, for compliance, locations selected by the COR.
  3. Mechanical Splices: Develop in tension and compression at least 125 percent of the yield strength ( $f_y$ ) of the bars. Stresses of transition splices between two reinforcing bar sizes based on area of smaller bar. Provide mechanical splices at locations indicated. Use approved exothermic, tapered threaded coupling, or swaged and threaded sleeve. Exposed threads and swaging in the field not permitted.
    - a. Initial qualification: In the presence of the COR, make three test mechanical splices of each bar size proposed to be spliced. Department of Veterans Affairs retained testing laboratory will perform load test.
    - b. During installation: Furnish, at no additional cost to the Government, one companion (sister) splice for every 50 splices for load testing. Department of Veterans Affairs retained testing laboratory will perform the load test.
- E. Bending: Bend bars cold, unless otherwise approved. Do not field bend bars partially embedded in concrete, except when approved by Contracting Officer Representative.
- F. Cleaning: Metal reinforcement, at time concrete is placed, shall be free from loose flaky rust, mud, oil, or similar coatings that will reduce bond.
- G. Future Bonding: Protect exposed reinforcement bars intended for bonding with future work by wrapping with felt and coating felt with a bituminous compound unless otherwise shown.

### **3.2 PLACING CONCRETE:**

- A. Preparation:
1. Remove hardened concrete, wood chips, shavings and other debris from forms.
  2. Remove hardened concrete and foreign materials from interior surfaces of mixing and conveying equipment.
  3. Have forms and reinforcement inspected and approved by the COR before depositing concrete.
  4. Provide runways for wheeling equipment to convey concrete to point of deposit. Keep equipment on runways which are not supported by or bear on reinforcement. Provide similar runways for protection of vapor barrier on coarse fill.

- B. Bonding: Before depositing new concrete on or against concrete which has been set, thoroughly roughen and clean existing surfaces of laitance, foreign matter, and loose particles.
1. Preparing surface for applied topping:
    - a. Remove laitance, mortar, oil, grease, paint, or other foreign material by sand blasting. Clean with vacuum type equipment to remove sand and other loose material.
    - b. Broom clean and keep base slab wet for at least four hours before topping is applied.
    - c. Use a thin coat of one part Portland cement, 1.5 parts fine sand, bonding admixture; and water at a 50: 50 ratio and mix to achieve the consistency of thick paint. Apply to a damp base slab by scrubbing with a stiff fiber brush. New concrete shall be placed while the bonding grout is still tacky.
- C. Conveying Concrete: Convey concrete from mixer to final place of deposit by a method which will prevent segregation. Method of conveying concrete subject to approval of the COR.
- D. Placing: For special requirements see Paragraphs, HOT WEATHER and COLD WEATHER.
1. Do not place concrete when weather conditions prevent proper placement and consolidation, or when concrete has attained its initial set, or has contained its water or cement content more than 1 1/2 hours.
  2. Deposit concrete in forms as near as practicable in its final position. Prevent splashing of forms or reinforcement with concrete in advance of placing concrete.
  3. Do not drop concrete freely more than 3000 mm (10 feet) for concrete containing the high-range water-reducing admixture (super plasticizer) or 1500 mm (5 feet) for conventional concrete. Where greater drops are required, use a tremie or flexible spout (canvas elephant trunk), attached to a suitable hopper.
  4. Discharge contents of tremies or flexible spouts in horizontal layers not exceeding 500 mm (20 inches) in thickness, and space tremies such as to provide a minimum of lateral movement of concrete.
  5. Continuously place concrete until an entire unit between construction joints is placed. Rate and method of placing concrete shall be such that no concrete between construction joints will be deposited upon or against partly set concrete, after its initial set has taken place, or after 45 minutes of elapsed time during concrete placement.
  6. On bottom of members with severe congestion of reinforcement, deposit 25 mm (1 inch) layer of flowing concrete containing the specified high-range water-reducing admixture (super plasticizer). Successive concrete lifts may be a continuation of this concrete or concrete with a conventional slump.
  7. Concrete on metal deck:
    - a. Concrete on metal deck shall be minimum thickness shown. Allow for deflection of steel beams and metal deck under the weight of wet concrete in calculating concrete quantities for slab.
      - 1) The Contractor shall become familiar with deflection characteristics of structural frame to include proper amount of additional concrete due to beam/deck deflection.
- E. Consolidation: Conform to ACI 309. Immediately after depositing, spade concrete next to forms, work around reinforcement and into angles of forms, tamp lightly by hand, and compact with mechanical vibrator applied directly into concrete at approximately 450 mm (18 inch) intervals. Mechanical vibrator shall be power driven, hand operated type with minimum frequency of 5000

cycles per minute having an intensity sufficient to cause flow or settlement of concrete into place. Vibrate concrete to produce thorough compaction, complete embedment of reinforcement and concrete of uniform and maximum density without segregation of mix. Do not transport concrete in forms by vibration.

1. Use of form vibration shall be approved only when concrete sections are too thin or too inaccessible for use of internal vibration.
2. Carry on vibration continuously with placing of concrete. Do not insert vibrator into concrete that has begun to set.

### **3.3 HOT WEATHER:**

Follow the recommendations of ACI 305 or as specified to prevent problems in the manufacturing, placing, and curing of concrete that can adversely affect the properties and serviceability of the hardened concrete. Methods proposed for cooling materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by the COR.

### **3.4 COLD WEATHER:**

Follow the recommendations of ACI 306 or as specified to prevent freezing of concrete and to permit concrete to gain strength properly. Use only the specified non-corrosive, non-chloride accelerator. Do not use calcium chloride, thiocyanates or admixtures containing more than 0.05 percent chloride ions. Methods proposed for heating materials and arrangements for protecting concrete shall be made in advance of concrete placement and approved by Contracting Officer Representative.

### **3.5 PROTECTION AND CURING:**

- A. Conform to ACI 308: Initial curing shall immediately follow the finishing operation. Protect exposed surfaces of concrete from premature drying, wash by rain and running water, wind, mechanical injury, and excessively hot or cold temperatures. Keep concrete not covered with membrane or other curing material continuously wet for at least 7 days after placing, except wet curing period for high-early-strength concrete shall be not less than 3 days. Keep wood forms continuously wet to prevent moisture loss until forms are removed. Cure exposed concrete surfaces as described below. Other curing methods may be used if approved by Contracting Officer Representative.
  1. Liquid curing and sealing compounds: Apply by power-driven spray or roller in accordance with the manufacturer's instructions. Apply immediately after finishing. Maximum coverage  $10\text{m}^2/\text{L}$  (400 square feet per gallon) on steel troweled surfaces and  $7.5\text{m}^2/\text{L}$  (300 square feet per gallon) on floated or broomed surfaces for the curing/sealing compound.
  2. Plastic sheets: Apply as soon as concrete has hardened sufficiently to prevent surface damage. Utilize widest practical width sheet and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with tape.
  3. Paper: Utilize widest practical width paper and overlap adjacent sheets 50 mm (2 inches). Tightly seal joints with sand, wood planks, pressure-sensitive tape, mastic or glue.

### **3.6 CONCRETE SURFACE PREPARATION:**

- A. Metal Removal: Unnecessary metal items cut back flush with face of concrete members.
- B. Patching: Maintain curing and start patching as soon as forms are removed. Do not apply curing compounds to concrete surfaces requiring patching until patching is completed. Use cement mortar for patching of same composition as that used in concrete. Use white or gray Portland cement as necessary to obtain finish color matching surrounding concrete. Thoroughly clean areas to be patched. Cut out honeycombed or otherwise defective areas to solid concrete to a depth of not less than 25 mm (1 inch). Cut edge perpendicular to surface of concrete. Saturate with water area to be patched, and at least 150 mm (6 inches) surrounding before placing patching mortar. Give area to be patched a brush coat of cement grout followed immediately by patching mortar. Cement grout composed of one part Portland cement, 1.5 parts fine sand, bonding admixture, and water at a 50:50 ratio, mix to achieve consistency of thick paint. Mix patching mortar approximately 1 hour before placing and remix occasionally during this period without addition of water. Compact mortar into place and screed slightly higher than surrounding surface. After initial shrinkage has occurred, finish to match color and texture of adjoining surfaces. Cure patches as specified for other concrete. Fill form tie holes which extend entirely through walls from unexposed face by means of a pressure gun or other suitable device to force mortar through wall. Wipe excess mortar off exposed face with a cloth.
- C. Upon removal of forms, clean vertical concrete surface that is to receive bonded applied cementitious application with wire brushes or by sand blasting to remove unset material, laitance, and loose particles to expose aggregates to provide a clean, firm, granular surface for bond of applied finish.

### **3.7 CONCRETE FINISHES:**

- A. Concrete surfaces will not require additional finishing.