

**SECTION 01 45 29**  
**TESTING LABORATORY SERVICES**

**PART 1 - GENERAL**

**1.1 DESCRIPTION:**

This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained and paid for by Contractor.

**1.2 APPLICABLE PUBLICATIONS:**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
  - T27-06.....Sieve Analysis of Fine and Coarse Aggregates
  - T96-02 (R2006).....Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  - T99-01 (R2004).....The Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop
  - T104-99 (R2003).....Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
  - T180-01 (R2004).....Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
  - T191-02(R2006).....Density of Soil In-Place by the Sand-Cone Method
- C. American Concrete Institute (ACI):
  - 506.4R-94 (R2004).....Guide for the Evaluation of Shotcrete
- D. American Society for Testing and Materials (ASTM):
  - A325-06.....Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
  - A370-07.....Definitions for Mechanical Testing of Steel Products
  - A416/A416M-06.....Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
  - A490-06.....Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
  - C31/C31M-06.....Making and Curing Concrete Test Specimens in the Field
  - C33-03.....Concrete Aggregates

C39/C39M-05.....Compressive Strength of Cylindrical Concrete  
Specimens  
C109/C109M-05.....Compressive Strength of Hydraulic Cement Mortars  
C138-07.....Unit Weight, Yield, and Air Content  
(Gravimetric) of Concrete  
C140-07.....Sampling and Testing Concrete Masonry Units and  
Related Units  
C143/C143M-05.....Slump of Hydraulic Cement Concrete  
C172-07.....Sampling Freshly Mixed Concrete  
C173-07.....Air Content of freshly Mixed Concrete by the  
Volumetric Method  
C330-05.....Lightweight Aggregates for Structural Concrete  
C567-05.....Density Structural Lightweight Concrete  
C780-07.....Pre-construction and Construction Evaluation of  
Mortars for Plain and Reinforced Unit Masonry  
C1019-08.....Sampling and Testing Grout  
C1064/C1064M-05.....Freshly Mixed Portland Cement Concrete  
C1077-06.....Laboratories Testing Concrete and Concrete  
Aggregates for Use in Construction and Criteria  
for Laboratory Evaluation  
C1314-07.....Compressive Strength of Masonry Prisms  
D698-07.....Laboratory Compaction Characteristics of Soil  
Using Standard Effort  
D1143-07.....Piles Under Static Axial Compressive Load  
D1188-07.....Bulk Specific Gravity and Density of Compacted  
Bituminous Mixtures Using Paraffin-Coated  
Specimens  
D1556-07.....Density and Unit Weight of Soil in Place by the  
Sand-Cone Method  
D1557-07.....Laboratory Compaction Characteristics of Soil  
Using Modified Effort  
D2166-06.....Unconfined Compressive Strength of Cohesive Soil  
D2167-94(R2001).....Density and Unit Weight of Soil in Place by the  
Rubber Balloon Method  
D2216-05.....Laboratory Determination of Water (Moisture)  
Content of Soil and Rock by Mass  
D2922-05.....Density of soil and Soil-Aggregate in Place by  
Nuclear Methods (Shallow Depth)  
D2974-07.....Moisture, Ash, and Organic Matter of Peat and  
Other Organic Soils

D3666-(2002).....Minimum Requirements for Agencies Testing and  
Inspection Bituminous Paving Materials  
D3740-07.....Minimum Requirements for Agencies Engaged in the  
Testing and Inspecting Road and Paving Material  
E94-04.....Radiographic Testing  
E164-03.....Ultrasonic Contact Examination of Weldments  
E329-07.....Agencies Engaged in Construction Inspection  
and/or Testing  
E543-06.....Agencies Performing Non-Destructive Testing  
E605-93(R2006).....Thickness and Density of Sprayed Fire-Resistive  
Material (SFRM) Applied to Structural Members  
E709-(2001).....Guide for Magnetic Particle Examination  
E1155-96(R2008).....Determining FF Floor Flatness and FL Floor  
Levelness Numbers

E. American Welding Society (AWS):

D1.1-07.....Structural Welding Code-Steel

**1.3 REQUIREMENTS:**

- A. Accreditation Requirements: Construction materials testing laboratories must be accredited by a laboratory accreditation authority and will be required to submit a copy of the Certificate of Accreditation and Scope of Accreditation. The laboratory's scope of accreditation must include the appropriate ASTM standards (i.e.; E 329, C 1077, D 3666, D3740, A 880, E 543) listed in the technical sections of the specifications. Laboratories engaged in Hazardous Materials Testing shall meet the requirements of OSHA and EPA. The policy applies to the specific laboratory performing the actual testing, not just the "Corporate Office."
- B. Inspection and Testing: Testing laboratory shall inspect materials and workmanship and perform tests described herein and additional tests requested by Contracting Officer's Representative (COR). When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of COR to such failure.
- C. Written Reports: Testing laboratory shall submit test reports to COR, Contractor, unless other arrangements are agreed to in writing by the COR. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D. Verbal Reports: Give verbal notification to COR immediately of any irregularity.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 EARTHWORK:**

- A. General: The Testing Laboratory shall provide qualified personnel, materials, equipment, and transportation as required to perform the services identified/required herein, within the agreed to schedule and/or time frame. The work to be performed shall be as identified herein and shall include but not be limited to the following:
1. Observe fill and subgrades during proof-rolling to evaluate suitability of surface material to receive fill or base course. Provide recommendations to the COR regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to COR extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
  2. Provide part time observation of fill placement and compaction and field density testing in building areas and provide part time observation of fill placement and compaction and field density testing in pavement areas to verify that earthwork compaction obtained is in accordance with contract documents.
  3. Provide supervised geotechnical technician to inspect excavation, subsurface preparation, and backfill for structural fill.
- B. Testing Compaction:
1. Determine maximum density and optimum moisture content for each type of fill, backfill and subgrade material used, in compliance with AASHTO, T99/T180, ASTM, D698, D1557, Method A, ASTM D698 and/or ASTM D1557.
  2. Make field density tests in accordance with the primary testing method following ASTM D2922, AASHTO T238, wherever possible. Field density tests utilizing ASTM D1556, AASHTO T191, or ASTM D2167 shall be utilized on a case by case basis only if there are problems with the validity of the results from the primary method due to specific site field conditions. Should the testing laboratory propose these alternative methods, they should provide satisfactory explanation to the COR before the tests are conducted.
- C. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
- D. Testing Materials: Test suitability of on-site and off-site borrow as directed by COR.

### **3.2 FOUNDATION PILES:**

- A. Witness load test procedure for conformance with ASTM D1143 and interpret test data to verify geotechnical recommendations for pile capacity. Submit load test report in accordance with ASTM D1143.
- B. Review Contractor's equipment, methods, and procedures prior to starting any work on site. Provide continuous inspection of pile installation. Maintain a record of all pertinent phases of operation for submittal to COR.
- C. Cast-in-Place Concrete Piles: Test concrete including materials for concrete as required in Article CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.
- D. Prestressed Concrete Piles:
  - 1. Inspection at Plant: Inspect forms, placement of reinforcing steel and strands, placement and finishing of concrete, and tensioning of strands.
  - 2. Concrete Testing: Test concrete including materials for concrete as required in Article, CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.
  - 3. Test strand for conformance with ASTM A416/A416M and furnish report to COR.
  - 4. Inspect piles to insure specification requirements for curing and finishes have been met.

### **3.3 FOUNDATION CAISSONS:**

- A. Concrete Testing: Test concrete including materials for concrete as required in Article, CONCRETE of this section, except make two test cylinders for each day's placement of concrete.
- B. Maintain a record of concrete used in each caisson. Compare records with calculated volumes.
- C. Inspect percussion hole in bottom of each caisson to determine that material is capable of supporting design load.
- D. Inspect sides and bottom of each caisson for compliance with contract documents.
- E. Submit a certified "Caisson Field Record" for each caisson, recording actual elevation at bottom of shaft; final center line location of top; variation of shaft from plumb; results of all tests performed; actual allowable bearing capacity of bottom; depth of socket into rock; levelness of bottom; seepage of water; still water level (if allowed to flood); variation of shaft (from dimensions shown); location and size of

reinforcement, and evidence of seams, voids, or channels below the bottom. Verify the actual bearing capacity of the rock strata by the use of a calibrated penetrometer or other acceptable method.

F. Caissons Bearing on Hardpan: Take undisturbed samples, suitable for tests required, from caisson bottom. Make auger probe to a depth of 2.5 meters (8 feet) below bottom and visually inspect and classify soil. Verify continuity of strata and thickness.

1. Conduct the following test on each sample, and report results and evaluations to the COR:
  - a. Unconfined Compression Test (ASTM D2166).
  - b. Moisture Content (ASTM D2216).
  - c. Density.

### **3.4 LANDSCAPING:**

- A. Test topsoil for organic materials, pH, phosphate, potash content, and gradation of particles.
  1. Test for organic material by using ASTM D2974.
  2. Determine percent of silt, sand, clay, and foreign materials such as rock, roots, and vegetation.
- B. Submit laboratory test report of topsoil to COR.

### **3.5 ASPHALT CONCRETE PAVING:**

- A. Aggregate Base Course:
  1. Determine maximum density and optimum moisture content for aggregate base material in accordance with AASHTO T180, Method D
  2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with AASHTO T191 and ASTM D1556.
- B. Asphalt Concrete:
  1. Aggregate: Sample and test aggregates in stock pile and hot-bins as necessary to insure compliance with specification requirements for gradation (AASHTO T27), wear (AASHTO T96), and soundness (AASHTO T104).
  2. Temperature: Check temperature of each load of asphalt concrete at mixing plant and at site of paving operation.
  3. Density: Make a minimum of two field density tests in accordance with ASTM D1188 of asphalt base and surface course for each day's paving operation.

### **3.6 SITE WORK CONCRETE:**

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

### **3.7 POST-TENSIONING OF CONCRETE:**

- A. Inspection Prior to Concreting: Inspect tendons, drape of tendons, and anchorage components for compliance prior to concreting.
- B. Concrete Testing: As required in Article, CONCRETE of this section except make three test cylinders representing each area to be tensioned and cylinders shall be cured in same manner as concrete they represent. Make compression test prior to determining minimum specified strength required for post-tensioning.
- C. Post-tensioning: Witness post-tensioning operation and record actual gauge pressures and elongations applied to each tendon.
- D. Submit reports in quadruplicate of the following:
  - 1. Inspection of placement and post-tensioning of all tendons.
  - 2. Size, number, location, and drape of tendons.
  - 3. Calculated elongations, based upon the length, modulus of elasticity, and cross-sectional area of the tendons used.
  - 4. Actual field elongations. Check elongation of tendons within ranges established by manufacturer.
  - 5. Calculated gauge pressure and jacking force applied to each tendon.
  - 6. Actual gauge pressures and jacking force applied to each tendon.
  - 7. Required concrete strength at time of jacking.
  - 8. Actual concrete strength at time of jacking.
  - 9. Do not cut or cover the tendon ends until the Contractor receives the COR's written approval of the post-tensioning records.

### **3.8 CONCRETE:**

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

(duplicate) that ingredients in truck-load mixes conform to proportions of aggregate weight, cement factor, and water-cement ratio of approved trial mixes.

B. Field Inspection and Materials Testing:

1. Provide a technician at site of placement at all times to perform concrete sampling and testing.
2. Review the delivery tickets of the ready-mix concrete trucks arriving on-site. Notify the Contractor if the concrete cannot be placed within the specified time limits or if the type of concrete delivered is incorrect. Reject any loads that do not comply with the Specification requirements. Rejected loads are to be removed from the site at the Contractor's expense. Any rejected concrete that is placed will be subject to removal.
3. Take concrete samples at point of placement in accordance with ASTM C172. Mold and cure compression test cylinders in accordance with ASTM C31. Make at least three cylinders for each 50 cubic yards or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. Label each cylinder with an identification number. COR may require additional cylinders to be molded and cured under job conditions.
4. Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
5. Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 25 cubic yards thereafter each day. For concrete not required to be air-entrained, test every 100 cubic yards at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.
6. If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
7. Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
8. Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
9. Verify that specified mixing has been accomplished.

10. Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
  - a. When ambient air temperature falls below 40 degrees F, record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
  - b. When ambient air temperature rises above 85 degrees F, record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
11. Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
12. Observe conveying, placement, and consolidation of concrete for conformance to specifications.
13. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
14. Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
15. Observe preparations for placement of concrete:
  - a. Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
  - b. Inspect preparation of construction, expansion, and isolation joints.
16. Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
17. Observe concrete mixing:
  - a. Monitor and record amount of water added at project site.
  - b. Observe minimum and maximum mixing times.
18. Measure concrete flatwork for levelness and flatness as follows:
  - a. Perform Floor Tolerance Measurements  $F_F$  and  $F_L$  in accordance with ASTM E1155. Calculate the actual overall F- numbers using the inferior/superior area method.
  - b. Perform all floor tolerance measurements within 48 hours after slab installation and prior to removal of shoring and formwork.
  - c. Provide the Contractor and the COR with the results of all profile tests, including a running tabulation of the overall  $F_F$  and  $F_L$

values for all slabs installed to date, within 72 hours after each slab installation.

19. Other inspections:

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

C. Laboratory Tests of Field Samples:

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

**3.9 REINFORCEMENT:**

- A. Review mill test reports furnished by Contractor.
- B. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.
- C. Written report shall include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.
- D. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

**3.10 SHOTCRETE:**

- A. Inspection and Material Testing:

1. Provide field inspection and testing service as required by COR to certify that shotcrete has been applied in accordance with contract documents.
2. Periodically inspect and test proportioning equipment for accuracy and report deficiencies to COR.
3. Sample and test mix ingredients as necessary to insure compliance with specifications.
4. Sample and test aggregates daily and as necessary for moisture content. Report instances of excessive moisture to COR.
5. Certify, in duplicate, that ingredients and proportions and amounts of ingredients in shotcrete conform to approved trial mixes.
6. Provide field inspection of the proper size and placement of the reinforcement in the shotcrete.

B. Shotcrete Sampling:

1. Provide a technician at site of placement to perform shotcrete sampling.
2. Take cores in accordance with ACI 506.
3. Insure maintenance of water-cement ratio established by approved trial mix.
4. Verify specified mixing has been accomplished.

C. Laboratory Tests of Field Sample Panels:

1. Compression test core for strength in accordance with ACI 506. For each test series of three cores, test one core at 7 days and one core at 28 days. Use remaining core as a spare to be tested at either 7 or 28 days as required. Compile laboratory test reports as follows: Compressive strength test shall be result of one core, except when one core shows evidence of improper sampling or testing, in which case it shall be discarded and strength of spare core shall be used.
2. Submit certified compression test reports (duplicate) to COR. On test report, indicate following information:
  - a. Core identification number and date cast.
  - b. Specific location at which test samples were taken.
  - c. Compressive strength of shotcrete in MPa (psi).
  - d. Weather conditions during placing.
  - e. Temperature of shotcrete in each test core when test core was taken.
  - f. Maximum and minimum ambient temperature during placing.
  - g. Ambient temperature when shotcrete sample was taken.
  - h. Date delivered to laboratory and date tested.

D. Submit inspection reports certification and instances of noncompliance to COR.

**3.11 PRESTRESSED CONCRETE:**

- A. Inspection at Plant: Forms, placement and concrete cover of reinforcing steel and tendons, placement and finishing of concrete, and tensioning of tendons.
- B. Concrete Testing: Test concrete including materials for concrete required in Article, CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.
- C. Test tendons for conformance with ASTM A416 and furnish report to COR.
- D. Inspect members to insure that specification requirements for curing and finishes have been met.

**3.12 ARCHITECTURAL PRECAST CONCRETE:**

- A. Inspection at Plant: Forms, placement of reinforcing steel, concrete cover, and placement and finishing of concrete.
- B. Concrete Testing: Test concrete including materials for concrete as required in Article CONCRETE of this section, except make two test cylinders for each day's production of each strength of concrete produced.
- C. Inspect members to insure specification requirements for curing and finishes have been met.

**3.13 TYPE OF TEST:**

A. Earthwork:

Laboratory Compaction Test, Soils:

(AASHTO T180), (AASHTO T99), (ASTM D1557), (ASTM D698) \_\_\_\_\_

Field Density, Soils (AASHTO T191, T205, or T238) \_\_\_\_\_

Penetration Test, Soils \_\_\_\_\_

B. Landscaping:

Topsoil Test \_\_\_\_\_

C. Aggregate Base:

Laboratory Compaction, (AASHTO T180), (ASTM D1557) \_\_\_\_\_

Field Density, (AASHTO T191), (ASTM D1556) \_\_\_\_\_

Aggregate, Base Course

Gradation (AASHTO T27) \_\_\_\_\_

Wear (AASHTO T96) \_\_\_\_\_

Soundness (AASHTO T104) \_\_\_\_\_

D. Concrete:

Making and Curing Concrete Test Cylinders (ASTM C31)	_____
Compressive Strength, Test Cylinders (ASTM C39)	_____
Concrete Slump Test (ASTM C143)	_____
Concrete Air Content Test (ASTM C173)	_____
Unit Weight, Lightweight Concrete (ASTM C567)	_____
Aggregate, Normal Weight:	
Gradation (ASTM C33)	_____
Deleterious Substances (ASTM C33)	_____
Soundness (ASTM C33)	_____
Abrasion (ASTM C33)	_____
Aggregate, Lightweight	
Gradation (ASTM C330)	_____
Deleterious Substances (ASTM C330)	_____
Unit Weight (ASTM C330)	_____
Flatness and Levelness Readings (ASTM E1155) (number of days)	_____

E. Reinforcing Steel:

Tensile Test (ASTM A370)	_____
Bend Test (ASTM A370)	_____
Mechanical Splice (ASTM A370)	_____
Welded Splice Test (ASTM A370)	_____

F. Shotcrete:

Taking and Curing Test Cores (ACI 506)	_____
Compressive Strength, Test Cores (ACI 506)	_____

G. Prestressed Concrete:

Testing Strands (ASTM A416)	_____
-----------------------------	-------

H. Inspection:

Technical Personnel (Man-days)	_____
--------------------------------	-------

- - - E N D - - -