

**SECTION 03 05 15**

**PORTLAND CEMENT CONCRETE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

- 1 Developing and Controlling Concrete Mix Design; controlling storage and quality of concrete ingredients; and batching, and mixing. Furnishing and delivering Portland Cement Concrete which meets the approved mix design. The section also includes the following:
  - a Portland cement.
  - b Aggregates.
  - c Drying shrinkage of concrete.
  - d Concrete admixtures and cementitious materials.
  - e Tests and analysis of materials.
  - f Mix designs.
  - g Batching, mixing, and transporting.
  - h Inspection and Testing.

**B. Related Sections:**

- 1 Section 01 33 00: Submittal Procedures
- 2 Section 01 43 00: Project Quality Assurance
- 3 Section 01 60 00: Product Requirements
- 4 Section 03 11 00: Concrete Forming
- 5 Section 03 20 00: Concrete Reinforcement
- 6 Section 03 30 00: Cast-In-Place Concrete

**1.02 REFERENCES**

**A. American Concrete Institute (ACI):**

1. ACI 116R - Cement and Concrete Terminology

**LNG UNDERGROUND STORAGE TANKS REMOVAL  
AT GARDEN GROVE AND ANAHEIM BUS BASES**

**IFB-7-1756  
EXHIBIT B**

2. ACI 211.1 - Selecting Proportions for Normal, Heavyweight, and Mass Concrete
3. ACI 301 - Structural Concrete
4. ACI 304R - Measuring, Mixing, Transporting, and Placing Concrete
5. ACI 304.2R - Placing Concrete by Pumping Methods
6. ACI 305R - Hot Weather Concreting
7. ACI 318 - Building Code Requirements for Structural Concrete
8. ACI 523.1R - Cast-in-Place Low Density Cellular Concrete

**B. ASTM International (ASTM):**

1. ASTM C31 - Making and Curing Concrete Test Specimens in the Field
2. ASTM C33 - Concrete Aggregates
3. ASTM C39 - Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C40 - Organic Impurities in Fine Aggregates for Concrete
5. ASTM C87 - Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
6. ASTM C88 - Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
7. ASTM C94 - Ready-Mixed Concrete
8. ASTM C127 - Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregates
9. ASTM C128 - Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregates
10. ASTM C131 - Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
11. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates
12. ASTM C138 - Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
13. ASTM C143 - Slump of Hydraulic Cement Concrete
14. ASTM C150 - Portland Cement
15. ASTM C157 - Length Change of Hardened Hydraulic Cement Mortar and Concrete
16. ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method
17. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot-Plate Apparatus
18. ASTM C231 - Air Content of Freshly Mixed Concrete by the Pressure Method

- 19. ASTM C260 - Air-Entraining Admixtures for Concrete
  - 20. ASTM C289 - Potential Alkali-Silika Reactivity of Aggregates (Chemical Method)
  - 21. ASTM C470 - Molds for Forming Concrete Test Cylinders Vertically
  - 22. ASTM C490 - Apparatus for the Determination of Length Change of Hardened Cement paste, Mortar, and Concrete
  - 23. ASTM C494 - Chemical Admixtures for Concrete
  - 24. ASTM C535 - Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  - 25. ASTM C618 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
  - 26. ASTM C979 - Pigments for Integrally Colored Concrete
  - 27. ASTM C1017 - Chemical Admixtures for Use in producing Flowing Concrete
  - 28. ASTM D75 - Sampling Aggregates
  - 29. ASTM #329 - Agencies Engaged in Construction Inspection and/or Testing
- C. National Ready Mix Concrete Association (NRMCA):
- 1. NRMCA - Certification of Ready Mix Concrete Production Facilities, Checklist
- D. Standard Specifications for Public Works Construction (SSPWC)
- E. National Bureau of Standards Handbook (NBS Handbook 44)

### **1.03 QUALITY ASSURANCE**

- A. Comply with Section 01 43 00 - Project Quality Assurance Requirements
- B. Concrete Supplier - Furnish concrete from a plant which has recently furnished specified concrete for a large project, or furnish evidence of plant's capacity to produce and deliver concrete conforming to specified requirements at required rate and which has laboratory capability to develop acceptable concrete mix designs and to control quality of concrete production, in accordance with a preapproved quality control plan.
- 1. Use semi-automatic 3- batching systems as described in National Ready-Mix Concrete Association (NRMCA) checklist for Certification of Ready Mix Concrete Production Facilities.
  - 2. Use NRMCA currently certified batch plant.
- C. Mix Design Criteria:
- 1. Design concrete mixes to conform to ACI 318 Chapter 5.
  - 2. Design mixes to produce concrete having workability, durability, strength, maximum density, minimum shrinkage and permeability as specified.

3. Develop the proportioning of concrete ingredients in accordance with ACI 211.1 for normal weight concrete.
4. Workability - Use approved admixtures to improve Workability, maximize density, reduce water and cement contents, and minimize shrinkage and permeability of concrete, provided admixtures do not adversely affect other required properties of concrete.
5. Strength
  - a. Design concrete mix for specified strength based on required overdesign factor of 1.24 according to ASTM C94, and assuming a coefficient of variation equal to 15. Design each class of concrete so that not more than 10 percent of strength tests will have values less than specified strength, and average of any three consecutive strength tests will be equal to or greater than specified strength.
6. Nominal compressive strength of concrete - Class 4000, unless otherwise indicated or specified for cast-in-place concrete.
7. Adjustments of mix designs - For every change in source and type of ingredient and class of concrete test new trial mixes and submit for review and acceptance.
8. Do not vary proportions of ingredients of approved mix without submitting results of laboratory tests of new proposed mix and obtaining written acceptance of OCTA Project Manager.
9. Concrete indicated to be air-entrained - Verify required air content, as determined by ASTM C173 or ASTM C231, conforms to value and is within tolerance recommended by ACI 301 and ACI 318, corresponding to maximum size of coarse aggregate.
10. Do not exceed following slump for concrete without water reducer admixtures, of average of three successive batches of concrete at placement, as determined by ASTM C143.
  - a. Concrete Classes:

Class 4000	4 inches
b. Non-reinforced concrete, other than paving	3 inches
c. Reinforced concrete slabs, Beams, girders, walls and other Structural members and second- Pour concrete after addition of high-range water reducer	5 inches
d. Concrete placed by pumping	6 inches
e. Drilled-pier concrete	6 inches
f. Concrete encasing structural steel	6 inches
11. Maximum Laboratory Drying Shrinkage as determined by ASTM C157  
Class 2500 - 0.065% after 28-days  
Class 4000 - 0.0548% after 28-days  
Class 5000 - 0.0548% after 28 days

- D. Concrete Pump Plant - Conform to ACI 304R. Maintain equipment in quantities to preclude stopping concreting because of failed equipment.
- E. Perform field job control tests as specified and accepted by OCTA Project Manager.
- F. Quality Control For Batch Plant
  - 1. Provide continuous batch plant quality control inspection during batching operations by an independent laboratory for structural placements of 50 cubic yards or greater and when required by the Project Quality Manager, for performing tests in accordance with reference standards listed. Provide concrete from batching plant, reviewed and accepted by OCTA Project Manager and meeting the following requirements:
    - a. Arrangement:
      - 1) Provide separate bins or compartments for each size or classification of aggregate and for each type of bulk portland cement.
      - 2) Provide compartments of ample size and constructed to maintain materials separately under working conditions. Equip batching plant such that flow of each material into batcher is stopped automatically when designated weight has been reached. Weigh aggregates in a separate scale in a separate weight batcher. Water may be measured by weight.
      - 3) Arrange plant to facilitate inspection of operations. Provide suitable access for obtaining representative samples of aggregate from each of the bins or compartments for test purposes. Provide delivery of materials from batching equipment to within accuracies specified in ASTM C94.
      - 4) Batching - In accordance with ACI 304R subject to review and acceptance by OCTA Project Manager.
      - 5) Do not use aluminum bins, compartments, hoppers or equipment.
    - b. Water Batchers and Dispensers for Admixtures:
      - 1) Provide equipment for batching water and air-entraining or other admixtures at batching plant except in cases where mixing is performed at Worksite in paving mixers or in truck mixers.
      - 2) Provide a suitable water measuring device capable of weighing mixing water within specified requirements for each batch.
      - 3) Provide measuring devices for addition of admixtures capable of ready adjustment that have at least three percent accuracy, to permit varying quantity of admixture batched.
      - 4) Calibrate dispensers at intervals required by the NRMCA. Record results of calibration and make available for inspection by OCTA Project Manager.
    - c. Aggregates Moisture Control - Independent testing laboratory shall perform tests of moisture content of aggregates as frequently as they deem necessary for adjustment of the amount of water required by design in the concrete mix.
    - d. Scales - Provide adequate facilities for accurate measurement and control of each material entering each batch of concrete. Conform to applicable requirements of NBS, Handbook 44.

- e. Recorders
  - 1) Provide accurate graphical or digital printout record of scale readings, including initial readings, after each of the aggregates, water, cement and admixtures have been batched before delivery to mixer, using accurate recorder or recorders.
  - 2) Record Data - Show on each printout, date and time of batching; identification number - identical to concrete ticket and codes for mix design and for Contract Section.
  - 3) House each recorder in a locked, dust-tight cabinet.
  - 4) Clearly indicate different types of mixes used by stamped letters, numerals, colored ink or other suitable means on charts or tapes so that variations in batch weights of each type of mix can be readily observed.
    - a) Show on charts or tapes, date and time of day (stamped or preprinted) at intervals of not more than 15 minutes.
    - b) Provide recorders of a type that prints required information in duplicate. One copy of recorded batch weights for each load shall accompany each delivery ticket as supplied by producer. Verify that the identification number is identical to concrete delivery ticket. Deliver one copy with its corresponding concrete ticket to OCTA Project Manager at time and site of concrete placement.
  - 5) Place recorders in a position convenient for observation by plant operator and OCTA Project Manager.
- f. Protect weighing, indicating and control equipment against exposure to dust and weather and insulate against vibration or movement caused by operating equipment in plant.
- g. Dry batching
  - 1) When bulk cement and aggregates are hauled from a central batching plant to mixer, place cement for each batch in an individual compartment which, during transit, will prevent cement from intermingling with aggregates and will prevent loss of cement.
  - 2) Provide bins of batch trucks with suitable covers to protect materials from wind and wet weather.
  - 3) Provide batch compartments of sufficient capacity to prevent loss in transit and to prevent spilling and intermingling of batches as compartments are being emptied.
- 2. Aggregates:
  - a. Coarse Aggregate
    - 1) Use one source of coarse aggregate only. Coarse aggregate grading - Conform with ASTM C33, Table 2, size number 467 (1 1/2 inch to No. 4). Coarse aggregate grading for walls 18 inch thick or less - Conform with ASTM C33, Table 2, size number 67 (3/4 inch to No. 4). Coarse aggregate - Use ASTM D75 for standard practice for sampling aggregates. Coarse aggregate to conform with ASTM C33.

- 2) Deleterious Substances - Do not allow amount of deleterious substances present in coarse aggregate to exceed following:

PERCENT DELETERIOUS SUBSTANCE	MAXIMUM PERCENT BY WEIGHT
Material passing No. 200 Sieve (ASTM C117)	
Normal Size range No. 4 to 3/4 inch	0.5
Nominal size range 3/4 inch to 1-1/2 inch:	0.4
Shale (ASTM C123, specific gravity of heavy liquid 1.95):	1.0
Clay lumps (ASTM C142):	0.5
Coal and lignite particles	0.5
Friable particles	0.25
Other deleterious substances	1.0
Total of all deleterious substances:	3.0

- 3) Abrasion - Do not exceed 52 percent of wear when coarse aggregate is tested in accordance with ASTM C131 or ASTM C535.
- 4) Soundness - Do not exceed 15 percent of weighted percentage of loss when coarse aggregate is subjected to five cycles of magnesium sulphate soundness test in accordance with ASTM C88.

b. Fine Aggregate

- 1) Use one source of fine aggregate only. Fine aggregate to conform to ASTM C33.
- 2) Do not allow the fineness modulus of fine aggregate from a given source to vary more than 0.2 from base fineness modulus. The base fineness modulus shall be that value that is used by the independent testing laboratory for the trial batch or for mix design, shall not exceed as specified in Section 2.01.C.2
- 3) Provide fine aggregate gradation represented by a smooth granulometric curve within the limits specified, using U.S. standard sieves, square openings.

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3/8 inch	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	10-30
No. 100	2-10
No. 200	0-5

- 4) Soundness - Do not exceed 12 percent by weight of weighted percentage of loss when fine aggregate is subjected to five cycles of magnesium sulphate soundness test in accordance with ASTM C88.
- 5) Deleterious Substances - Do not allow following substances to be present individually in amounts exceeding following:

PERCENT DELETERIOUS SUBSTANCE	MAXIMUM PERCENT BY WEIGHT
Material passing No. 200 Sieve (ASTM C117)	3.0
Shale (ASTM C123, specific gravity of heavy liquid 1.95):	1.0
Clay lumps (ASTM C142):	1.0
Friable particles	1.0
Coal and lignite particles	0.5
Other deleterious sub stances: (such as shale, alkali, mica, coated grains, soft and flaky particles, and loam)	2.0
Total of all deleterious substances:	5.0

- 6) Organic Impurities - Provide fine aggregate free from harmful injurious amounts of organic impurities as determined by ASTM C40. Should material fail to pass test for organic impurities in sand for concrete, material will be acceptable after passing test described in ASTM C87. If fine aggregate shows by colorimetric test a darker color than sample originally approved for Work, withhold use until tests have been made to determine whether change in color is indicative of harmful injurious amount of deleterious substances.

G. Ready-Mixed Concrete - Conform to ASTM C94.

#### **1.04 SUBMITTALS**

- A. Refer to Section 01 33 00 - Submittal Procedures, for submittal requirements and procedures.
- B. Mix design for each concrete class and for each change of ingredients and ingredient sources, including admixtures, and at least 10 cylinder compression test of past record of mix.
- C. Mix design to include test report of compression strength at time of form removal as indicated in Article 3.06B.
- D. Methods for hot weather mixing capable of producing concrete with a temperature not over 90F nor under 55F at time of placement. Refer to ACI 305R for hot weather concreting.

- E. NRMCA batch plant certification to OCTA Project Manager 30 days before prior to delivery of concrete to Worksite.
- F. Mix design, laboratory test reports, and mill or manufacturer's certificates attesting the conformance of ingredients with these Specifications. Use ingredients in design mix which are representative samples of materials used in Work. Provide one design mix for each class of concrete. Establish mix design through an approved testing laboratory.
- G. Certifications by concrete supplier of design mixes to specified requirements in respect to strength, unit weight, maximum size aggregate, air-entrainment, slump and water-cement ratio.
- H. If source, brand or characteristic properties of ingredients need to be varied during term of Contract, submit compliance with Article 1.04.B.7 to OCTA Project Manager for review and acceptance.
- I. Copy of recorder printout with corresponding concrete delivery ticket.
- J. Manufacturer's product data.
- K. Batch Tickets - Certification or delivery tickets before unloading at Worksite in accordance with ASTM C94 from concrete supplier with each batch delivered to Worksite listing following information in addition to ASTM C94 requirements:
  - 1. Name of supplier
  - 2. Name of batching plant and location
  - 3. Serial number of ticket
  - 4. Date
  - 5. Truck number
  - 6. Specific job designation (Contract number and location)
  - 7. Volume of concrete in cubic yards
  - 8. Specific class and type of concrete, in conformance with specification requirement
  - 9. Time loaded and amount of water added
  - 10. Type and brand of cement
  - 11. Weight of cement
  - 12. Weight of water
  - 13. Maximum size of aggregates
  - 14. Weights of coarse and fine aggregates, respectively
  - 15. Type and amount of admixtures
  - 16. Certification that mix complies with reviewed and accepted laboratory design mix and quality control plan.
  - 17. Mix design designation.
  - 18. Class and weight of mineral admixtures.

19. Batch weight of mix

L. Certificate of nonreactive aggregates: fine and coarse aggregate.

### **1.05 DEFINITIONS**

- A. "As indicated": Plan, elevation, sections, details, and general notes shown on approved contract drawings, shop drawings, and working drawings, Approved for Construction by OCTA Project Manager and as specified herein.
- B. The word "concrete" followed only by a class designation (that is, Concrete Class 4000-1-inch) indicates normal weight aggregate concrete, such as concrete having a 28- day compressive strength of 4,000 psi, a maximum coarse aggregate size of 1 inch, and a minimum unit weight of 150 pounds per cubic foot (without reinforcement) at 28 days.
- C. The word "HVFAC " followed only by a class designation (that is, HVFAC 4000 – 1- inch) includes normal weight aggregate high volume fly ash concrete, such as HVFAC having a 56-day compressive strength of 4,000 psi, a maximum coarse aggregate size of 1 inch, with a minimum unit weight of 145 pounds per cubic foot (without reinforcement).
- D. The term "fill concrete" indicates a concrete containing sufficient cement to develop a 28-day compressive strength of 2500 psi.
- E. The term "lean concrete" indicates a concrete containing the equivalent of two 94-pound sacks of cement per cubic yard.
- F. The term "controlled density fill" indicates a flow-able mixture of aggregate and cementitious materials containing sufficient cement to develop a 28-day compressive strength of 50 to 150 psi.
- G. The term "mass concrete" indicates any volume of concrete with dimensions large enough to require that measures be taken to cope with the generation of heat from hydration of the cement and attendant volume change in order to minimize shrinkage and cracking.
- H. The term "high volume fly ash concrete" (HVFAC) indicates concrete using a mix that replaces 25 percent or more of weight of Portland cement with specified fly ash.
- I. Except for the foregoing definitions, the words and terms used in these Specifications conform to the definitions given in ACI 116R.

### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 01 60 00 - Product Requirements, for general requirements for product delivery, storage, and handling procedures.
- B. Deliver packaged materials in manufacturer's original, unopened containers bearing manufacturer's name and brand.

- C. Load, transport, handle, store and batch concrete materials in a manner to ensure materials are not contaminated, unclean, segregated or affected in any way detrimental to final product.
- D. Aggregates:
  - 1. Transport and stockpile aggregates separately according to sources and gradations. Handle aggregates in manner to prevent segregation and loss of fines, and contamination with earth and foreign materials.
  - 2. If aggregates show segregation or different grades become mixed, rescreen aggregates before placing in proportioning bins.
  - 3. Do not use aggregates from different sources or of different gradations alternately. Mix aggregates only to obtain different gradations.
  - 4. Do not transfer aggregates directly from trucks to proportioning bins when moisture content will affect accuracy of proportioning of concrete mixture. In such cases, stockpile aggregates until excess moisture drains off.
- E. Packaged Cement:
  - 1. Deliver packaged cement to mixing site in original sealed packages labeled with weight, name of manufacturer, brand and type specified.
  - 2. Store packages on raised platforms in a manner to protect from moisture and contamination (in watertight enclosures).
  - 3. Do not use cement which has been reclaimed by cleaning bags.
  - 4. Do not use cement which has been damaged by exposure or overstocking.
  - 5. Do not use packages varying more than three percent from specified weight.
  - 6. Packaged cement - Subject to test at any time.
  - 7. Do not store packaged cement more than six months.
  - 8. Use packaged cement on basis of first received, first used.
- F. Bulk Cement:
  - 1. Store bulk cement separately from other cement and protect to prevent deterioration from exposure to moisture and intrusion of foreign matter.
  - 2. Provide facilities in ready-mix plant to maintain separation of cement meeting specified requirements from other cement.
  - 3. Provide facilities in cement manufacturer's plant for sampling of cement at weighing hopper or in feed line immediately before entering hopper.
  - 4. Use only the brands of cement approved in the concrete mix design.
  - 5. Store admixtures to prevent contamination, evaporation or damage. Protect liquid admixtures from harmful temperature ranges.

## **1.07 TRANSPORTATION**

- A. Verify each transit mix truck used for delivery of concrete to Worksite has been satisfactorily inspected by the Contractor's inspector.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Portland cement: Confirm to ASTM C150, Type II, low alkali for underground construction, Type I or Type II or other construction. Type III portland cement may be used where high early strength concrete is a requirement as approved by OCTA Project Manager.
- B. Coarse Aggregates:
1. Coarse Aggregate: ASTM C33, clean and uniformly graded as indicated in Section 1.04.F.2.a.1 or specified elsewhere. When not specified, provide 1 inch maximum size (ASTM C33, Size No. 57). Deleterious materials in aggregates shall not exceed the limits specified in ASTM C33 or specified per section 1.04.F.2.a.2
  2. Aggregate for Exposed Concrete: Aggregate for concrete which will be exposed to the public shall be obtained from one source for each type of aggregate required in order to produce a uniform color.
  3. Source of Aggregates: Aggregates shall be obtained from a selected aggregate source, known to produce aggregates complying with the specified requirements, as approved by OCTA Project Manager.
  4. Coarse aggregate shall consist of hard, dense, durable crushed or uncrushed gravel or crushed aggregate conforming to ASTM C33 and the herein specified requirements.
  5. Coarse aggregate shall conform to the following requirements when tested in accordance with the specified ASTM Test Methods:
    - a. Resistance to Abrasion (ASTM C131): The loss for aggregate size range 3/4 inch to 3/16 inch after 100 revolutions and 500 revolutions shall not exceed 10 percent and 40 percent, respectively. The test sample shall consist of 7 parts of grading B and 3 parts of grading C.
    - b. Resistance to Abrasion (ASTM C535): The loss for aggregate size range 1-1/2 inch to 3/4 inch (grading 3) after 200 revolutions and 1000 revolutions shall not exceed 10 percent and 40 percent, respectively.
    - c. Soundness (ASTM C88): Weighted average loss after 5 cycles shall not exceed 12 percent when tested with sodium sulfate.
    - d. Specific Gravity (ASTM C127): Bulk specific gravity on the basis of saturated surface-dry aggregate shall be not less than 2.60.
    - e. Potential Reactivity (ASTM C33): Only aggregates considered innocuous in accordance with Appendix XI shall be used in the work.
- C. Fine Aggregate:

1. Fine aggregate shall consist of hard, dense, durable, stone or rock fragments uniformly graded from 3/8-inch to fines, washed clean, conforming to ASTM C33 and the herein specified requirements. Deleterious substances in aggregate shall not exceed as specified in section 1.04.F.2.b.5
  2. Fine aggregate shall conform to the following requirements when tested in accordance with the specified ASTM Test Methods:
    - a. Specific Gravity (ASTM C128): Not less than 2.60 on a saturated surface-dry basis.
    - b. Organic Impurities (ASTM C40): Supernatant liquid must be lighter in color than the reference standard color solution.
    - c. Soundness (ASTM C88): Loss in 5 cycles of sodium sulfate test shall not exceed 12 percent.
    - d. Potential Reactivity (ASTM C289): Only fine aggregate considered innocuous shall be used in the work.
    - e. Fineness Modulus (ASTM C33): Fineness modulus shall be in the range of 2.30 to 3.00, however, the variation of the fineness modulus shall not exceed 0.20.
- D. Drying Shrinkage of Concrete:
1. A trial batch of the proposed (mix design) concrete shall be prepared using the aggregates, cement, and admixture proposed for this work. From the trial batch, three specimens (4 inches by 4 inches by 11 inches) for determining "Drying Shrinkage" shall be prepared, cured, dried, and measured as specified in ASTM C157 and ASTM C490, with the following modifications:
    - a. Cast-in-place concrete shall be moist cured for 10 days.
    - b. Measurements shall be made and reported for 7, 14, 21, and 28 days of drying after 9 days of moist curing and 1 day of steam curing. Measurements for HFVAC shall also be made and reported for 56 days of drying.
  2. Shrinkage of specimens for cast-in-place concrete shall not exceed 0.040 percent when measured in accordance with ASTM C157 and ASTM C490 after 21 days of drying.
  3. Shrinkage of HFVAC specimens shall not exceed 0.055 percent when measured in accordance with ASTM C157 after 28 days drying including minimum 7 days moist cure.
- E. Concrete Admixtures and Cementitious Materials: The Contractor may include accepted concrete admixtures and cementitious materials in the mix to improve the water-cement ratio or water-cementitious ratio or workability of the concrete, providing the strengths specified and other desirable characteristics of the concrete can be achieved and maintained. Admixtures shall be included in the design mix, introduced in solution form. Admixtures shall be added at the batch plant, except as directed by OCTA Project Manager.
1. Demonstrate that admixtures have minimum three years history of demonstrable satisfactory performance on major public projects under equivalent conditions.
  2. Chemical Admixtures, Water-Reducing: ASTM C494, Type A.

3. Air-entraining admixtures – Conform to ASTM C260
4. Pozzolanic Admixtures: ASTM C618, Class N or F.
5. Fly Ash: ASTM C618, Class F, with a maximum of 25 percent retained on the No. 325 mesh sieve and a loss on ignition of 1.0 percent maximum.
6. Pigments for integrally colored concrete: ASTM C979, for synthetic or natural iron oxides (red). Concentrated color pigments containing no fillers, adulterants or admixtures that will affect characteristics or performance of concrete mix design.
7. Chemical Admixtures, Plasticizing: ASTM C1017, or ASTM C494 Type F or Type G, high-range water-reducing admixtures. Introduce chemical admixture in solution form, in accordance with manufacturer's recommendations.
8. Prohibited Admixtures: Admixtures containing chlorides or sulfides are not acceptable.
9. Use admixtures that are compatible with each other.
10. Do not use retarding or accelerating admixtures unless specifically approved by OCTA Project Manager and at no cost to owner.

**F. Water:**

1. Water for concrete mixes, curing, and cleaning shall be clean and potable.
2. Does not contain impurities, suspended particles, algae or dissolved natural salts in quantities that will cause:
  - a. Corrosion of reinforcing steel.
  - b. Volume changes that will increase shrinkage cracking.
  - c. Efflorescence.
  - d. Excessive air-entraining.
3. Free from substance which would interfere with the chemical action by which concrete is formed, detract from concrete strength and durability, cause variations of concrete color, or cause a combination of such defects. Chloride concentrations in total concrete mix to not exceed 250 ppm. Wash aggregates with potable water and do not use recycled wash water for mixing concrete.

- G. Reinforcement Fibers: Chopped strands of alkali-resistant polypropylene fibers added to the concrete mix for protection against shrinkage cracks where indicated or required.

**2.02 COMPONENTS**

- A. AGGREGATES FOR FILL AND LEAN CONCRETE - Conform to SSPWC, Subsection 200, 1.4 and 1.5.5.
- B. AGGREGATES FOR PUMPED CONCRETE - Conform to ACI 304.2R, Chapter 4.
- C. TEST EQUIPMENT - Provide six cylinders conforming to ASTM C470 for casting test specimens in accordance with ASTM C31, as specified herein, for each 150 cubic yards

and fractions thereof, of each class of concrete, and for daily pours less than 150 cubic yards, of structural concrete.

## **PART 3 - EXECUTION**

### **3.01 MATERIAL PREPARATION - Mixing Concrete**

#### **A. Operations:**

1. Provide concrete mixers that discharge concrete from mixer that is uniform in composition and consistency throughout mixed batch.
2. Reduce size of batch to be mixed or increase mixing time when charging and mixing operations fail to produce a concrete batch which conforms to above criteria.
3. Add water before, during and following mixer charging operations. Amount of water to be as indicated by mix design; do not add water more than in excess of the weight indicated by mix design.

#### **B. Central-mixed Concrete:**

1. Arrange mixers in centralized mixing plants so mixing action in mixers can be observed by plant operator from a location convenient to mixing plant operator's station.
2. Do not load mixers more than in excess of rated capacity. Mix concrete ingredients in a batch mixer for not less than time specified for various mixer capacities after ingredients, except full amount of water, are in mixer. Mixing time may be reduced if thorough mixing, can be obtained in less time, as determined by testing.

#### **3. Mixing Time**

CAPACITY OF MIXER	TIME OF MIXING
2 cu. yd. or less	1 1/2 minutes
3 cu. yd.	2 minutes
4 cu. yd.	2 1/2 minutes
Larger than 4 cu. yd.	Determined by mixer performance tests by Design Consultant.

4. Equip each mixer with a mechanically operated batch counter, and a timing and signaling device to indicate completion of required mixing period.

#### **C. Truck-mixed Concrete - Conform equipment and procedures to ASTM C94.**

### **3.02 EXAMINATION**

- A. Verify aggregates from different sources are not mixed, except as required to satisfy accepted mix design.
- B. Verify mix designs and sources of aggregates are not changed without written review and acceptance by OCTA Project Manager.

- C. Verify aggregate mixtures have not become segregated.

### **3.03 TEMPERATURE CONTROL**

- A. Prepare aggregates by methods which produce concrete having a temperature of not more than 90°F and not less than 55°F immediately before placing.
- B. Cool concrete ingredients as required and by methods acceptable to OCTA Project Manager.

### **3.04 PROPORTIONING**

- A. Verify concrete ingredients are proportioned in conformance with established mix design, as accepted by OCTA Project Manager, for particular strength class and usage.

### **3.05 INSTALLATION**

- A. MEASURING, BATCH PLANT, MIXERS AND AGITATORS, MIXING AND DELIVERY - Verify ASTM C94, Sections 7, 8, 9 and 10 are satisfied by concrete supplier.
- B. ADMIXTURES
  - 1. Verify admixtures are dispensed for each batch from a dispenser having capacity to measure quantity required for one batch.
  - 2. Chemical admixtures - Use water-reducing admixtures in concrete which will be below grade and in contact with rock, earth, ribs and lagging or fill and concrete that will be placed by pumping.
  - 3. Consistency - Maintain slump range at point of delivery for concrete compacted by approved mechanical vibrators within specified limits. Do not use concrete in Work if slump exceeds maximum allowable by one inch or more.
    - a. Use same type and brand cement from same mill for entire project.
    - b. Supply fine or coarse aggregate from one source, non-reactive.
    - c. Provide a concrete mix of consistent quality. Maintain uniform weight ratio of pigment to cement. Do not change mix design without acceptance by OCTA Project Manager. Vary ratio of pigment to cement only when mix design significantly affects color.
    - d. Do not exceed slump as specified in section 1.04.C.9.
    - e. Rinse mixer drum thoroughly before batching colored concrete and after colored concrete has been discharged.
    - f. Determine pigment amount introduced to batch by weight, not volume. Do not estimate.
    - g. Add color by weight directly into mixer along with aggregate, cement and water.
    - h. Operate transit mixer at charging or mixing speed (50 to 100 revolutions) for five to 10 minutes while adding color.

**3.06 FIELD QUALITY CONTROL**

- A. Perform field job quality control tests in accordance with the test method and at the frequency specified below.

TEST DESCRIPTION	STANDARD MINIMUM	FREQUENCY PROCEDURE
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**Material Qualifications**

Manufacturer's Product Data of Certifications of Compliance - Each material/ component used	As Specified in Part 2	Once - Initial acceptance; each shipment used on Worksite
Aggregate	ASTM D75, C33	Once - Initial acceptance and at each change in source of supply
Potential Reactivity	ASTM C289	Once - Initial acceptance and at each change in source of supply
Cement	ASTM C150	Once - Initial acceptance and at each change in source of supply
Water	Paragraph 2.01.F	Once - Initial acceptance and at each change in source of supply
Admixtures	Paragraph 2.01.E	Once - Initial acceptance and at each change in source of supply
Concrete Mix Design	ASTM C94	Once - Initial acceptance and each revision; each class of concrete used

**Job Control**

Aggregate Gradation	ASTM C136	Monthly, as a minimum or as directed by OCTA Project Manager
Cement	ASTM C150	Once per month or every 1000 tons
Chemical Admixture	ASTM C494	Once - Initial acceptance and at each change in source of supply
Mineral Admixture	ASTM C618	Once - Initial acceptance and at each change in source of supply
Slump	ASTM C143	First load and each set of cylinders
Compressive Strength	ASTM C31 and C39	Six cylinders per each 150 cu. yd. or portion thereof

**LNG UNDERGROUND STORAGE TANKS REMOVAL  
AT GARDEN GROVE AND ANAHEIM BUS BASES**

**IFB-7-1756  
EXHIBIT B**

Air Content	ASTM C231	First load and each set of cylinders when required by mix design
Temperature	ASTM C177	Paragraph 3.3 First load and each set of cylinders
Compressive Strength	ACI 318	Continuous throughout job moving Average

**B. Concrete Testing**

1. Contractor to employ and pay for services of a testing laboratory to perform material evaluation and concrete design mix. Concrete testing agency to meet requirements of ASTM E-329.
2. For each 150 cubic yards of structural concrete, or less, placed in one operation take four 6 inch by 12 inch cylinders to be tested for compression strength per ASTM C39 as follows:
3. Test one cylinder at seven days and record compressive strength.
4. Test two cylinders at 28 days to determine compressive strength. Record average of two cylinders. Concrete represented by sample - Acceptable if:
  - a. Average of all sets of three consecutive strength tests per shift equals or exceeds design strength.
  - b. No individual strength test (average of two cylinders) falls below design strength by more than 500 psi.
  - c. Maintain one cylinder as a spares, Discard after acceptance of 28 days test
5. Prepare and test trial mixes. From trial mixes, prepare a combined particle distribution curve for concrete mix.
6. Construction mixes not conforming to combined particle distribution curve, or with unacceptable water/cement ratio, total mix water, or total cementitious material, or yielding concrete of unsatisfactory unit weight, will be rejected and will require adjustments in concrete mix and new test trial, for review and acceptance of adjusted mix.
7. Conduct a proof test for pumpability of design mix. Reproduce job conditions by introducing "U" turns in steel pipe laid on ground. Pumped concrete may be deposited in another mixer. Use accepted concrete mix only. OCTA Project Manager may elect to conduct independent testing of materials to verify actual properties.

**END OF SECTION**

**SECTION 03 11 00**

**CONCRETE FORMING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes:
  - 1. Transport, labor, materials, and equipment to design, install, and remove formwork, including screeds and related work, for cast-in-place concrete.
  - 2. Setting in forms, anchor bolts, metal inserts, sleeves, etc., embedded in concrete.
  - 3. Miscellaneous concrete work, including but not limited to areaways, cast-in-place valve boxes, pits, splash blocks, equipment bases, concrete fill for steel pan stair treads, and other items as shown or required to complete the work.
- B. Related Sections:
  - 1. Section 03 20 00, Concrete Reinforcing.
  - 2. Section 03 30 00, Cast-in-Place Concrete.
  - 3. Section 32 13 13, Concrete Paving.
  - 4. Section 32 16 13, Concrete Curbs and Gutters.

**1.02 REFERENCE STANDARDS**

- A. ASTM: ASTM International (formerly American Society for Testing and Materials).
- B. APA: APA – The Engineered Wood Association (formerly American Plywood Association).
- C. ACI: American Concrete Institute:
  - 1. ACI 117, Specifications for Tolerances for Concrete Construction and Materials.
  - 2. ACI 347, Guide to Formwork for Concrete.
  - 3. ACI 318, Building Code Requirements for Structural Concrete.
- D. SSPWC: Standard Specifications for Public Works Construction.

- E. CBC: California Building Code, 2007 (CCR Title 24 Part 2).
- F. American Concrete Institute: ACI 347 – Guide to Formwork for Concrete.

### **1.03 SUBMITTALS**

- A. Submit manufacturer's data and installation instructions for proprietary materials including form coatings, ties, and accessories, and manufactured form systems if used.
- B. Shop Drawings:
  - 1. Shop Drawings: Submit shop drawings showing formwork materials, form ties and surface finish. For architectural and concrete pavement, show form pattern layouts of all exposed concrete dimensioned to precisely locate grooves, form panel jointing, and similar features. Review and approval will not include form strength and adequacy.
  - 2. Record Documents: Keep an accurate record of the dates of removal of forms and form shores, and furnish copies to OCTA Project Manager.

### **1.04 QUALITY ASSURANCE**

- A. Construct forms according to ACI 347 and conforming to tolerances specified in ACI 301, as applicable, unless exceeded by code requirements or otherwise indicated or specified.

### **1.05 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials for forms in timely manner to ensure uninterrupted progress.
- B. Store materials by methods that prevent damage and permit ready access for inspection and identification.

## **PART 2 – PRODUCTS**

### **2.01 GENERAL**

- A. Except for metal forms, use all new materials. Non-metal materials may be used a maximum of three times, provided they are completely cleaned and reconditioned, re-coated for each use, and are still capable of producing concrete work of required quality.

**2.02 FORM MATERIALS**

- A. Form Lumber: WCLIB Construction grade or better, WWPA No. 1 or better, or equal. Use dimensions as required to support required loads, but not less than 2x4.
- B. Form Plywood: PS 1, Group I, Exterior Grade B-B plyform or better, minimum 5-ply and 3/4 inch thick for exposed locations and not less than 5/8 inch thick for unexposed locations, grade marked, not mill oiled. Plywood having medium or high density overlay is acceptable.
- C. Coated Form Plywood: For exposed architectural concrete, plastic overlaid plywood of grade specified above, factory coated with a form coating and release agent.
- D. Form Ties: Prefabricated rod, flat band, wire, internally threaded disconnecting type, or equal, not leaving metal within 1-1/2 inches of concrete surface.
- E. Form Coating: Non-staining clear coating free from oil, silicone, wax, not grain-raising. Where form liners are used, provide form coatings recommended by form liner manufacturer.
- F. Form Liner: Rigid or resilient, types as shown on the drawings for the patterns indicated, matching approved sample.
- G. Chamfer Strips: Clear white pine with planes surface against concrete. Set nails used to attach to formwork and cover w/ non-staining putty.

**PART 3 - EXECUTION**

**3.01 FORMWORK**

- A. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.
- B. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and assure ease of removal.
- C. Provide for openings, offsets, keyways, recesses, moldings, reglets, chamfers, blocking, screeds, bulkheads, anchorages, inserts, and other features as required.
- D. Conform to ACI 301 and ACI 347 except as exceeded by the requirements of Code, regulatory agencies, or specifications. Formwork tolerances shall conform to ACI 117.

- E. Corners and Angles: Provide 3/4 inch by 3/4 inch beveled chamfer strips for all exposed concrete corners and angles unless otherwise indicated. Form concealed concrete corners and angles square unless otherwise indicated.
- F. Reglets and Rebates: Form required reglets and rebates to receive frames, flashing, and other equipment. Obtain required dimensions, details, and precise positions for work to be installed under other sections and form concrete accordingly.
- G. Form Joints: Fill joints to produce smooth surfaces, intersections, and arrises. Use polymer foam or equivalent fillers at joints and where forms abut or overlap existing concrete to prevent leakage of mortar.
- H. Recesses, Drips, and Profiles: Provide smooth milled wood or preformed rubber or plastic shapes of types shown and required.
- I. Cleanouts and Cleaning: Provide temporary openings in all wall forms and other vertical forms for cleaning and inspection. Clean forms and surfaces to receive concrete prior to placing.
- J. Re-Use: Clean and recondition form material before re-use.

### **3.02 FORM CONSTRUCTION**

- A. Notify OCTA Project Manager one full working day prior to concrete placement, so that the forms can be inspected. Contractor shall correct any defective work found in Residents Engineer's inspection, prior to delivery of concrete to the project. Formwork surfaces that were in good condition and accepted for use, but were damaged during removal and handling, shall not be reused on additional pours.
- B. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement.
- C. Form panels on each side of the panel joint shall be precisely aligned, by means of supports or fasteners common to both panels, to result in a continuous unbroken concrete plane surface.
- D. Forms shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template for concrete which is to be finished to a specified elevation, slope, or contour.
- E. Support form materials by structural members spaced sufficiently close to prevent deflection. Undulations exceeding either 3/32 inch or 1/270 of the center-to-center distance between studs, joists, form stiffeners, form fasteners, or wales are unacceptable and will be rejected by OCTA Project Manager. Formwork tolerances shall not exceed the limits in ACI 117.

- F. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required to prevent leakage and fins.
- G. Accurately place and securely support items to be built into the concrete.
- H. Sides of all footings and grade beams shall be formed, unless permission is obtained to place concrete directly against earth. Where this permission is granted, the footing or grade beam dimension shall be increased by 3 inches. Remove formwork prior to backfilling operations.
- I. Should any form or forming system, even though previously approved for use, produce a concrete surface with unacceptable undulations, its use shall be discontinued until modifications satisfactory to OCTA Project Manager have been made.

### **3.03 FORM COATINGS**

- A. Coat form contact surfaces with form coating material before reinforcement is placed.
- B. Do not allow excess form coating to accumulate in the forms or to come in contact with surfaces which will bond to fresh concrete.
- C. Apply form coating in strict accordance with the manufacturer's written recommendations.

### **3.04 CONCRETE PLACEMENT**

- A. The rate of deposition of concrete in forms shall be controlled to prevent deflections of the forms or form panels in excess of the deflections permitted by these specifications.

### **3.05 REMOVAL OF FORMS**

- A. Take care in removing forms to avoid surface gouging, corner or edge breakage, and other damage to the concrete.
- B. Solidly pack form tie holes, rod holes, and similar holes in the concrete as specified in Section 03 30 00, Cast-In-Place Concrete.
- C. Remove forms in accordance with SSPWC Section 303-1.4.
- D. Do not remove concrete forms until concrete attains sufficient strength to support its own weight and all superimposed loads as determined by testing field cured concrete cylinders, but not sooner than specified in ACI 347, paragraph 3.7.
- E. Store reusable forms for exposed architectural concrete to prevent damage to contact surfaces.

**3.06 FORMWORK TOLERANCES**

- A. Deflection: Limit deflection of forming surfaces from concrete pressure to  $L/240$ .
- B. Finish Lines of Platforms: Position formwork to maintain hardened concrete finish lines within following permissible deviations.
  - 1. Variation from Plumb:
    - a. In 10 feet (3.05 m) 1/4 inch (6 mm)
    - b. In 20 feet (6.1 m) 3/8 inch (10 mm)
    - c. In 40 feet or more (12.19 m) 3/4 inch (19 mm)
  - 2. Variation from Level or Grades Indicated
    - a. In 10 feet (3.05 m) 1/4 inch (6 mm)
    - b. In 20 feet (6.1 m) 3/8 inch (10 mm)
    - c. In 40 feet or more (12.2 m) 3/4 inch (19 mm)
  - 3. Cross-Sectional Dimensions
    - a. Minus 1/4 inch (6 mm)
    - b. Plus 1/2 inch (13 mm)
- C. Slab Openings: Variations in size and location of sleeves and slab openings shall not exceed 1/4 inch (6 mm).

**3.07 SURVEY AND ADJUSTMENT**

- A. Check forms before and during placement of concrete, using an instrument, and make corrections as work proceeds.

**3.08 EMBEDDED PIPING AND ROUGH HARDWARE**

- A. Where work of other sections require openings for passage of pipes, conduits and other inserts in the concrete, obtain all dimensions and other information from installer of same. All necessary pipe sleeves, anchors, or other required inserts shall be accurately installed as part of the work of other sections, according to following requirements.
- B. Conduits or Pipes: Locate so as not to reduce strength of concrete. In no case place pipes, other than conduits, in a slab 4-1/2 inches thick or less. Conduit buried in a concrete slab shall not have an outside diameter greater than 1/3 the slab thickness nor be placed below the bottom reinforcing steel or over top reinforcing steel.
- C. Sleeves: Pipe sleeves may pass through slabs or walls if not exposed to rusting or other deterioration and are of uncoated or galvanized iron or steel. Provide sleeves of diameter large enough to pass any hub or coupling on pipe, including any insulation.
- D. Conduits: Conduits may be embedded in walls only if the outside diameter does not exceed 1/3 the wall thickness, are spaced no closer than 3 diameters on centers, and do not impair the strength of the structure.

**3.09 FIELD QUALITY CONTROL**

- A. Inspection: Obtain inspection and approval of forms from OCTA Project Manager before placing concrete.

**PART 4 - MEASUREMENT AND PAYMENT**

- A. No separate measurement or payment will be made for the work of this section.

**END OF SECTION**

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**SECTION 03 20 00**

**CONCRETE REINFORCING**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. Section Includes: Labor, materials, and equipment necessary and incidental to placing:
  - 1. Reinforcing bars for cast-in-place concrete.
  - 2. Reinforcing mesh for cast-in-place concrete.
  - 3. Accessories, including but not limited to chairs and tie wires.
  - 4. Steel bar reinforcing for masonry (furnish and deliver to site).
  - 5. Miscellaneous concrete work, including but not limited to areaways, cast-in-place valve boxes, pits, splash blocks, equipment bases, and other items as shown or required to complete the work.

**1.02 RELATED SECTIONS**

- A. Section 03 11 00, Concrete Forming.
- B. Section 03 30 00, Cast-in-Place Concrete.
- C. Section 32 13 13, Concrete Paving.
- D. Section 32 16 13, Concrete Curbs and Gutters.

**1.03 REFERENCE STANDARDS**

- A. ACI – American Concrete Institute:
  - 1. ACI 301, Specifications for Structural Concrete.
  - 2. ACI 318, Building Code Requirements for Structural Concrete.
  - 3. ACI SP-66, ACI Detailing Manual.
- B. ASTM: American Society for Testing and Materials.
- C. AWS – American Welding Society: AWS D1.4, Structural Welding Code—Reinforcing Steel.
- D. Caltrans – California Department of Transportation: Standard Specifications.

**1.04 SUBMITTALS**

- A.. Shop Drawings: Indicate bar sizes, spacing, locations, and quantities of reinforcing steel and wire fabric, bending and cutting schedules, supporting and spacing devices, and lengths of any lap splices.
- B. Product data and certifications for mechanical couplers.
- C. Product data for epoxy bonding adhesive.
- D. Certification: Manufacturer or supplier's certification that products meet specified requirements.
- E. Plan, procedures, and materials for anchoring reinforcing bars into existing concrete.
- F. Certification: Welding operator's certificate.
- G. Chemical Analysis: For bars to be welded, in accordance with code.

**1.05 QUALITY CONTROL**

- A. Perform work in accordance with ACI 301, ACI SP-66, ACI 318, and Caltrans Standard Specifications.
- B. Provide OCTA Project Manager with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
- C. Source Quality Control: Refer to Section 01 45 00, Quality Control, for general requirements and to following paragraphs for specific procedures. Testing laboratory shall perform the following conformance testing, shall select test samples of bars, ties, and stirrups from the material at the site or from place of distribution, each sampling including at least two 18-inch pieces, and shall perform the following tests according to ASTM A615.
  - 1. Identified Bars: If samples are obtained from bundles as delivered from the mill, identified as to heat number, accompanied by mill analyses and mill test reports, and properly tagged with Identification Certificate so as to be readily identified, perform one tensile and one bend test for each 10 tons or fraction thereof of each size of bars. Submit mill reports when samples are selected.

2. Unidentified Bars: When positive identification of reinforcing bars cannot be made and when random samples are obtained, perform tests for each 2.5 tons or fraction thereof, one tensile and one bend test from each size of bars.
- D. Certification of Welders: All welding both in shop and in field shall be performed by certified welding operators.

## **1.06 MARKING AND SHIPPING**

- A. Deliver materials in a timely manner to ensure uninterrupted progress.
- B. Bundle bars, tag with identification, and transport and store so as not to damage any material. Use metal tags indicating size, length and other marking shown on placement drawings. Maintain tags after bundles are broken. Store materials by methods that permit ready access for inspection and identification.

## **PART 2 - PRODUCTS**

### **2.01 MATERIALS**

- A. Reinforcing Steel: ASTM A706, Grade 60, for structural concrete.
- B. Spiral Reinforcement: ASTM A82.
- C. Mechanical Couplers: Sleeve-threaded per Caltrans Standard Specifications Section 52-1.08C(2).
- D. Magnesium Phosphate Concrete: Conform to Caltrans Section 83-2.02D(1).
- E. Welded Wire Fabric: ASTM A185, furnished in sheets only.
- F. Welding Electrodes: AWS D1.4, Table 5.1 and 5.5 low hydrogen electrodes, E9018 for Grade 60 steel, E70XX Series for grade 40 steel.

### **2.02 ACCESSORY MATERIALS**

- A. Tie Wire: ASTM A82, annealed copper-bearing steel, minimum 0.0625 inch (aka 16 gauge) uncoated diameter, galvanized.
- B. Chairs and Similar Support Items:
  1. Standard manufactured products conforming to CRSI Manual of Standard Practice.
  2. Use dense precast concrete supports with embedded wire ties for reinforcement placed on grade. Elsewhere, use wire bar supports.

3. Items in contact with formed surfaces shall not have the potential of staining concrete surfaces exposed to view.

## **2.03 FABRICATION**

- A. Comply with CRSI Manual of Standard Practice for fabrication of reinforcing steel.
- B. Bending and Forming: Fabricate bars of the indicated sizes and bend and form to required shapes and lengths by methods not injurious to materials. Do not heat reinforcement for bending. Bend bars No. 6 size and larger in the shop only. Bars with unscheduled kinks or bends are subject to rejection. Use only tested and approved bar materials.
- C. Welding: Use only ASTM A706 steel where welding is proposed. Perform welding, where shown or approved, by the direct electric arc process in accordance with AWS D1.4 using specified low-hydrogen electrodes. Preheat 6 inches each side of joint. Protect joints from drafts during the cooling process; accelerated cooling is prohibited. Do not tack weld bars. Clean metal surfaces to be welded of all loose scale and foreign material. Clean welds each time electrode is changed and chip burned edges before placing welds. When wire brushed, the completed welds must exhibit uniform section, smooth welded metal, feather edges without undercuts or overlays, freedom from porosity and clinkers, and good fusion and penetration into the base metal. Cut out welds or parts of welds found defective with chisel and replace with proper welding. Prequalification of welds shall be in accordance with Code.

## **PART 3 - EXECUTION**

### **3.01 PLACEMENT**

- A. Coordinate with placement of formwork, formed openings, and other work.
- C. Place, support, and secure reinforcement against displacement. Do not deviate from required position. Spot welding of chairs or other items to reinforcing steel is not permitted.
- D. Provide additional reinforcing bars at wall and slab openings as detailed. Before placing bars, and again before concrete is placed, clean bars of loose mill scale, oil, or any other coating that might destroy or reduce bond.
- E. Drill, install, and bond reinforcing steel dowels into existing concrete as indicated on the drawings, in accordance with Caltrans Section 75 1.03 using the approved magnesium phosphate concrete (not mortar) and in accordance with the approved plan, procedures, and materials.
- F. Maintain concrete cover around reinforcing as indicated on drawings.

- G. Securing in Place: Accurately place bars and wire tie in precise position where bars cross. Bend ends of wire ties away from the forms. Wire tie bars to corners of ties and stirrups. Support bars according to CRSI's Placing Reinforcing Bars using approved accessories and chairs. Place precast concrete cubes with embedded wire ties to support reinforcing steel bars in concrete placed on grade and in footings. Use care not to damage vapor barriers where they occur.
- H. Exposed Concrete Surfaces: Provide stainless steel or exterior quality vinyl plastic tipped chairs, bolsters, and accessories where exposed on exterior or interior concrete surfaces not to be painted or permanently covered.
- I. Splices: Do not splice reinforcing bars at the points of maximum stress except where indicated. Lap splices as shown or required to develop the full strength or stress of bars. Stagger splices in horizontal wall bars at least 48 inches longitudinally in alternate bars and opposite faces.
- J. Field Welding of Bars: As specified for fabrication.
- K. Maintaining Bars In Position: Take adequate precautions to assure that reinforcing position and spacing is maintained during placement of concrete.
- L. Reinforcing Mesh: Lap one full mesh plus 2 inches, but not less than 6 inches. At splices, wire tie, and support the same as specified for bars.

### **3.02 FIELD QUALITY CONTROL**

- A. The OCTA Project Manager will perform field inspection under Section 01 45 00, Quality Control. Reinforcement shall be placed in accordance with the approved detailed shop drawings.
  - 1. Inspection: Obtain inspection and approval of reinforcing before concrete is placed.
  - 2. Welding Inspection. Whether welding is done in the shop or at the site, perform welding of reinforcing bars under inspection of the testing laboratory welding inspector retained by OCTA.

### **PART 4 – MEASUREMENT AND PAYMENT**

- A. No separate measurement or payment will be made for the work of this section.

**END OF SECTION**

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**SECTION 03 30 00**

**CAST-IN-PLACE CONCRETE**

**PART 1 - GENERAL**

**1.01 SUMMARY**

**A. Section Includes:**

1. Furnishing, placing, testing, repair/patching, and initial curing of cast-in-place concrete unless otherwise specified.
2. Grout and drypack, except as otherwise specified.
3. Placing of embedded anchor bolts and inserts.
4. Vapor barrier under slabs on grade.
5. Miscellaneous concrete work and other items as shown or required to complete the work.

**B. Related Sections:**

- 1 Section 01 33 00: Submittal Procedures
- 2 Section 01 43 00: Project Quality Assurance
- 3 Section 01 60 00: Product Requirements
- 4 Section 03 05 15: Portland Cement Concrete
- 5 Section 03 11 00: Concrete Forming
- 6 Section 03 20 00: Concrete Reinforcement

**C. Section Does Not Include:**

1. The provision of this section shall not apply to:
  - a. Section 32 13 13, Concrete paving.
  - b. Section 32 16 14, Concrete Curbs and Gutters.

**1.02 REFERENCES**

**A. American Association of State Highway and Transportation Officials (AASHTO):**

1. AASHTO M171 - Sheet Materials for Curing Concrete

2. AASHTO M182 - Burlap Cloth Made from Jute or Kenaf
- B. American Concrete Institute (ACI):
1. ACI 117 - Tolerances for Concrete Construction & Materials and Commentary
  2. ACI 301 - Structural Concrete
  3. ACI 304R - Measuring, Mixing, Transporting, and Placing Concrete
  4. ACI 304.2R - Placing Concrete by Pumping Methods
  5. ACI 305R - Hot Weather Concreting
  6. ACI 309R - Consolidation of Concrete
  7. ACI 318 - Building code Requirements for Structural Concrete
  8. ACI SP-15 - Standard Specification for Structural Concrete
- C. ASTM International (ASTM):
1. ASTM C33 - Concrete Aggregates
  2. ASTM C42 - Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
  3. ASTM C94 - Ready-Mixed Concrete
  4. ASTM C150 - Portland Cement
  5. ASTM C171 - Sheet Materials for Curing Concrete
  6. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete
  7. ASTM C881 - Epoxy-Resin-Base Bonding Systems for Concrete
  8. ASTM D994 - Preformed Expansion Joint Filler for Concrete (Bituminous Type)
  9. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber
  10. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam)
  11. ASTM D1751 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
  12. ASTM D1752 - Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
  13. ASTM D3740 - Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D. South Coast Air Quality Management District (SCAQMD) Volatile Organic Compounds (VOC) regulations

E. Caltrans: State of California Department of Transportation, Standard Specifications

**1.03 QUALITY ASSURANCE**

- A. Comply with Section 01 43 00 - Project Quality Assurance, for Quality Assurance Requirements.
- B. Qualifications of Concreting Supervisor; Responsible charge experience in placing, consolidating and curing portland cement concrete in structures similar to those of this Contract.
- C. Comply with South Coast Air Quality Management District (SCAQMD) regulations for Volatile Organic Compounds (VOC).
- D. Construction tolerances allowable for various cast-in-place concrete components shall be per ACI 117.
- E. Obtain material from same source throughout work.
- F. Furnish materials in manufacturer's packaging with applicable instructions.

**1.04 SUBMITTALS**

- A. Refer to Section 01 33 00 - Submittal Procedures, for submittal requirements and procedures.
- B. For each concrete placement operation:
  - 1. Detailed descriptions of intended equipment and methods for conveying, placing, consolidating, preliminary finishing and curing of concrete.
  - 2. Ready-mix delivery tickets: In accordance with ASTM C94.
  - 4. Detailed description of proposed methods for protecting fresh concrete from inclement weather and extremes of temperature.
  - 5. Location of concrete placement with scheduled date, intended rate of placing, mix design designation and updates.
  - 6. Special concrete placement and compaction procedures.
  - 7. Proposed method capable of controlling concrete temperature at time of placement between 55°F minimum, 90°F maximum.

**1.05 DEFINITIONS**

- A. "As indicated": Plan, elevation, sections, details, and general notes shown on approved contract drawings, shop drawings, and working drawings Approved for Construction by OCTA Project Manager and as specified herein.

**1.06 WORKSITE CONDITIONS**

**A. Environmental Requirements:**

1. Hot weather concreting: Maximum temperature as recommended in ACI 305R.
  - a. Do not allow temperature of concrete, when deposited, to exceed 90F during hot weather.
  - b. When ice is used to maintain concrete temperature, add with or without water; include weight of ice in calculation of water cement ratio.
  - c. Protect concrete from direct sunlight during curing period.
  - d. Keep concrete moist with cool water sprinkling, wet burlap or cotton mats, or other acceptable methods which do not adversely affect concrete.
2. Wet Weather: Do not place concrete in locations exposed to weather if rain intensity is expected to wash cement paste off aggregate, unless adequate shelter for concrete has been provided.

**B. Inspection Immediately Before Concreting:**

1. Substrate Surface Condition
  - a. Verify surface is hard, reasonably level, slightly moist, and free from loose, saturated and frosty material and debris.
  - b. Verify previously placed concrete has been prepared for bonding as specified and is free from loose and extraneous matter.
2. Membrane: Verify hydrocarbon resistant (HCR) membrane has been placed, is intact, and joints and penetrations have been sealed and that all required QC inspections have been completed.
3. Products to be Embedded:
  - a. Inspect anchorage devices, remove defective pieces, install new pieces, and correct omissions, improper positioning, and weaknesses in fastenings.
  - b. Verify pipes and conduits to be embedded are satisfactorily tested, with external threads capped, internally-threaded and non-threaded ends plugged, and anchorage devices secured in indicated locations.
4. Formwork: Inspect for defects in alignment, grade and integrity of bracing, tie-bolts, falsework, camber, and joints; eliminate defects.
5. Concrete Reinforcement: Inspect for quantity, sizes and positioning. Verify fastenings will prevent displacement.
6. Do not place concrete until inspection has been completed and defects have been corrected.

- C. Where reinforcement is so congested concrete placement is impeded, implement special concrete placement and compaction procedures, with prior acceptance of OCTA Project Manager.

#### **1.07 DELIVERY, STORAGE, AND HANDLING**

- A. Refer to Section 01 60 00 - Product Requirements, for general requirements for product delivery, storage and handling procedures.
- B. Transport and deliver concrete in accordance with ASTM C94, ACI 304R and this Section.
- C. Arrange and maintain delivery schedules; once placement has begun, do not delay more than 30 minutes between fresh deposits and previously placed deposits.
- D. Handle, store and batch concrete materials to prevent contamination, dampness, segregation and other conditions detrimental to final product.

### **PART 2 - PRODUCTS**

#### **2.01 MATERIALS**

- A. Class 2500 (2500 psi) for curbs, curb and gutter and sidewalks. Class 4000 (4000 psi) for concrete pavement, unless otherwise indicated.
- B. Non-Slip Material: Nonmetallic, dry shake, emery or silica quartz abrasive aggregate.
- C. Water: Any potable additional water required during placement of concrete shall be in accordance with CRD-C400.
- D. Sand: Clean, dry, natural or manufactured sand, free from clay lumps, rocks and debris for under/over vapor barrier.
- E. Reinforcement: As specified in Section 03 20 00 - Concrete Reinforcement.

#### **2.02 ACCESSORIES**

- A. Curing Materials:
  - 1. Burlap - Double thickness conforming to AASHTO M182, Class 3.
  - 2. Sheet Materials - Conform to ASTM C171.
  - 3. White Polyethylene Sheeting - Conform to AASHTO M171.
  - 4. Liquid Membrane Forming Curing Compound - Conform to ASTM C309, Type 1-D or 2 as selected by OCTA Project Manager. Certify Class B curing agent will not affect bond of subsequent finishes. Comply with SCAQMD rules and Federal air quality regulation 40 CFR 52.254.

- a. Type 1-D compound, containing fugitive dye readily distinguished upon concrete surface and will become inconspicuous within seven days after application.
  - b. Type 2 compound, containing white pigment that when applied to surface exhibits reflectance not less than 60 percent of magnesium oxide. Use where surfaces are subjected to sunlight.
  - c. Products: Subject to compliance with requirements, use Mastercure 100 WB, BASF Construction Chemicals, 100-Clear Series, W. R. Meadows or equal approved.
- B. Hardener:
  - 1. Furnish hardener conforming to ASTM C309 and consisting of one of the following:
    - a. Blend of magnesium fluosilicate and zinc flousilicate combined with wetting agent, containing not less than two pounds of flousilicate per gallon.
    - b. 35 percent sodium silicate having a specific gravity corresponding to 42 degrees as tested by the Baume Method.
  - 2. Hardener - Penetrating compound, leaving no residue, compatible with abrasive aggregate, curing compound, sealer and subsequent floor finishes.
  - 3. Hardener may be combined with a curing agent and sealer to form a single compound conforming to these requirements.
- C. Mortar for Patching Concrete: One part portland cement of type and manufacture used in damaged concrete to two parts fine aggregate conforming to ASTM C33.
- D. Grout for Bond New Concrete to Set Concrete: Equal parts of portland cement and fine aggregate by weight and not more than six gallons water per sack cement.
- E. Vapor Barrier: Six-mil polyethylene.
- F. Neoprene Membrane for Noise and Vibration Control: Closed cell neoprene expanded rubber conforming to ASTM D1056, Grade RE-45L, and as indicated.
- G. Epoxy-Resin Adhesive: In conformance with ASTM C881. Concreseive Epoxy by BASF, Sikadur Epoxy by Sika Corporation, HVA Capsule Anchors by Hilti, Ultrabond by Adhesives Technology Corporation or equal, subject to approval by OCTA Project Manager.
- H. Construction Joint Materials:
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved as a comparable product:
    - a. Key-Loc Joints, Form-a-Key Products.

- b. Keyway PVC Tongue and Groove Joint Form, Sealtite by W. R. Meadows

**2.03 DRYPACK AND GROUT MIXES**

- A. 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 as follows:
  - 1. Products: Subject to compliance with requirements, provide one of the following, or equal approved as a comparable product:
    - a. Set Grout, BASF Building Systems.
    - b. Dry Pack Grout, Euclid Chemical Company.
- B. Portland Cement Grout:
  - 1. Prepare grout consisting of portland cement, sand, and water.
  - 2. Use portland cement grout in recesses, holes, and surfaces under structural members, and at other locations shown.
  - 3. Do not use staining ingredients in grout exposed to view.
  - 4. Formulation: Two parts sand and one part cement measured by volume. Mix grout with sufficient water to permit placing and packing, approximately 45 minutes before use.
- C. Non-Shrink Grout: Furnish factory premixed such that only water is added at the jobsite. Mix in a mechanical mixer with the minimum amount of water necessary to produce a workable grout. Non-shrink grout shall conform to ASTM C1107, Grade A, and shall be a commercial formulation suitable for the proposed application. Grout shall be capable to attain a minimum of 7000 psi strength, unless a higher strength is noted on the gdrawings. Subject to compliance with requirements, provide one of the following, or equal approved as a comparable product:
  - 1. L & M Crystex
  - 2. Master Builders "Masterflow 713 Grout"
  - 3. U. S. Grout "Five Star Grout"
- D. Epoxy Grout:
  - 1. Epoxy grout for bonding freshly-mixed concrete to existing or previously poured concrete shall be in conformance with ASTM C881, Type II
  - 2. Two-component liquid epoxy adhesive with inert aggregate filler and appropriate viscosity for intended use.
  - 3. Factory pre-packaged separately and field mixed.
  - 4. Mix in proportions according to manufacturer's recommendations.

5. For floors and horizontal surfaces (Low viscosity):
  - a. Adhesive Engineering "Concresive 1463"
  - b. Sika "Hi-Mod LV"
6. For floors and horizontal surfaces (Medium viscosity):
  - a. Adhesive Engineering "Concresive 1000"
  - b. Sika "Hi-Mod LPL"
7. For vertical and overhead applications (Non-sag consistency):
  - a. Adhesive Engineering "Concresive 1441"
  - b. Sika "Hi Mod Gel"
8. Aggregate: As recommended by epoxy grout manufacturer.
9. Water: Clean and free from deleterious substances.

## **2.04 FINISHES**

- A. Surface Sealer: Surface sealers shall be clean, penetrating, non-glossy, non-darkening and nearly imperceptible after curing with no surface buildup. Coating/sealer - Water repellent - Effective against chlorides. Composition - Alkyl - Alkoxy Silixane with long alkyl groups.

## **PART 3 - EXECUTION**

### **3.01 PREPARATION**

- A. Verify HCR membrane for slabs-on-grade has been properly installed as specified in Section 07 13 19 - Hydrocarbon-Resistant Membrane for Cast-In-Place Concrete.
  1. Before placing reinforcement and concrete, verify subgrade and base are smooth and free from debris.
  2. Place mud slab uniformly over areas to receive membrane.
  3. Dampen 24 hrs. before placing concrete, but do not muddy, re-roll where necessary for smoothness and remove loose material.
- B. Install vapor barrier under slabs-on-grade, except where hydrocarbon-resistant membrane is used, as follows:
  1. Before placing reinforcement and concrete, verify subgrade and aggregate base are smooth and free from debris.
  2. Lay vapor barrier on undisturbed sand. Lap side and end joints not less than four inches and seal watertight. Inspect vapor barrier for punctures and tears; patch penetrations in same manner as joints.

3. Dampen 24 hrs. before placing concrete, but do not muddy, re-roll where necessary for smoothness and remove loose material.
- C. 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.
- D. Wet wood form sufficiently to tighten up cracks. Wet other materials sufficiently to reduce absorption and to help maintain concrete workability.
- E. Provide concrete in accordance with Section 03 05 15 - Portland Cement Concrete.
- F. Working Platforms: Arrange temporary runways for buggies. Support runways on formwork, not on reinforcing.
- G. Immediately before placing concrete, ensure required volume of concrete will be delivered in manner to permit placement at constant rate. Do not use aluminum components for conveying concrete.
- H. Immediately before placing concrete, check forms, falsework and shoring; make adjustments to ensure finished Work will conform to indicated lines and grades. Provide plumb lines and tell-tales to permit ready measurement by OCTA Project Manager to determine settlement and deviation from Contract Drawing requirements.
- I. Do not place concrete until formwork, hydrocarbon-resistant membrane where indicated, reinforcing steel and embedded items have been checked and appropriate placement certification has been signed by Contractor and accepted by OCTA Project Manager.
- J. Embedments in Concrete: Position embedded steel items, inserts, pipes, conduits and anchors, and securely support as specified in Sections of architectural, electrical and mechanical Work and as indicated.
- K. Concrete Reinforcement: Except as indicated, install concrete reinforcement as specified in Section 03 20 00 - Concrete Reinforcement. Verify requirements for concrete cover over reinforcement.
- L. Set screeds before placing concrete.
  1. Set screeds at walls and maximum 8'-0" centers in between. Set to provide level floor, check with an instrument level, transit, or laser during placing operation to maintain level floor.
  2. Use weighed pads or cradle type screeds over vapor barriers. Do not drive stakes through the vapor barriers.
- M. Verify that the decking joints are sealed and there are no openings or voids that will permit concrete leakage.

- N. Provide shores for tributary construction loads to floor and roof beam as required, or camber the beams as approved by Architect/Engineer.

### **3.02 BONDING**

- A. Bond New Concrete to Existing Concrete. Roughen surface to ¼" amplitude and clean concrete as required to remove laitance, coatings, loose particles and foreign matter; clean reinforcing steel and uniformly expose clean coarse aggregate before applying grout or placing new concrete. Coat the surface with bonding epoxy in accordance with manufacturer's instructions.

### **3.03 CONVEYING OR PUMPING OF CONCRETE**

- A. Conveying: Convey concrete from mixer with equipment acceptable to OCTA Project Manager to ensure continuous flow of concrete to point of placement without segregation or loss of mortar.
- B. Belt Conveyors: Slope belt conveyors to prevent segregation and loss of mortar. Provide approved arrangement at discharge end of conveyor to prevent segregation. Discharge long conveyor runs of concrete into hopper, without segregation, before depositing in forms.
- C. Chutes and Open Troughs: Provide non-aluminum metal or metal-lined chutes and open troughs where steep slopes are required. Equip chutes and troughs with baffles to minimize segregation of aggregates. Keep chutes and open troughs clean of hardened concrete; thoroughly flush with water after each use. Discharge cleaning water outside the line of structure. Chute and open trough slope - Do not exceed one foot vertical in two feet horizontal and not less than one foot vertical to three feet horizontal. Discharge concrete from chutes 20 feet or more in length into hopper before final distribution.
- D. Adjustable Length Pipes (Elephant Trunks):
  - 1. Flexible pipes of metal, rubber or plastic will be permitted provided they are of four inch minimum diameter and used in manner to prevent segregation of concrete.
  - 2. Locate pipe and flexible pipe so concrete is delivered in continuous flow to points not more than five feet horizontally and five feet vertically from final location. In vicinity of construction joints, reduce horizontal distance to three feet maximum.
  - 3. Clean flexible pipes or elephant trunks after each use.
  - 4. Do not use aluminum.
- E. Buggies: Construct runways on which buggies will operate; ensure buggies will not come in contact with or be supported by reinforcing steel. Do not use buggies on concrete which has not achieved full design strength. Do not use aluminum buggies.

**F. Pumping:**

- 1 Provide suitable pumping and pneumatic conveying equipment sized to adequately handle volumes of concrete conveyed. Provide equipment acceptable to OCTA Project Manager. Control pneumatic equipment to prevent segregation in discharged concrete. Operate pump or pneumatic equipment to produce continuous stream of concrete without air pockets. Position discharge end of line as near final position of concrete as possible; do not exceed five feet. Position discharge lines horizontal, inclined upwards or vertical from machine. After each operation and at conclusion of placement, thoroughly clean equipment; waste debris and flushing water outside of forms. Place concrete in horizontal layers not more than 18" high within 90 minutes after water is first added to batch. Place all concrete by methods that prevent segregation of materials.
- 2 Equipment:
  - a. Install, operate and maintain equipment in accordance with reviewed and accepted Working Drawings and with ACI 304R.
  - b. Have spare equipment available to minimize delay should equipment breakdown occur.
  - c. Do not use aluminum for pumping concrete.
- 3 Preparation:
  - a. Before charging pipe line, operate pump and verify moving parts will operate satisfactorily.
  - b. Pump portland cement grout through line immediately ahead of concrete. Unless pumped grout will be used for bedding at construction joints, transport pumped grout off Worksite.
- 4 Clean-Up:
  - a. At end of pumping operation, purge line from placement area to pumping area with water. Dump waste concrete in container and remove from Worksite.
  - b. Immediately after purging line thoroughly clean lines and pumping system equipment.

**3.04 JOINTS**

- A. Construction Joints - As indicated.
1. Locate joints as indicated, or when not indicated at reveals and rustications. Do not impair strength of structure nor adversely affect appearance when exposed to view.
  2. Provide longitudinal keys or inclined dowels at least 1 1/2 inches deep at joints in walls and between walls and slabs or footings unless otherwise indicated. Make other construction joints without keys, except where keys are indicated. Where keys are indicated, form keyways to dimensions indicated.
  3. When indicated or permitted, obtain bond surface using acceptable chemical retarder to delay but not prevent setting of surface mortar. Remove retarded mortar within 24 hours after placement; produce clean exposed coarse aggregate bonding surface.
  4. After pour has been completed to construction joint, and before placement of fresh concrete, clean reinforcing steel and surfaces of construction joints free of surface laitance, curing compound, and other materials foreign to concrete. Clean hardened concrete surfaces by abrasive blast methods to expose coarse aggregate, after curing period or immediately before placing concrete at joint. Surfaces of concrete in-place not more than eight hours may be cleaned with air and water jets if surface laitance is removed and clean coarse aggregate is exposed. Clean surfaces of construction joints of dirt, sawdust and other loose materials. Moisten surfaces, on which concrete is to be placed, with water immediately before placing concrete.
  5. When necessary to make construction joint because of emergency, furnish and place additional reinforcing steel across joint as required.
  6. On-Grade Slab Construction and Contraction Joints: Use types as indicated at column lines intermediate locations.
  7. Expansion Joints: Conform to Drawing details and approved submittal. Provide expansion joint filler finished flush with slab surface except for those joints shown to be sealed with sealant. Conform to Section 07 92 00, Joint Sealants, where sealant sealed joints are shown or specified, including multicomponent urethane sealant, backing, and bond breaker.
  8. Control Joints: Provide for concrete slabs as indicated. 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.

9. On-Grade Slab Construction and Contraction Joints: Use standard types equal to Key-Loc construction joint at column lines and Keyway contraction joint at intermediate spacings. Machine saw cut 1/8 inch by 3/4 inch deep intermediate joints where indicated or approved. Conform to approved submittal.

- B. Neoprene Membrane for Noise and Vibration Control - Install as indicated.

### **3.05 PLACING CONCRETE**

- A. Depositing:
  1. Deposit concrete continuously and as rapidly as practicable after mixing.
  2. Do not use vibrators to shift mass of fresh concrete.
  3. Do not deposit concrete at rate which would endanger formwork or at rate faster than placing crew can properly consolidate placed concrete. Do not deposit concrete on concrete which has hardened sufficiently to cause formation of seams (cold joints) or planes of weakness within Section. Cover each concrete lift with fresh concrete within 30 minutes.
  4. Deposit concrete in continuous flow to points not more than five feet horizontally and five feet vertically from final location.
  5. Remove temporary spreaders in forms when concrete has reached an elevation making spreaders unnecessary. Spreaders may remain embedded in concrete only if made of concrete or nonstaining metal, and with prior acceptance of OCTA Project Manager.
  6. Place concrete for columns and walls through adjustable flexible pipes or elephant trunks. Stop placement of concrete in walls and columns 1-1/2 inch below bottom of beams or supported slabs. Stop placement at sills and heads of wall openings in the same manner. Allow concrete in vertical elements to be in place at least 2 hours and until vertical settlement has ceased before placing concrete for floor framing.
  7. Maximum vertical lift heights shall be 4 ft. in an hour. Contractor shall take precaution when pouring walls with thickness greater than 4" in order to ensure form pressures do not result in bulging or failures of form resulting in blowout.
- B. Placement: Not permitted when, in opinion of OCTA Project Manager, sun, heat, wind, or limitations of facilities furnished by Contractor prevent proper finishing and curing of concrete.
- C. Deposit concrete as near as practicable to final position, and in continuous flow. Do not allow mortar to separate from aggregate.
- D. Deposit concrete against leading face of lift being placed.
- E. Deposit concrete continuously in level layers of thickness which can be properly consolidated; cover previously-placed layers before concrete has begun to harden.

Start placing at low point and proceed up grade unless otherwise permitted by OCTA Project Manager.

- F. When truck or agitator is used for transporting concrete to delivery point, complete discharge within 1 1/2 hours, or before 300 revolutions of drum or blades, whichever comes first, after introduction of mixing water to cement and aggregates except as permitted by ASTM C94. Under conditions contributing to quick stiffening of concrete, and when concrete temperature is 90°F or above, less than 1 1/2 hours may be required.
- G. Concrete Deposited Under Water: Do not deposit concrete under water except in manner acceptable to OCTA Project Manager; use acceptable tremie method.
- H. Do not permit fresh concrete to fall more than five feet without use of adjustable length pipes.
- I. Do not retemper partially hardened concrete with additional water.

### **3.06 CONSOLIDATING CONCRETE**

- A. Consolidate concrete during placement until voids have been filled and free mortar appears on surface.
- B. Compaction:
  - 1. As concrete is being placed, compact concrete thoroughly and uniformly by means of mechanical vibration in order to secure a dense mass, close bond with reinforcement, and a smooth surface. Work concrete well around reinforcement, embedded items and into corners of forms.
  - 2. Use internal vibration unless OCTA Project Manager specifically requests use of external vibrators for consolidating when concrete is inaccessible for adequate internal consolidation. When external vibration is required, construct forms sufficiently rigid to resist displacement and damage from vibrations.
  - 3. Provide vibrators capable of generating vibration at frequencies not less than 9,000 impulses per minute. Check vibrators; ensure good condition before starting concrete placement. Provide sufficient number of vibrators to properly consolidate each batch of concrete immediately after placement in forms. Determine size of vibrators by space available for use in forms between reinforcing bars. Provide not less than one spare vibrator, for each size, in good Working condition at site of pour for emergency use.
  - 4. Use external vibrators of size, type and operation acceptable to OCTA Project Manager.
  - 5. Use experienced Workmen to operate vibrators in accordance with ACI 309R. Provide location, manner and duration of application to ensure maximum consolidation of concrete without causing segregation of mortar and coarse aggregate. Vibrate deposited concrete in manner to prevent damage to forms, damage and displacement of reinforcement and

embedded materials, and segregation in concrete. Prevent formation of laitance and accumulation of excessive water on surface as concrete is deposited. Remove excessive water accumulation by pumping, bailing or other methods satisfactory to OCTA Project Manager before additional concrete is placed. Do not penetrate previously placed layers more than two inches in order to consolidate layers and prevent overvibration of previously vibrated layer. Where, in opinion of OCTA Project Manager, internal vibration is impractical or might cause damage to electrical conduits, spade or rod as required; internal vibration will not be permitted.

6. When spading, thoroughly compact coarse aggregate away from form and into plastic mass. Perform spading with approved equipment and rod concrete around embedded materials, and into corners and spaces to ensure even, dense surface, free from aggregate pockets and honeycomb.
- C. Vibrate concrete only as necessary to obtain maximum consolidation without segregating mortar and coarse aggregate, and without causing water and cement paste to flush to surface.
- D. Space points of vibrator insertion at 1 1/2 times radius of action recommended by ACI 309R, Table 5.1.4 for particular application.
- E. Revibrate approximately 15 minutes after initial vibration to remove air and limit settlement cracking, by raising vibrator at a rate of one foot in three seconds.
- F. Do not officially transport concrete in forms with vibrators nor allow vibrators to contact forms or reinforcing. Push vibrator vertically into the proceeding 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.

### **3.07 FINISHES**

- A. Formed surfaces not exposed to view shall receive ordinary surface finish in accordance with Caltrans Standard Specification Section 51-1.3F(2), Ordinary Surface Finish.
- B. Formed surfaces exposed to view shall receive Class 1 surface finish in accordance with Caltrans Standard Specification Section 51-1.3F(2), Class 1 Surface Finish.
- C. Fresh concrete at unformed surfaces, other than construction joints, shall be tamped, struck off level, and given a wood float finish that provides a surface free of undulations greater than 1/4 inch in 10 feet. Surfaces subject to pedestrian or vehicle traffic shall receive a broom finish.

### **3.08 CURING**

- A. Protect freshly deposited concrete from excessively hot temperatures as specified; maintain without drying for period of time necessary for hydration of cement and

proper hardening of concrete. Provide material for curing and protection of concrete at Worksite ready for use before starting actual placement of concrete.

1. Provide, and use when necessary, sufficient tarpaulins or other acceptable material to cover completely, or enclose forms and Working areas during placing and finishing operations.
2. Except as otherwise specified, maintain newly placed concrete continuously moist for seven days (three days for high-early strength) at air temperature above 50 F.
3. Cure concrete by normal curing methods as specified, unless otherwise permitted by OCTA Project Manager.
4. Provide clean and potable water for curing concrete.
5. Maintain steel forms and wood forms, exposed to sun and in contact with concrete, moist during curing period. If forms are removed during curing period, employ one of following curing materials or methods immediately and continue for remainder of curing period.

**B. Moist Curing and Protection:**

1. Moist cure concrete by one of methods specified below:
  - a. Ponding on horizontal surfaces, providing surface is submerged for required curing period.
  - b. Continuous sprinkling with nozzle or nozzles which, during first 24 hours, atomizes flow of water, providing mist and not spray. Do not apply moisture under pressure directly upon concrete and do not allow water to flow or wash surface and cause erosion.
  - c. Covering entire surface of concrete with burlap or absorptive mat or fabric laid directly on concrete and kept wet at all times.
  - d. Sprinkling, as specified above, for at least 18 hours and then immediately covering concrete surface with waterproof paper or plastic sheeting free from holes and tears; maintain in position so entire surface of concrete being cured is fully covered.
2. When using burlap or cotton mats for curing concrete, prevent damage and marring of concrete surfaces.

**C. Membrane-Forming Curing: Apply compounds uniformly over surface at thickness recommended by manufacturer.**

1. Do not apply compounds to surfaces where bond is required for additional concrete, and where bonded surface coating such as paint, nonconductive flooring or tile is to be applied, unless certified compatible with subsequent finish and acceptable to OCTA Project Manager.
2. Warm curing compound that has become chilled to such a degree that it is too viscous for satisfactory application in accordance with manufacturer's recommendations. Repair portions of compound film, damaged before expiration of curing period, immediately with additional compound.

3. Apply required surface finish before application of curing compounds. Apply curing compound as recommended by manufacturer for desired effect. Apply immediately after stripping forms and acceptance of concrete finish. If surface is dry, wet concrete with water and apply curing compound just as surface film of water disappears. Apply second coat, if required, after first application has set. During curing operations wet unsprayed surfaces with water. Protect coating against damage at least 10 days after application. If surface coating is subjected to disturbance, OCTA Project Manager may require water curing be applied at once. If use of curing compound results in streaked or blotchy appearance, stop method and perform water curing as specified until cause of defective appearance is corrected.
4. Uniformly apply compound over surface at application rate recommended by compound manufacturer.
  - a. Surfaces exposed to sunlight - Pigmented type.
  - b. Surfaces protected from sunlight - Clear type.
5. Apply non-wax resin type curing compounds to surface where bond is required for additional concrete or where a bonded surface coating such as paint, tile, waterproofing or roofing will be applied.
6. Do not apply curing compound to construction joints, to permanently exposed concrete floors, and walls that will be chemically sealed.

### **3.09 PROTECTION OF COMPLETED WORK**

- A. During curing period, protect concrete against damage from mechanical disturbances, water flow, loading, shock and vibration.
- B. Protect concrete from physical damage or visual defects until Work is accepted by OCTA Project Manager.
- C. Seal the surface as specified in Section 03 35 05, Unformed Concrete Finishes.

### **3.10 FIELD QUALITY CONTROL**

- A. Provide free access to OCTA Project Manager to the work site(s) to facilitate quality control measures, testing and inspections. Cooperate with all inspection personnel.
- B. Level of Slabs: Continuously monitor concrete placing to maintain level platforms and slabs by use of an instrument level, transit, or laser.
- C. Continuous Inspection: Construct structural concrete exceeding 2500 psi compressive strength under continuous inspection of inspector. Obtain inspection and approval of forms and reinforcing by building department as required and by the inspector and OCTA Project Manager before placing structural concrete.

- D. Testing of Concrete: Testing laboratory shall perform the 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 100 cubic yards, or fraction thereof, or not less than once for each 2000 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 deg 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.
- E. 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 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.

### **3.11 REPAIR**

- A. Document nonconforming conditions on a Nonconformance Report. Obtain approved Engineering disposition prior to repair. OCTA Project Manager will determine extent and action required to repair or replace defective concrete revealed by surface defects and otherwise. Fill holes and cracks extending through concrete; use plunger-type gun or other suitable device acceptable to OCTA Project Manager from least exposed face; hold flush stop at exposed face.
- B. Repair of Formed Surfaces:
1. Patch defective areas with cement mortar of mix proportions and materials identical to surrounding concrete. Before starting to patch, produce finish on sample patch indistinguishable from appearance of finish of concrete patched immediately after removing forms. Patch in manner and method reviewed and accepted in writing by OCTA Project Manager.
  2. Patch surfaces indicated to receive abrasive blast finish or other type of exposed aggregate finish with patching mortar containing cement and coarse aggregate of type used in surrounding concrete, and in identical proportions to surrounding concrete. Do not patch before abrasive blasting, except when approved by OCTA Project Manager.
  3. Cut out honeycomb, rock pockets and voids having diameter more than 1/2 inch to solid concrete, but not shallower than one inch. Make edges of cuts perpendicular to exposed concrete surface. Before placing cement mortar,

thoroughly clean, dampen, and brush neat cement grout on area to be patched.

4. When reinforcing bars are exposed at rock pockets or when there is insufficient concrete cover around reinforcing bars, concrete around the reinforcing bars shall be chipped out to expose at least 1 inch around the rebar to ensure proper bonding between the rebars and repairing concrete material.

**C. Repair of Unformed Surfaces:**

1. Test surfaces for smoothness and verify conformance of surface plane to tolerances specified. Eliminate low and high areas.
2. Test sloped surfaces for trueness of slope and smoothness; use template of required slope. Eliminate high and low areas.
3. Repair finished surfaces containing defects which adversely affect durability of concrete.
4. Grind high areas of surfaces after concrete has cured sufficiently to make repairs without damaging adjacent areas.
5. Cut out low areas in surfaces during or immediately after completing surface finishing; fill with fresh concrete. Finish repaired areas to blend into adjacent concrete.
6. Cut out defective areas, except random cracks and single holes not larger than one inch in diameter and fill with fresh concrete. Remove defective areas to sound concrete; leave clean, square cuts. Expose reinforcing steel at least 3/4 inch all around. Dampen concrete surfaces which will contact patching concrete and brush with neat cement grout or concrete bonding agent. Place patching concrete before grout initially sets. Mix patching concrete of same materials and in same proportions as adjacent concrete. Place, compact and finish patch to blend with adjacent concrete. Cure patch same as adjacent concrete.
7. Repair isolated random cracks and single holes not larger than one inch in diameter by dry-pack method. Groove tops of cracks, cut out holes to sound concrete, and remove dust, dirt and loose particles. Dampen cleaned concrete surfaces and brush with neat cement grout. Mix dry-pack, consisting of one part portland cement to 2 1/2 parts fine aggregate passing No. 16 sieve; use only amount of water necessary to facilitate handling and patching. Place dry-pack before grout initially sets. Compact dry-pack in-place and finish to match adjacent concrete. Keep patched areas continuously moist not less than 72 hours.

**D. Defective Concrete**

1. Sampling and Testing
  - a. Sampling and testing of cast-in-place concrete deemed defective, as directed by the OCTA Project Manager.
  - b. Test concrete in accordance with ASTM C42.

- c. If testing reveals defective concrete, pay testing laboratory for collecting samples, furnishing equipment, performing tests and certifying tests results.
  - d. If test results do not reveal defective concrete, cost of testing concrete will be reimbursed by OCTA.
- 2. Defective Concrete Criteria
  - a. Defective and unacceptable if average of three core specimens shows less than 85 percent of specified compressive strength, and single core is less than 75 percent of specified compressive strength.
  - b. Defective and unacceptable if structurally unsound, contains cracks or openings affecting water tightness or gas tightness, improperly finished, or not within specified tolerances.
  - c. At discretion of OCTA Project Manager remove and replace unacceptable concrete.
- E. Corrective Work for Defective Concrete
  - 1. If OCTA Project Manager gives permission to correct minor defects, roughen defective concrete to form key and soak remaining concrete surfaces with water before patching with concrete or mortar of color to match surrounding concrete. White cement may be added to patching material to produce same color as original concrete.
  - 2. Clean cavities produced on surfaces by form ties and other holes, honeycomb spots, broken corners, edges and other defects. Saturate cavities with water and point with mortar paste consisting of cement and fine aggregate; mix in generally same proportions as original concrete; match appearance of original concrete.
  - 3. Prepare patching mortar not more than 30 minutes before use. Cure mortar patches properly. Where required, leave joint filler exposed full length with clean and true edges.
  - 4. Leave articulated joints in completed Work carefully tooled and free of mortar and concrete.
  - 5. Protect concrete structure from rust staining by structural steel members and from other substances during Work. If staining occurs, remove stains and restore concrete to original color.
  - 6. Damaged Work: Before final acceptance of Work, repair damaged surfaces, corners of concrete, and concrete finish. Bring damaged places where surface repairs are permitted to smooth, dense, watertight condition to satisfaction of OCTA Project Manager.

### **3.12 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 deg 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.
  - 5. Insulating mixer drums or cooling them with sprays or wet burlap.

### **3.13 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 manufacturers 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 to 6 mm amplitude, 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. Thickness Under Baseplates: 1.5 inches, unless otherwise shown.
  - 4. Protect against rapid loss of moisture with wet rags or polyethylene sheets.
- D. Epoxy Grouting:
  - 1. Holes shall be drilled for anchor bolts, reinforcing bars, and the like.
  - 2. Hole diameter: ¼ inch larger than largest bolt dimension; 1 inch larger than reinforcing bar diameter, unless otherwise specified by epoxy grout manufacture.

3. Minimum depth of drilled hole: ten bolt or reinforcing bar diameters.
4. Holes shall be blown free of dust and latence with compressed air. Compressed air shall be free of oils, moisture or other foreign substances. Prepare holes per manufacture's recommendations.
5. Anchor bolts, reinforcing bars and other embedded items: clean, dry and free of grease or other substances which may interfere with epoxy bonding.
6. Set and position bolts, bars, and place epoxy grout and finish per manufacturer's instructions. Completely fill all voids, spaces and cavities.
7. Any epoxy which overflows out of the grouted holes shall be removed and the concrete surface shall be sandblasted, as required by OCTA Project Manager.
8. Cure in accordance with manufacture's recommendations.
9. Do not disturb embedded items until fully cured.

### **3.14 SITE CONCRETE WORK**

- A. Refer to Section 32 13 13, Concrete Paving and Section 32 16 14, Concrete Curbs and Gutters for requirements for this work.

### **3.15 OFF-SITE CONCRETE WORK**

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

### **3.16 WATER INFLOW IN FINISHED CUT-AND-COVER STRUCTURE**

- A. Water leakage into completed cut-and-cover structures (underground vault) is not permitted.
- B. If leakage is observed in structure, take following remedial measures:
  1. Prepare leak remediation plan for review and acceptance by OCTA Project Manager 10 days before beginning remedial Work.
  2. Undertake remedial measures reviewed and accepted by OCTA Project Manager.
  3. Maintain or re-establish integrity of hydrocarbon-resistant (HCR) membrane.
  4. After sealing of water leakage, repair surfaces, materials and equipment affected by the water leakage to a like-new condition.
  5. Repairs require OCTA Project Manager's acceptance.

**PART 4 – MEASUREMENT AND PAYMENT**

**4.01 MEASUREMENT**

- A. No separate measurement or payment will be made for the work of this section.

**END OF SECTION**