

**SECTION 01 45 29**  
**SPECIAL INSPECTION AND 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 an Inspector and 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 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
  - 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
  - C138-07.....Unit Weight, Yield, and Air Content (Gravimetric) of Concrete

C140-07.....	Sampling and Testing Concrete Masonry Units and Related Units
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
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

D. American Welding Society (AWS):

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

**1.3 REQUIREMENTS:**

- A. Inspector and Testing/Inspecting Agency shall be accepted by the Registered Design Professional (RDP) and the Resident Engineer.
- B. Inspections shall be performed by agents who have relevant experience for each category of inspections indicated in the drawings.
- C. Minimum qualifications of inspection agents are indicated in Drawing S0.2.

**1.4 DEFINITIONS:**

- A. Registered Design Professional: Licensed Professional Engineer or Registered Architect whose seal appears in the Construction Drawings. Unless noted otherwise, references to the Registered Design Professional in this section refer to the Structural Engineer for building design.
- B. Inspector and Testing/Inspecting Agency: Agents retained by Inspector Contractor to perform inspection and testing services.
- C. Schedule of Inspections and Testing Laboratory Services: An itemized list of inspections, verifications, and tests (including frequency) required for the project and individuals, agencies, or firms who will be retained to perform these services. The Schedule of Inspections and Testing Laboratory Services is located in Drawing S0.2.
- D. Continuous Inspection: Full-time observation of work by the Inspector or Testing Agency while the work is being performed.
- E. Periodic Inspection: Part-time or intermittent observation of work by the Inspector or Testing Agency for work that has been or is being performed and at completion of the work.

**1.5 SUBMITTALS:**

- A. Inspector and Testing/Inspecting Agency shall submit to the Registered Design Professional and Resident Engineer for review, a copy of their qualifications including names and qualifications of each inspector and technician who will be performing inspections or tests.
- B. Inspector and Testing/Inspecting Agency shall disclose potential conflict of interest with Contractor or Subcontractors whose work will be inspected or tested.

**1.6 PAYMENT:**

- A. Contractor will engage and pay for services of Inspector and Testing/Inspecting Agency.
- B. Contractor shall be responsible for cost of retesting or reinspection of work failing to comply with requirements of Contract Documents.

**1.7 CONTRACTOR RESPONSIBILITIES:**

- A. Contractor shall cooperate with Inspector and Agents so inspections and testing may be performed without hindrance.
- B. As indicated in the Inspections and Testing Laboratory Services, Contractor shall notify Inspector or Testing/Inspecting Agency at least 48 hours in advance of a required inspection or test.
- C. Contractor shall provide incidental labor and facilities to provide access to work to be inspected or tested, to obtain and handle samples at site or at source of products to be tested, to facilitate tests and inspections, and for storing and curing of test samples.
- D. If inspections or testing require the use of Contractor's scaffolding to access work areas, Contractor shall provide competent person to perform daily evaluation of scaffolding to verify it is safe to use. Contractor shall notify Inspector and Testing Agent of this review before each use. Contractor is responsible for safe assembly and stability of scaffolding.
- E. Contractor shall keep latest set of Construction Drawings, field sketches, accepted shop drawings, and specifications at project site for field use by Inspectors and Testing Technicians.
- F. Contractor shall perform remedial work if required and sign nonconformance reports stating remedial work has been completed. Contractor shall submit signed reports to Inspector as work proceeds.
- G. The Inspection program shall not relieve Contractor of obligation to perform work in accordance with requirements of Contract Documents or from implementing an effective Quality Control program.
- H. Contractor shall be solely responsible for construction site safety.

#### **1.8 LIMITS ON AUTHORITY:**

- A. Inspector or Testing/Inspecting Agency shall not release, revoke, alter, or enlarge on requirements of Contract Documents.
- B. Inspector or Testing/Inspecting Agency shall not have control over Contractor's means and methods of construction.
- C. Inspector or Testing/Inspecting Agency shall not be responsible for construction site safety.
- D. Special Inspector or Testing/Inspecting Agency shall not have authority to stop work.

#### **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. Identify soils requiring undercutting and replacing while observing proof rolling and when subgrade is exposed.
  - 2. Verify footing bearing strata.

3. Review and accept materials proposed by Contractor for use as compacted fill based on test data and information submitted by Testing Agency. Material approval shall be based on requirements and recommendations stated in Project Geotechnical and Subsurface Investigation.
4. Observe and accept filling and compaction procedures.
5. Observe and accept preparation of slab-on-grade subgrade and crushed stone subbase.

B. Testing Compaction:

1. Testing Agency shall perform moisture content testing of slab subbase in accordance with ASTM D3017 and for each type of fill, backfill, and subgrade material used, in compliance with ASTM D1557.
2. Testing Agency shall perform field density tests for building subgrades and for fill materials including slab subbase in accordance with ASTM D 1557 or ASTM D2922 as follows:
  - a. Building Subgrade, Including Slab Subbase: At least one test of subgrade for every 2000 square feet of building slab, but in no case fewer than four tests. In each compacted fill layer, perform one test for every 2000 square feet, but in no case fewer than four tests.
  - b. Foundation Wall Backfill: One test per 100 feet of each layer of compacted fill but in no case fewer than two tests.
  - c. Pavement Subgrade: One test for each 335 m<sup>2</sup> (400 square yards), but in no case fewer than two tests.
  - d. Curb, Gutter, and Sidewalk: One test for each 90 m (300 feet), but in no case fewer than two tests.
  - e. Trenches: One test at maximum 30 m (100 foot) intervals per 1200 mm (4 foot) of vertical lift and at changes in required density, but in no case fewer than two tests.
  - f. Footing Subgrade: At least one test for each layer of soil on which footings will be placed. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested subgrade when acceptable to Resident Engineer. In each compacted fill layer below footings, perform one field density test at each spread footing and for every 20 foot length of wall footing. Verify subgrade is level, all loose or disturbed soils have been removed, and correlate actual soil conditions observed with those indicated by test borings.

- C. Inspect each subgrade and fill layer before further backfill or construction work is performed. Approval shall be based on satisfactory achievement of compaction criteria.
- D. Verify use of fill material and lift thicknesses in field.

### **3.2 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.

### **3.3 ASPHALT CONCRETE PAVING:**

- A. Aggregate Base Course:
  - 1. Determine maximum density and optimum moisture content for aggregate base material in accordance with AASHTO T180.
  - 2. Make a minimum of three field density tests on each day's final compaction on each aggregate course in accordance with AASHTO T191
  - 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.

### **3.4 SITE WORK CONCRETE:**

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

### **3.5 CONCRETE:**

- A. 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. Sample and test concrete during placement as follows. Tests shall be taken at point of discharge into structure:
    - a. Record specific locations where concrete was placed. Refer to column lines where possible.
    - b. Record time concrete is batched as shown in truck ticket, time placement begins/sample time, and time truck is emptied.
    - c. Sample fresh concrete in accordance with ASTM C172, except modified for slump to comply with ASTM C94.
    - d. Perform slump test in accordance with ASTM C143.
    - e. Measure air content in accordance with ASTM C231, pressure method, one for each truckload of ready-mixed concrete, air-entrained or non-air-entrained.
    - f. Record temperature of concrete for each truck. Test in-place concrete temperature hourly when ambient temperature is 40 degrees F and below and when 80 degrees F and above.
    - g. Record air temperature and general weather conditions (cloudy, windy, sunny, etc.).
    - h. Record unit weight of fresh normal-weight concrete in accordance with ASTM C138. Record unit weight of lightweight concrete in accordance with ASTM C567.
    - i. Perform concrete compressive tests as follows:
      - 1) Prepare compressive test specimens in accordance with ASTM C31. Store undisturbed in insulated box during cold weather. Deliver to laboratory between 16 and 32 hours after making. Perform compressive tests in accordance with ASTM C39: two specimens tested at 7 days, two specimens tested at 28 days, and two specimens retained for later testing if required.
      - 2) In cold weather or whenever steel erection is scheduled commence less than 14 days after placement of supporting foundation concrete, cast additional set of four cylinders for each 50 cubic yards or fraction thereof of supporting foundation concrete. Field-cure cylinders, and test two specimens at 7 days, retaining two specimens for later testing if required. Steel erection may not begin until supporting concrete obtains 75 percent of its design strength.

- j. Perform additional testing as follows if required:
  - 1) Take additional set of cylinders for compressive strength testing for each truck in which total time period between batching and completing placement has exceeded ACI-recommended, 90-minute-maximum time limit and is likely to exceed 120 minutes. Take additional cylinders within 10 minutes of placement completion.
  - 2) Make additional tests of in-place concrete when test results indicate specified concrete strengths or other characteristics have not been attained in structure.
  - 3) Perform tests to determine adequacy of concrete by cored cylinders complying with ASTM C42 or by other methods acceptable to Resident Engineer.
- 4. Inspect Concrete placement for proper application techniques.
- 5. 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.
- 6. Inspect for maintenance of specified curing temperatures and techniques.
- 7. Perform floor flatness ( $F_F$ ) and levelness ( $F_L$ ) testing no later than 48 hours after slab placement in accordance with ASTM E1155.  $F_L$  testing is not required for slabs on metal deck.
- 8. Perform moisture vapor emission and alkalinity testing in accordance with ASTM F1869 and ASTM F710, respectively, as follows:
  - a. Perform testing after building is enclosed, prior to installation of adhered floor finishes, and once HVAC systems are operational.
  - b. Test results must be reviewed and accepted by floor finish installer.
- 9. 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.
- 10. Inspect welding of reinforcing bars.
- 11. Inspect embedded bolts and anchor rods prior to concrete placement.
- 12. Observe condition of formed surfaces upon removal of formwork prior to repair of surface defects and observe repair of surface defects.



**3.6 MASONRY:**

- A. As masonry construction begins, the following shall be verified to ensure compliance:
  - 1. Construction of mortar joints.
  - 2. Size and location of joint reinforcement.
  - 3. Size, grade, and type of reinforcement.
  - 4. Type, size, and location of anchors.
  - 5. Protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F).
- B. Mortar:
  - 1. Verify proportions of site-prepared mortar.
  - 2. Sample and test mortar composition and properties in accordance with ASTM C780. Perform tests for each 5,000 square feet of wall area or portion thereof.
- C. Grouting:
  - 1. Verify grout space is clean.
  - 2. Verify placement of reinforcement and connectors.
  - 3. Verify grout placement to ensure compliance with code and Construction Document provisions.
  - 4. Sample and test grout compressive strength in accordance with ASTM C1019. Perform tests for each 5,000 square feet of wall area or portion thereof.
- D. Prism Tests: For each type of wall construction indicated, test masonry prisms per ASTM C1314 for each 5000 square feet of wall area. Prepare one set of prisms for testing at 7 days and one set for testing at 28 days.

**3.7 STRUCTURAL STEEL, STEEL DECKING, AND SHEAR CONNECTOR STUDS:**

- A. Verify Fabricator maintains detailed fabrication and Quality Control procedures:
  - 1. Review procedures for completeness and adequacy relative to code requirements.
  - 2. If Fabricator is designated as AISC-Certified, inspection of shop-fabricated members and assemblies is not required.
  - 3. If Fabricator is not designated as AISC-Certified, inspection and testing in Fabricator's shop is required.
- B. Review manufacturer's certificates of compliance for high-strength bolts and weld filler material.
- C. Review certified mill test reports.

- D. Inspect steel frame joint details for compliance with approved Construction Documents.
- E. Verification that copies of accepted field welding procedure specifications are available on-site or reference by erector's welders.
- F. Verification that erector's welder's qualifications are current and appropriate for joint type, welding position, and welding process.
- G. Verification that joint fitup for partial and complete joint penetration groove welds are in compliance with AWS tolerances as follows:
  - 1. Visually inspect 50 percent of partial and complete penetration groove weld joints.
  - 2. Visually inspect 100 percent of moment connections that are part of the lateral force resisting system.
- H. Inspect high-strength bolting. Snug tight joints require only visual inspection.
- I. Material verification of structural steel and metal deck, including review of identification markings.
- J. Perform pull-out tests on adhesive, expansion, and sleeve anchors.
- K. Inspect welding of structural steel and metal deck as follows:
  - 1. Visually inspect welds according to AWS.
  - 2. Ultrasonic inspection (UT) according to ASTM E587 is required for partial and complete penetration field groove welds as follows:
    - a. UT inspect 50 percent of partial and complete penetration joints.
    - b. UT inspect 100 percent of moment connections that are part of the lateral force resisting system.
    - c. UT inspect 50 percent or minimum of six partial or complete penetration groove welds completed by each welder. Increase inspection percentage to 100 percent for each welder with more than one rejected weld.
  - 3. Magnetic particle inspection according to ASTM E709 is required for Fabricator's not designated as AISC-Certified for 10 percent of shop fillet welds.
  - 4. Magnetic particle inspection according to ASTM E709 is required for 10 percent of field fillet welds.
  - 5. UT inspect according to ASTM E587 is required for 10 percent of shop partial or complete penetration welds.
- L. Inspect every shear connector by striking once with 10-pound hammer. Direction of hammer swing shall be parallel with member containing connector. Inspection by striking with hammer does not replace bend tests in accordance with AWS.
- M. Inspect welding of reinforcing steel.

- N. Inspect condition of erected materials.
- O. Inspect columns for plumbness within tolerances specified in Section 05 12 00, Part 3: Execution.
- P. Inspect fasteners for metal deck, including side-lap fasteners.
- Q. Additional testing shall be performed as follows if required:
  - 1. Testing agency shall perform additional tests of connections and framing members field modified by Contractor to correct errors in shop drawings, fabrication, or erection.
  - 2. Anchor rods and embedded structural supports incorrectly located or damaged after installation shall be field modified by Contractor as indicated in Section 03 30 00, Paragraph 3.4 and tested by Testing Agency.
  - 3. Testing and reporting of field modifications shall be in accordance with this section and have the following additional requirements:
    - a. Magnetic particle inspection according to ASTM E709 is required for 100 percent of fillet welds.
    - b. UT inspection according to ASTM E587 is required for 100 percent of complete penetration welds.
    - c. Perform pull-out tests on 100 percent of each type of adhesive, expansion, or sleeve anchor used by applying a load equal to 125 percent of the allowable pull-out strength listed in manufacturer's literature.
  - 4. Additional testing shall be performed at the Contractor's expense.

### **3.8 COLD-FORMED METAL FRAMING:**

- A. Visually inspect connections.
- B. Visually inspect framing and details.
- C. Verify member size and thickness.
- D. Verify weight of galvanized coating according to ASTM A90.
- E. Inspect framing for damage.
- F. Visually inspect welds according to AWS.
- G. Perform pull-out tests on adhesive, expansion, and sleeve anchors.

### **3.9 SPRAYED FIRE RESISTANT MATERIALS:**

- A. Verify surface preparation in accordance with manufacturer's written instructions.
- B. Verify temperature and area ventilation before and after application in accordance with manufacturer's written instructions.
- C. Verify thickness in accordance with ASTM E605. Perform minimum of four measurements per 1000 square feet of floor, roof, and wall areas or portion thereof, but not less than 25 percent of structural members per floor or roof.

- D. Verify density in accordance with ASTM E605.
- E. Verify cohesive/adhesive bond strength in accordance with ASTM E736 and ASTM E760. Perform minimum of one test per 10,000 square feet of floor, roof, and wall areas or portion thereof.

#### **PART 4 - DOCUMENTATION**

##### **4.1 RECORDS AND REPORTS:**

- A. Prepare detailed reports of each test or inspection. Include the following general information:
  - 1. Project name and number.
  - 2. Date of test or inspection.
  - 3. Name of Testing Agency or Inspecting Agency.
  - 4. Name of technician or inspector.
  - 5. Weather conditions.
  - 6. Locations and elevations of specific areas tested or inspected referenced to grid lines.
  - 7. Description of test or inspection.
  - 8. Reference to applicable ASTM standard.
  - 9. Summary of observations, results, and recommendations.
  - 10. Description of areas or materials requiring retesting or reinspection.
- B. Concrete compressive strength test reports shall contain the following information:
  - 1. Name of Contractor and concrete supplier.
  - 2. Name of concrete testing service.
  - 3. Name of technician making and testing specimens.
  - 4. Truck number and delivery ticket number.
  - 5. Date and location within structure of concrete placement.
  - 6. Concrete type, class, mix proportions of materials, and design compressive strength at 28 days.
  - 7. Slump, air content, unit weight, and concrete temperature.
  - 8. Total time period between batching and completing placement for each truck.
  - 9. Compressive strength and type of break for tests.
- C. Field reports for concrete inspection shall contain general information noted above plus ambient temperature and cylinder numbers.
- D. Test reports for masonry materials shall include proportions, composition, and compressive strength.

##### **4.2 COMMUNICATION:**

- A. Testing/Inspecting Agency shall immediately notify Contractor, Registered Design Professional, and Resident Engineer by telephone, fax, or e-mail of test results failing to comply with requirements of Contract Documents.

- B. Inspector shall immediately notify Contractor of work found to be in nonconformance with Contract Documents during inspections. If nonconforming work is not corrected while Inspector is on-site, Inspector shall notify Registered Design Professional and Resident Engineer within 24 hours (one business day) and issue a nonconformance report.
- C. If nonconforming work is not corrected at time of substantial completion of structure or other appropriate time, Inspector shall notify Resident Engineer.

#### **4.3 DISTRIBUTION OF REPORTS:**

- A. Testing/Inspecting Agency and Inspector shall submit reports to Registered Design Professional and Resident Engineer within 7 days of inspection or test. Legible handwritten reports may be submitted if final typed copies are not available.

#### **4.4 FINAL REPORT OF INSPECTIONS:**

- A. At completion of work, each Testing/Inspecting Agency shall submit Final Report to Resident Engineer stating work was completed in substantial conformance with Contract Documents and appropriate inspections and tests were performed.

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