

SECTION 01 45 29
TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.1 DESCRIPTION:

- A. This section specifies materials testing activities and inspection services required during project construction to be provided by a Testing Laboratory retained 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):
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| T27-11 | Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates |
| T96-02 (R2006) | Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine |
| T99-10 | Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5 Kg (5.5 lb.) Rammer and a 305 mm (12 in.) Drop |
| T104-99 (R2007) | Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate |
| T180-10 | Standard Method of Test for Moisture-Density Relations of Soils using a 4.54 kg (10 lb.) Rammer and a 457 mm (18 in.) Drop |
| T191-02(R2006) | Standard Method of Test for Density of Soil In-Place by the Sand-Cone Method |
- C. American Concrete Institute (ACI):
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| 506.4R-94 (R2004) | Guide for the Evaluation of Shotcrete |
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- D. American Society for Testing and Materials (ASTM):
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| A325-10 | Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength |
| A370-12 | Standard Test Methods and Definitions for Mechanical Testing of Steel Products |
| A416/A416M-10 | Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete |
| A490-12 | Standard Specification for Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength |
| C31/C31M-10 | Standard Practice for Making and Curing Concrete Test Specimens in the Field |
| C33/C33M-11a | Standard Specification for Concrete Aggregates |
| C39/C39M-12 | Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| C109/C109M-11b | Standard Test Method for Compressive Strength of Hydraulic Cement Mortars |
| C136-06 | Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates |

C138/C138M-10b	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
C140-12	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
C143/C143M-10a	Standard Test Method for Slump of Hydraulic Cement Concrete
C172/C172M-10	Standard Practice for Sampling Freshly Mixed Concrete
C173/C173M-10b	Standard Test Method for Air Content of freshly Mixed Concrete by the Volumetric Method
C330/C330M-09	Standard Specification for Lightweight Aggregates for Structural Concrete
C567/C567M-11	Standard Test Method for Density Structural Lightweight Concrete
C780-11	Standard Test Method for Pre-construction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
C1019-11	Standard Test Method for Sampling and Testing Grout
C1064/C1064M-11	Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
C1077-11c	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
C1314-11a	Standard Test Method for Compressive Strength of Masonry Prisms
D422-63(2007)	Standard Test Method for Particle-Size Analysis of Soils
D698-07e1	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
D1140-00(2006)	Standard Test Methods for Amount of Material in Soils Finer than No. 200 Sieve
D1143/D1143M-07e1	Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
D1188-07e1	Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
D1556-07	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D1557-09	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft lbf/ft ³ (2,700 KNm/m ³))
D2166-06	Standard Test Method for Unconfined Compressive Strength of Cohesive Soil
D2167-08)	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D2216-10	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2974-07a	Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
D3666-11	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
D3740-11	Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as used in Engineering Design and Construction
D6938-10	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
E94-04(2010)	Standard Guide for Radiographic Examination
E164-08	Standard Practice for Contact Ultrasonic Testing of Weldments
E329-11c	Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection
E543-09	Standard Specification for Agencies Performing Non-Destructive Testing
E605-93(R2011)	Standard Test Methods for Thickness and Density of Sprayed Fire Resistive Material (SFRM) Applied to Structural Members
E709-08	Standard Guide for Magnetic Particle Examination
E1155-96(R2008)	Determining FF Floor Flatness and FL Floor Levelness Numbers

E. American Welding Society (AWS):

D1.D1.1M-10	Structural Welding Code-Steel
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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.; E329, C1077, D3666, D3740, A880, E543) 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 Resident Engineer. When it appears materials furnished, or work performed by Contractor fail to meet construction contract requirements, Testing Laboratory shall direct attention of Resident Engineer to such failure.
- C. Written Reports: Testing laboratory shall submit test reports to Resident Engineer, Contractor, unless other arrangements are agreed to in writing by the Resident Engineer. Submit reports of tests that fail to meet construction contract requirements on colored paper.
- D. Verbal Reports: Give verbal notification to Resident Engineer 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 Resident Engineer regarding suitability or unsuitability of areas where proof-rolling was observed. Where unsuitable results are observed, witness excavation of unsuitable material and recommend to Resident Engineer extent of removal and replacement of unsuitable materials and observe proof-rolling of replaced areas until satisfactory results are obtained.
 - a) SPEC WRITER NOTE: Adjust the following requirements to include applicable conditions for specific project. Weigh the requirement for full time observation and costs.
 - 2) Provide // full time // part time // observation of fill placement and compaction and field density testing in building areas and provide // full time // 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 // Method A // // 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 D6938 // 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 Resident Engineer before the tests are conducted.
 - a) SPEC WRITER NOTE: Include only applicable types of construction. Rates are for typical project; adjust for individual project.
- C. Fill and Backfill Material Gradation: One test per //____// cubic//meters// //yards// stockpiled or in-place source material. Gradation of fill and backfill material shall be determined in accordance with //ASTM C136// //ASTM D422// //ASTM D1140//.
- D. Testing for Footing Bearing Capacity: Evaluate if suitable bearing capacity material is encountered in footing subgrade.
- E. Testing Materials: Test suitability of on-site and off-site borrow as directed by Resident Engineer.

3.2 FOUNDATION PILES:

- A. SPEC WRITER NOTE: Verify that test piles are required and location is shown.

- B. 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.
- C. 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 Resident Engineer.
- D. 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. //
- E. Prestressed Concrete Piles:
- F. Inspection at Plant: Inspect forms, placement of reinforcing steel and strands, placement and finishing of concrete, and tensioning of strands.
- G. 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.
- H. Test strand for conformance with ASTM A416/A416M and furnish report to Resident Engineer.
- I. 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 Resident Engineer:
 - 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 Resident Engineer.

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 // ASTM D1557, 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 // ASTM D1556 //.
 - 3) Sample and test aggregate as necessary to insure compliance with specification requirements for gradation, wear, and soundness as specified in the applicable state highway standards and specifications.
- 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:

- A. 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 Resident Engineer'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 Resident Engineer with concurrence of Contracting Officer and perform periodic inspections thereafter as determined by Resident Engineer.
- 2) Periodically inspect and test batch proportioning equipment for accuracy and report deficiencies to Resident Engineer.
- 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 40 m3 (50 cubic yards) or less of each concrete type, and at least three cylinders for any one day's pour for each concrete type. // After good concrete quality control has been established and maintained as determined by Resident Engineer make three cylinders for each 80 m3 (100 cubic yards) or less of each concrete type, and at least three cylinders from any one day's pour for each concrete type. // Label each cylinder with an identification number. Resident Engineer may require additional cylinders to be molded and cured under job conditions.
- 4) Perform slump tests in accordance with ASTM C143. Test the first truck each day, and every time test cylinders are made. Test pumped concrete at the hopper and at the discharge end of the hose at the beginning of each day's pumping operations to determine change in slump.
- 5) Determine the air content of concrete per ASTM C173. For concrete required to be air-entrained, test the first truck and every 20 m3 (25 cubic yards) thereafter each day. For concrete not required to be air-entrained, test every 80 m3 (100 cubic yards) at random. For pumped concrete, initially test concrete at both the hopper and the discharge end of the hose to determine change in air content.

- 6) If slump or air content fall outside specified limits, make another test immediately from another portion of same batch.
- 7) Perform unit weight tests in compliance with ASTM C138 for normal weight concrete and ASTM C567 for lightweight concrete. Test the first truck and each time cylinders are made.
- 8) Notify laboratory technician at batch plant of mix irregularities and request materials and proportioning check.
- 9) Verify that specified mixing has been accomplished.
- 10) Environmental Conditions: Determine the temperature per ASTM C1064 for each truckload of concrete during hot weather and cold weather concreting operations:
 - a) When ambient air temperature falls below 4.4 degrees C (40 degrees F), record maximum and minimum air temperatures in each 24 hour period; record air temperature inside protective enclosure; record minimum temperature of surface of hardened concrete.
 - b) When ambient air temperature rises above 29.4 degrees C (85 degrees F), record maximum and minimum air temperature in each 24 hour period; record minimum relative humidity; record maximum wind velocity; record maximum temperature of surface of hardened concrete.
- 11) Inspect the reinforcing steel placement, including bar size, bar spacing, top and bottom concrete cover, proper tie into the chairs, and grade of steel prior to concrete placement. Submit detailed report of observations.
- 12) Observe conveying, placement, and consolidation of concrete for conformance to specifications.
- 13) Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.
- 14) Observe curing procedures for conformance with specifications, record dates of concrete placement, start of preliminary curing, start of final curing, end of curing period.
- 15) Observe preparations for placement of concrete:
 - a) Inspect handling, conveying, and placing equipment, inspect vibrating and compaction equipment.
 - b) Inspect preparation of construction, expansion, and isolation joints.
- 16) Observe preparations for protection from hot weather, cold weather, sun, and rain, and preparations for curing.
- 17) Observe concrete mixing:
 - a) Monitor and record amount of water added at project site.
 - b) Observe minimum and maximum mixing times.
- 18) Measure concrete flatwork for levelness and flatness as follows:
 - a) Perform Floor Tolerance Measurements FF and FL 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 Resident Engineer with the results of all profile tests, including a running tabulation of the overall FF and FL 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 Resident Engineer. 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 Resident Engineer. In test report, indicate the following information:
 - a) Cylinder identification number and date cast.
 - b) Specific location at which test samples were taken.
 - c) Type of concrete, slump, and percent air.
 - d) Compressive strength of concrete in MPa (psi).
 - e) Weight of lightweight structural concrete in kg/m3 (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. Perform sampling at fabricating plant. Take two samples from each 23 t (25 tons) or fraction thereof of each size of reinforcing steel No. 10 thru No. 57 (No. 3 thru No. 18). //
- C. Make one tensile and one bend test in accordance with ASTM A370 from each pair of samples obtained.
- D. Written report shall include, in addition to test results, heat number, manufacturer, type and grade of steel, and bar size.
- E. Perform tension tests of mechanical and welded splices in accordance with ASTM A370.

3.10 3.10 SHOTCRETE:

- A. Inspection and Material Testing:
 - 1) Provide field inspection and testing service as required by Resident Engineer 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 Resident Engineer.
 - 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 Resident Engineer.
 - 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 Resident Engineer. 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 Resident Engineer.

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 Resident Engineer.
- 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 MASONRY:

- A. Mortar Tests:
 - 1) Laboratory compressive strength test:
 - a) Comply with ASTM C780.
 - b) Obtain samples during or immediately after discharge from batch mixer.
 - c) Furnish molds with 50 mm (2 inch), 3 compartment gang cube.
 - d) Test one sample at 7 days and 2 samples at 28 days.

- 2) Two tests during first week of operation; one test per week after initial test until masonry completion.
- B. Grout Tests:
 - 1) Laboratory compressive strength test:
 - a) Comply with ASTM C1019.
 - b) Test one sample at 7 days and 2 samples at 28 days.
 - c) Perform test for each 230 m2 (2500 square feet) of masonry.
- C. Masonry Unit Tests:
 - 1) Laboratory Compressive Strength Test:
 - a) Comply with ASTM C140.
 - b) Test 3 samples for each 460 m2 (5000 square feet) of wall area.
- D. Prism Tests: For each type of wall construction indicated, test masonry prisms per ASTM C1314 for each 460 m2 (5000 square feet) of wall area. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

3.14 STRUCTURAL STEEL:

- A. General: Provide shop and field inspection and testing services to certify structural steel work is done in accordance with contract documents. Welding shall conform to AWS D1.1 Structural Welding Code.
- B. Prefabrication Inspection:
 - 1) Review design and shop detail drawings for size, length, type and location of all welds to be made.
 - 2) Approve welding procedure qualifications either by pre-qualification or by witnessing qualifications tests.
 - 3) Approve welder qualifications by certification or retesting.
 - 4) Approve procedure for control of distortion and shrinkage stresses.
 - 5) Approve procedures for welding in accordance with applicable sections of AWS D1.1.
- C. Fabrication and Erection:
 - 1) Weld Inspection:
 - a) Inspect welding equipment for capacity, maintenance and working condition.
 - b) Verify specified electrodes and handling and storage of electrodes in accordance with AWS D1.1.
 - c) Inspect preparation and assembly of materials to be welded for conformance with AWS D1.1.
 - d) Inspect preheating and interpass temperatures for conformance with AWS D1.1.
 - e) Measure 25 percent of fillet welds.
 - f) Welding Magnetic Particle Testing: Test in accordance with ASTM E709 for a minimum of:
 - (1) 20 percent of all shear plate fillet welds at random, final pass only.
 - (2) 20 percent of all continuity plate and bracing gusset plate fillet welds, at random, final pass only.
 - (3) 100 percent of tension member fillet welds (i.e., hanger connection plates and other similar connections) for root and final passes.
 - (4) 20 percent of length of built-up column member partial penetration and fillet welds at random for root and final passes.
 - (5) 100 percent of length of built-up girder member partial penetration and fillet welds for root and final passes.
 - 2) Bolt Inspection:

- a) Inspect high-strength bolted connections in accordance AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts.
 - b) Slip-Critical Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in each connection in accordance with AISC Specifications for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
 - c) Fully Pre-tensioned Connections: Inspect 10 percent of bolts, but not less than 2 bolts, selected at random in 25 percent of connections in accordance with AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Inspect all bolts in connection when one or more are rejected.
 - d) Bolts installed by turn-of-nut tightening may be inspected with calibrated wrench when visual inspection was not performed during tightening.
 - e) Snug Tight Connections: Inspect 10 percent of connections verifying that plies of connected elements have been brought into snug contact.
 - f) Inspect field erected assemblies; verify locations of structural steel for plumbness, level, and alignment.
- D. Submit inspection reports, record of welders and their certification, and identification, and instances of noncompliance to Resident Engineer.

3.15 STEEL DECKING:

- A. Provide field inspection of welds of metal deck to the supporting steel, and testing services to insure steel decking has been installed in accordance with contract documents and manufacturer's requirements.
- B. Qualification of Field Welding: Qualify welding processes and welding operators in accordance with "Welder Qualification" procedures of AWS D1.1. Refer to the "Plug Weld Qualification Procedure" in Part 3 "Field Quality Control."
- C. Submit inspection reports, certification, and instances of noncompliance to Resident Engineer.

3.16 SHEAR CONNECTOR STUDS:

- A. Provide field inspection and testing services required by AWS D.1 to insure shear connector studs have been installed in accordance with contract documents.
- B. Tests: Test 20 percent of headed studs for fastening strength in accordance with AWS D1.1.
- C. Submit inspection reports, certification, and instances of noncompliance to Resident Engineer.

3.17 SPRAYED-ON FIREPROOFING:

- A. Provide field inspection and testing services to certify sprayed-on fireproofing has been applied in accordance with contract documents.
- B. Obtain a copy of approved submittals from Resident Engineer.
- C. Use approved installation in test areas as criteria for inspection of work.
- D. Test sprayed-on fireproofing for thickness and density in accordance with ASTM E605.
 - 1) Thickness gauge specified in ASTM E605 may be modified for pole extension so that overhead sprayed material can be reached from floor.
- E. Location of test areas for field tests as follows:

- 1) Thickness: Select one bay per floor, or one bay for each 930 m² (10,000 square feet) of floor area, whichever provides for greater number of tests. Take thickness determinations from each of following locations: Metal deck, beam, and column.
 - 2) Density: Take density determinations from each floor, or one test from each 930 m² (10,000 square feet) of floor area, whichever provides for greater number of tests, from each of the following areas: Underside of metal deck, beam flanges, and beam web.
- F. Submit inspection reports, certification, and instances of noncompliance to Resident Engineer.

3.18 TYPE OF TEST:

Approximate Number of Tests Required

A. Earthwork:

Laboratory Compaction Test, Soils:

AASHTO T180, AASHTO T99, ASTM D1557, and ASTM D698 _____

Field Density, Soils AASHTO T191, T205, or T238 _____

Penetration Test, Soils _____

B. Landscaping:

Topsoil Test _____

C. Aggregate Base:

Laboratory Compaction, AASHTO T180 or ASTM D1557 _____

Field Density, AASHTO T191 or ASTM D1556 _____

Aggregate, Base Course Gradation (AASHTO T27) _____

Wear (AASHTO T96) _____

Soundness (AASHTO T104) _____

D. Asphalt Concrete:

Field Density, (AASHTO T230)//ASTM D1188// _____

Aggregate, Asphalt Concrete Gradation (AASHTO T27) _____

Wear (AASHTO T96) _____

Soundness (AASHTO T104) _____

E. 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)(# of days) _____

F. Reinforcing Steel:

Tensile Test (ASTM A370) _____

- Bend Test (ASTM A370) _____
- Mechanical Splice (ASTM A370) _____
- Welded Splice Test (ASTM A370) _____
- G. Shotcrete:
- Taking and Curing Test Cores (ACI 506) _____
- Compressive Strength, Test Cores (ACI 506) _____
- H. Prestressed Concrete:
- Testing Strands (ASTM A416) _____
- I. Masonry:
- Making and Curing Test Cubes (ASTM C109) _____
- Compressive Strength, Test Cubes (ASTM C109) _____
- Sampling and Testing Mortar, Comp. Strength (ASTM C780) _____
- Sampling and Testing Grout, Comp. Strength (ASTM C1019) _____
- Masonry Unit, Compressive Strength (ASTM C140) _____
- Prism Tests (ASTM C1314) _____
- J. Structural Steel:
- Ultrasonic Testing of Welds (ASTM E164) _____
- Magnetic Particle Testing of Welds (ASTM E709) _____
- Radiographic Testing of Welds (ASTM E94) _____
- K. Sprayed-On Fireproofing:
- Thickness and Density Tests (ASTM E605) _____
- L. Inspection:
- Technical Personnel (Man-days) _____
- M. Technical Personnel: (Minimum _____ months)
- 1) Technicians to perform tests and inspection listed above.
 Laboratory will be equipped with concrete cylinder storage
 facilities, compression machine, cube molds, proctor molds,
 balances, scales, moisture ovens, slump cones, air meter, and all
 necessary equipment for compaction control.

END OF SECTION