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Remarks and Instructions

The complete manual, revision packages, and individual chapters can be accessed at www.wsdot.wa.gov/publications/manuals/m46-01.htm.

For updating printed manuals, page numbers indicating portions of the manual that are to be removed and replaced are shown below.

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Please contact Linda Hughes at 360-709-5412 or hughel@wsdot.wa.gov with comments, questions, or suggestions for improvement to the manual.

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Approved By

Signature

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Engineering and Regional Operations
Materials Laboratory

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T 198	AASHTO			Splitting Tensile Strength of Cylindrical Concrete Specimens
T 200	AASHTO			pH of Aqueous Solutions With the Glass Electrode
T 201	AASHTO			Kinematic Viscosity of Asphalts
T 202	AASHTO			Viscosity of Asphalts by Vacuum Capillary Viscometer
T 208	AASHTO			Unconfined Compressive Strength of Cohesive Soil
T 209	AASHTO			Theoretical Maximum Specific Gravity and Density of Hot Mix Asphalt (HMA)
T 209	WSDOT	✓	✓	FOP for AASHTO for Theoretical Maximum Specific Gravity and Density of Hot-Mix Asphalt Paving Mixtures
T 215	AASHTO			Permeability of Granular Soils (Constant Head)
T 216	AASHTO			One-Dimensional Consolidation Properties of Soils
D 217	ASTM			Standard Test Methods for Cone Penetration of Lubricating Grease
T 217	WSDOT	✓	✓	FOP for AASHTO for Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester
T 224	AASHTO			Correction for Coarse Particles in the Soil Compaction Test
T 228	AASHTO			Specific Gravity of Semi-Solid Bituminous Material
T 231	AASHTO			Capping Cylindrical Concrete Specimens
T 231	WSDOT	✓	✓	FOP for AASHTO for Capping Cylindrical Concrete Specimens
T 236	AASHTO			Direct Shear test of Soils Under Consolidated Drained Conditions

Procedure Number	Owner	Field Use	In Manual	Test Method
T 240	AASHTO			Effect of Heat and Air on a Moving Film of Asphalt Binder (Rolling Thin-Film Oven Test)
T 242	AASHTO			Frictional Properties of Paved Surfaces Using a Full-Size Tire
T 244	AASHTO			Mechanical Testing of Steel Products
T 248	AASHTO			Reducing Field Samples of Aggregates to Testing Size
T 248	WSDOT	✓	✓	FOP for AASHTO for Reducing Samples of Aggregate to Testing Size
T 255	AASHTO			Total Evaporable Moisture Content of Aggregate by Drying
T 255	WSDOT	✓	✓	FOP for AASHTO for Total Evaporable Moisture Content of Aggregate by Drying
T 257	AASHTO			Instrumental Photometeric Measurements of Retroreflectivie Material and Retroreflective
T 260	AASHTO			Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials
T 265	AASHTO		✓	Laboratory Determination of Moisture Content of Soils
T 267	AASHTO			Determination of Organic Content in Soils by Loss on Ignition
T 269	AASHTO			Percent Air Void in Compacted Dense and Open Asphalt Mixtures
T 272	AASHTO			Family of Curves – One Point Method
T 272	WSDOT	✓	✓	FOP for AASHTO for Family of Curves – One Point Method
T 275	AASHTO			Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Paraffin-Coated Specimen
T 277	AASHTO			Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration
T 288	AASHTO		✓	Determining Minimum Laboratory Soil Resistivity (Checklist Only)
T 289	AASHTO			Determining pH of Soil for Use in Corrosion
T 296	AASHTO			Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression
T 297	AASHTO			Consolidated, Undrained Triaxial Compressive Test on Cohesive Soils Shear
T 301	AASHTO			Elastic Recovery Test of Asphalt Materials by Means of a Ductilometer
T 303	AASHTO			Accelerated Detection of Potentially Deleterious Expansion of Mortar Bars Due to Alkali-Silica Reaction
T 304	WSDOT	✓	✓	FOP for AASHTO for Uncompacted Void Content of Fine Aggregate
T 307	AASHTO		✓	Determining the Resilient Modulus of Soils and Aggregate Materials
T 308	AASHTO			Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
T 308	WSDOT	✓	✓	FOP for AASHTO for Determining the Asphalt Binder Content of Hot Mix Asphalt (HMA) by the Ignition Method
T 309	AASHTO			Temperature of Freshly Mixed Hydraulic Cement Concrete
T 309	WSDOT	✓	✓	FOP for AASHTO for Temperature of Freshly Mixed Portland Cement Concrete
T 310	WSDOT	✓	✓	FOP for AASHTO for In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
T 312	WSDOT	✓	✓	FOP for AASHTO for Preparing Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

Procedure Number	Owner	Field Use	In Manual	Test Method
T 313	AASHTO			Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
T 313	WSDOT		✓	Method of Test for Cement-Latex Compatibility
T 314	WSDOT		✓	Method of Test for Photovolt Reflectance
T 315	AASHTO			Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR)
T 316	AASHTO			Viscosity Determination of Asphalt Binder Using Rotational Viscometer
SOP 318	WSDOT		✓	Standard Operating Procedure for Melting of Flexible Bituminous Pavement Marker Adhesive for Evaluation
T 324	AASHTO		✓	Standard Method of Test for Hamburg Wheel-Track Testing of Compacted Hot Mix Asphalt (HMA)
T 329	WSDOT	✓	✓	FOP for AASHTO for Moisture Content of Asphalt (HMA) by Oven Method
CAL 331				Caltrans Method of Test for Residue by Evaporation of Latex Modified Asphalt Emulsion
CAL 332				Caltrans Method of Test for Recovery From Deformation of Latex Modified Asphalt Emulsion Residue
T 335	AASHTO			Determining the Percentage of Fracture in Coarse Aggregate
T 335	WSDOT	✓	✓	FOP for AASHTO for Determining the Percentage of Fracture in Coarse Aggregate
A 370	ASTM			Standard Test Methods and Definitions for Mechanical Testing of Steel Products
D 395	ASTM			Test Methods for Rubber Property – Compression Set
D 412	ASTM			Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
T 413	WSDOT	✓	✓	Method of Test for Evaluating Waterproofing Efectiveness of Membrane and Membrane-Pavement Systems
T 417	WSDOT		✓	Method of Test for Determining Minimum Resistivily and pH of Soil and Water
T 420	WSDOT	✓	✓	Test Method for Determining the Maturity of Compost (Solvita Test)
T 421	WSDOT		✓	Test Method for Traffic Controller Inspection and Test Procedure
T 422	WSDOT		✓	Test Method for Traffic Controller Transient Voltage Test (Spike Test) Procedure
T 423	WSDOT		✓	Test Method for Traffic Controller Conflict Monitoresting
T 424	WSDOT		✓	Test Method for Traffic Controller Power Interruption Test Procedure
T 425	WSDOT		✓	Test Method for Traffic Controller NEM and 170 Type Environmental Chamber Test
T 426	WSDOT		✓	Pull-Off Test for Hot Melt Traffic Button Adhesive
T 427	WSDOT		✓	Test Method for Loop Amplifier Testing Procedure
T 428	WSDOT		✓	Test Method for Traffic Controller Compliance Inspection and Test Procedure
SOP 429	WSDOT		✓	Methods for Determining the Acceptance of Traffic Signal Controller Assembly
T 429	WSDOT	✓	✓	Retroreflectance of Newly Applied Pavement Marking Using Portable Hand-Operated Instruments

Procedure Number	Owner	Field Use	In Manual	Test Method
T 432	WSDOT		✓	Flexibility Test for Hot-Melt Adhesives
C 457	ASTM			Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete
D 470	ASTM			Test Method for Crossedlinked Insulation and Jackets for Wire and Cable
C 495	ASTM			Test Method for Compressive Strength of Lightweight Insulated Concrete
T 501	WSDOT		✓	Test Method to Determine Durability of Very Weak Rock
D 562	ASTM			Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
T 601	WSDOT		✓	Method of Test for Sieve Analysis of Soils – Coarse Sieving
F 606	ASTM			Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
T 606	WSDOT		✓	Method of Test for Compaction Control of Granular Materials
T 610	WSDOT		✓	Method of Test for the Capillary Rise of Soils
SOP 615	WSDOT	✓	✓	Determination of the % Compaction for Embankment and Untreated Surfacing Materials Using the Nuclear Moisture-Density Gauge
DMCT 700	ATSI			Manual on Signal Controller Evaluation
T 712	WSDOT	✓	✓	Standard Method of Reducing Hot Mix Asphalt Paving Mixtures
T 716	WSDOT	✓	✓	Method of Random Sampling for Locations of Testing and Sampling Sites
T 718	WSDOT		✓	Method of Test for Determining Stripping of Hot Mix Asphalt
T 720	WSDOT		✓	Method of Test for Thickness Measurement of Hot Mix Asphalt (HMA) Cores
SOP 723	WSDOT		✓	Standard Operating Procedure for Submitting Hot Mix Asphalt (HMA) Mix Designs for Verification
T 724	WSDOT	✓	✓	Method of Preparation of Aggregate for Hot Mix Asphalt (HMA) Mix Designs
T 726	WSDOT	✓	✓	Mixing Procedure for Hot Mix Asphalt (HMA)
SOP 728	WSDOT	✓	✓	Standard Operating Procedure for Determining the Ignition Furnace Calibration Factor (IFCF) for Hot Mix Asphalt (HMA)
SOP 729	WSDOT	✓	✓	Standard Operating Procedure for Determination of the Moving Average of Theoretical Maximum Density (TMD) for HMA
SOP 730	WSDOT	✓	✓	Standard Operating Procedure for Correlation of Nuclear Gauge Densities With Hot Mix Asphalt (HMA) Cores
SOP 731	WSDOT	✓	✓	Standard Operating Procedure for Determining Volumetric Properties of Hot Mix Asphalt
SOP 732	WSDOT	✓	✓	Standard Operating Procedure for Volumetric Design for Hot-Mix Asphalt (HMA)
SOP 733	WSDOT	✓	✓	Standard Operating Procedure for Determination of Pavement Density Differentials Using the Nuclear Density Gauge
SOP 734	WSDOT	✓	✓	Standard Operating Procedure for Sampling Hot Mix Asphalt After Compaction (Obtaining Cores)
SOP 735	WSDOT	✓	✓	Standard Operating Procedure for Longitudinal Joint Density

Procedure Number	Owner	Field Use	In Manual	Test Method
SOP 736	WSDOT		✓	In-Place Density of Bituminous Mixes Using Cores
T 802	WSDOT	✓	✓	Method of Test for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)
C 805	ASTM			Test Method for Rebound Number of Hardened Concrete
C 805	WSDOT	✓	✓	Rebound Hammer Determination of Compressive Strength of Hardened Concrete
T 807	WSDOT	✓	✓	Method of Operation of California Profilograph and Evaluation of Profiles
T 808	WSDOT	✓	✓	Method for Making Flexural Test Beams
E 810	ASTM			Standard Test Method for Coefficient of Retroreflection of Retroreflective Sheeting Utilizing the Coplanar Geometry
T 810	WSDOT	✓	✓	Method of Test for Determination of the Density of Portland Cement Concrete Pavement Cores
T 812	WSDOT	✓	✓	Method of Test for Measuring Length of Drilled Concrete Cores
T 813	WSDOT	✓	✓	Field Method of Fabrication of 2 in (50 mm) Cube Specimens for Compressive Strength Testing of Grouts and Mortars
T 814	WSDOT		✓	Method of Test for Water Retention Efficiency of Liquid Membrane-Forming Compounds and Impermeable Sheet Materials for Curing Concrete
T 816	WSDOT		✓	Method of Test for Parting Compound
T 818	WSDOT		✓	Air Content of Freshly Mixed Self-Compacting Concrete by the Pressure Method
T 819	WSDOT		✓	Making and Curing Self-Compacting Concrete Test Specimens in the Field
C 881	ASTM			Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
C 882	ASTM		✓	Bond Strength (Diagonal Shear) (Checklist Only)
T 914	WSDOT	✓	✓	Practice for Sampling of Geosynthetic Material for Testing
T 915	WSDOT		✓	Practice for Conditioning of Geotextiles for Testing
T 923	WSDOT		✓	Thickness Measurement of Geotextiles
T 925	WSDOT		✓	Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement
T 926	WSDOT		✓	Geogrid Brittleness Test
C 939	ASTM			Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
C 939	WSDOT	✓	✓	FOP for ASTM for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
D 1208	ASTM			Test Methods for Common Properties of Certain Pigments (Loss on Ignition)
D 1210	ASTM			Standard Test Method for Fineness of Dispersion of Pigment-Vehicle Systems by Hegman-Type Gage
C 1218	ASTM			Standard Test Method for Water-Soluble Chloride in Mortar and Concrete
C 1231	ASTM			Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
D 1293	ASTM			Standard Test Methods for pH of Water

Procedure Number	Owner	Field Use	In Manual	Test Method
D 1347	ASTM			Standard Test Method for Color and Color-Difference Measurement by Tristimulus Colorimetry
D 1429	ASTM			Standard Test Methods for Specific Gravity of Water and Brine
C 1437	ASTM			Standard Test Method for Flow of Hydraulic Cement Mortar
D 1475	ASTM			Test Method for Consistency of Paints Test Method for Density of Paint, Varnish, Lacquer, and Related Products
C 1611	WSDOT	✓	✓	FOP for ASTM C 1611/C 1611M Standard Test Method for Slump Flow of Self-Consolidating Concrete
C 1621	WSDOT	✓	✓	FOP for ASTM C 1621/C 1621M Standard Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring
D 1632	ASTM			Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory
D 1683	ASTM			Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics
PCMZ 2000	TS			Manual on Signal Controller Evaluation
D 2240	ASTM			Standard Test Method for Rubber Property – Durometer Hardness
D 2244	ASTM			Standard Practice for Calculation of Color Tolerances and Color Differences From Instrumentally Measured Color Coordinates
D 2369	ASTM			Test Method for Volatile Content of Coatings (Ordinary Laboratory Oven)
D 2371	ASTM			Standard Test Method for Pigment Content of Solvent-Reducible Paints (Centrifuge)
D 2487	ASTM			Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
D 2488	ASTM			Practice for Description and Identification of Soils (Visual-Manual Procedure)
D 2621	ASTM			Standard Test Method for Infrared Identification of Vehicle Solids From Solvent-Reducible Paints
D 2628/ M 220	ASTM	✓	✓	Test for High and Low Temperature Recovery of Elastomeric Joint Seals for Concrete Pavements
D 2633	ASTM			Standard Test Methods for Thermoplastic Insulations and Jackets for Wire and Cable
D 2697	ASTM			Standard Test Method for Volume Nonvolatile Matter in Clear or Pigmented Coatings
3011	FTMS			Method for Determination of Condition in Container
D 3111	ASTM			Standard Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method
D 3723	ASTM			Standard Test Method for Pigment Content of Water Emulsion Paints by Temperature Ashing
D 3786	ASTM			Standard Test Method for Bursting Strength of Textile Fabrics – Diaphragm Bursting Strength Tester Method
4053	FTMS			Method for Determination of Nonvolatile Vehicle Content
4061	FTMS			Method for Determination of Drying Time (Oil-Based Paints)
4122	FTMS			Method for Determination of Hiding Power (Contrast Ratio)
D 4186	ASTM			Standard Test Method for One-Dimensional Consolidation Properties of Saturated Cohesive Soils Using Controlled-Strain Loading

Procedure Number	Owner	Field Use	In Manual	Test Method
D 4354	ASTM		✓	Standard Practice for Sampling of Geosynthetics for Testing
D 4355	ASTM			Standard Test Method for Deterioration of Geotextiles From Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
D 4491	ASTM			Standard Test Methods for Water Permeability of Geotextiles by Permittivity
D 4505	ASTM			Standard Specification for Preformed Plastic Pavement Marking Tape for Extended Service Life
D 4533	ASTM			Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D 4595	ASTM			Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
D 4632	ASTM			Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
D 4644	ASTM			Standard Test Method for Slake Durability of Shales and Similar Weak Rocks
D 4694	ASTM			Test Method for Deflections With Falling-Eight Type Impulse Load Device
D 4751	ASTM			Test Method for Determining Apparent Opening Size of a Geotextile
D 4758	ASTM			Test Method for Nonvolatile Contents of Latexes
D 4791	WSDOT	✓	✓	FOP for ASTM for Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 4833	ASTM			Test Method for Index Puncture Resistance of Geomembranes and Related Products
D 4956	ASTM			Standard Specification for Retroreflective Sheeting for Traffic Control
D 5084	ASTM			Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
D 5311	ASTM			Standard Test Method for Load Controlled Cyclic Triaxial Strength of Soil
D 5329	ASTM			Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphaltic and Portland Cement Concrete Pavements
D 5731	ASTM			Standard Test Method for Determination of the Point Load Strength Index of Rock and Application to Rock Strength Classifications
D 6467	ASTM			Standard Test Method for Torsional Ring Shear Test to Determine Drained Residual Shear Strength of Cohesive Soils
D 6528	ASTM			Standard Test Method for Consolidated Undrained Direct Simple Shear Testing of Cohesive Soils
D 6931	ASTM		✓	Standard Test Method for Indirect Tensile (IDT) Strength of Bituminous Mixtures
D 7012	ASTM		✓	Standard Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens
D 7091	ASTM	✓	✓	Nondestructive Measurement of Thickness of Nonmagnetic Coatings on a Ferrous Base (Checklist Only)
D 7585	ASTM			Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments

WSDOT FOP FOR WAQTC TM 2

Sampling Freshly Mixed Concrete

Scope

This method covers procedures for obtaining representative samples of fresh concrete delivered to the project site and on which tests are to be performed to determine compliance with quality requirements of the specifications under which concrete is furnished. The method includes sampling from stationary, paving and truck mixers, and from agitating and non-agitating equipment used to transport central mixed concrete.

This method also covers the procedure for preparing a sample of concrete for further testing where it is necessary to remove aggregate larger than the designated size for the test method being performed. The removal of large aggregate particles is accomplished by wet sieving.

Sampling concrete may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices.

Warning – Fresh Hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.

Apparatus

- Wheelbarrow
- Cover for wheelbarrow (plastic, canvas, or burlap)
- Shovel
- 5 gal bucket for water

Procedure

Use every precaution in order to obtain samples representative of the true nature and condition of the concrete being placed being careful not to obtain samples from the very first or very last portions of the batch. The size of the sample will be 1.5 times the volume of concrete required for the specified testing, but not less than 1 ft^3 after wet-sieving, if required.

Note 1: Sampling should normally be performed as the concrete is delivered from the mixer to the conveying vehicle used to transport the concrete to the forms; however, specifications may require other points of sampling, such as at the discharge of a concrete pump.

- **Sampling from stationary mixers, except paving mixers**

  Obtain the sample after a minimum of 1/2 m3 (1/2 yd3) of concrete has been discharged. Perform sampling by passing a receptacle completely through the discharge stream, or by completely diverting the discharge into a sample container. If discharge of the concrete is too rapid to divert the complete discharge stream, discharge the concrete into a container or transportation unit sufficiently large to accommodate the entire batch and then accomplish the sampling in the same manner as given for paving mixers. Take care not to restrict the flow of concrete from the mixer, container, or transportation unit so as to cause segregation. These requirements apply to both tilting and nontilting mixers.

- **Sampling from paving mixers**

  Obtain material from at least five different locations in the pile and combine into one test sample. Avoid contamination with subgrade material or prolonged contact with absorptive subgrade. To preclude contamination or absorption by the subgrade, sample the concrete by placing a shallow container on the subgrade and discharging the concrete across the container. The container shall be of a size sufficient to provide a sample size that is in agreement with the nominal maximum aggregate size.

- **Sampling from revolving drum truck mixers or agitators**

  Obtain the sample after a minimum of 1/2 m3 (1/2 yd3) of concrete has been discharged. Do not obtain samples until after all of the water has been added to the mixer. Do not obtain samples from the very first or last portions of the batch discharge. Sample by repeatedly passing a receptacle through the entire discharge stream or by completely diverting the discharge into a sample container. Regulate the rate of discharge of the batch by the rate of revolution of the drum and not by the size of the gate opening.

- **Sampling from open-top truck mixers, agitators, non-agitating equipment or other types of open-top containers**

  Sample by whichever of the procedures described above is most applicable under the given conditions.

- **Sampling from pump or conveyor placement systems**

  Obtain sample after a minimum of 1/2 m3 (1/2 yd3) of concrete has been discharged. Do not obtain samples until after all of the pump slurry has been eliminated. Sample by repeatedly passing a receptacle through the entire discharge system or by completely diverting the discharge into a sample container. Do not lower the pump arm from the placement position to ground level for ease of sampling, as it may modify the air content of the concrete being sampled. Do not obtain samples from the very first or last portions of the batch discharge.

Transport samples to the place where fresh concrete tests are to be performed and specimens are to be molded.

Combine and remix the sample minimum amount necessary to ensure uniformity. Protect the sample from direct sunlight, wind, rain, and sources of contamination.

Complete test for temperature and start tests for slump and air content within 5 minutes of obtaining the sample. Complete tests as expeditiously as possible. Start molding specimens for strength tests within 15 minutes of obtaining the sample.

Report results on concrete delivery ticket (i.e., Certificate of Compliance).

The name of the qualified tester who performed the field acceptance test is required on concrete delivery tickets containing test results.

Wet Sieving

When required for slump testing, air content testing or molding test specimens the concrete sample shall be wet-sieved, prior to remixing, by the following:

1. Place the sieve designated by the test procedure over dampened sample container.
2. Pass the concrete over the designated sieve. Do not overload the sieve (one particle thick.)
3. Shake or vibrate the sieve until no more material passes the sieve.
4. Discard oversize material including all adherent mortar.
5. Repeat until sample of sufficient size is obtained.
6. Mortar adhering to the wet-sieving equipment shall be included with the sample.

Note 1: Wet-sieving is not allowed for samples being utilized for density determinations according to the FOP for AASHTO T 121.

Performance Exam

Checklist Sampling Freshly Mixed Concrete
FOP for WAQTC TM 2

Participant Name ________________________________ Exam Date ____________________

Procedure Element	**Yes**	**No**
1. The tester has a copy of the current procedure on hand?	☐	☐
2. Obtain a representative sample:		
a. Sample the concrete after ½ cy discharged?	☐	☐
b. Pass receptacle through entire discharge stream or completely divert discharge stream into sampling container?	☐	☐
c. Transport samples to place of testing?	☐	☐
d. Sample remixed?	☐	☐
e. Sample protected?	☐	☐
f. Correct sample size?	☐	☐
3. Start tests for slump and air within 5 minutes of sample being obtained?	☐	☐
4. Start molding cylinders within 15 minutes of sample being obtained?	☐	☐
5. Protect sample against rapid evaporation and contamination?	☐	☐

First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Signature of Examiner ____________________________________

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Comments:

Washington State
Department of Transportation

WSDOT Standard Practice QC 3

Quality System Laboratory Review

1. Scope

   This standard specifies requirements and procedures for the review of WSDOT Regional Materials Laboratory and for Private Laboratories by the Quality Systems Laboratory Review Team. The on-site laboratory review shall include the following elements:

   - Review of the testing facility.
   - Review of the equipment calibration/verification records.
   - Review of the testing technician's training records.
   - Physical inspection of the equipment used to perform tests.
   - Observation of technician performing the test procedure.
   - Review of test reports and calculations.

2. Referenced Documents

   2.1 AASHTO Standards

   R 18 – Establishing and Implementing a Quality System for Construction Materials Testing Laboratories

   R 61 – Establishing Requirements for and Performing Equipment Calibrations, Standardizations, and Checks

   2.2 WSDOT Standards

   Materials Manual M 46-01
   Construction Manual M 41-01
   Standard Specifications for Road, Bridge, and Municipal Construction M 41-10

3. Terminology

   3.1 AASHTO – American Association of State Highway and Transportation Officials

   3.2 ASTM – American Society for Testing and Materials

   3.3 Calibration – A process that establishes the relationship (traceability) between the results of a measurement instrument, measurement system, or material measure and the corresponding values assigned to a reference standard (Note 1).

   Note 1: The definition for calibration and the following definitions for check, standardization, traceability, uncertainty, and verification of calibration are based on the definitions in R 61.

   3.4 Check – A specific type of inspection and/or measurement performed on equipment and materials to indicate compliance or otherwise with stated criteria.

3.5 Standardization – A process that determines (1) the correction to be applied to the result of a measuring instrument, measuring system, material measure, or reference material when its values are compared to the values realized by standards; or (2) the adjustment to be applied to a piece of equipment when its performance is compared with that of an accepted standard or process.

3.6 WSDOT – Washington State Department of Transportation

4. Significance and Use

4.1 This standard specifies procedures for reviewing laboratories for the purpose of determining the capability of the facility and its personnel to perform the necessary acceptance testing for WSDOT.

5. Laboratory Requirements

5.1 Facility and Equipment

5.1.1 Laboratory facilities shall adequately house and allow proper operation of all required equipment in accordance with the applicable test procedures.

5.1.2 The temperature and humidity of the laboratory shall meet the requirements of all test procedures performed in the laboratory.

5.1.3 The testing areas shall be clean and free of clutter.

5.1.4 The laboratory shall use testing equipment that meets the requirements of each test procedure.

5.1.5 Testing equipment for private laboratories and the State Materials Laboratory shall be calibrated/standardized/checked in accordance with the test procedure, appropriate sections of AASHTO R 18 and AASHTO R 61. WSDOT region and field laboratories testing equipment shall be calibrated/standardized/checked in accordance with the test procedure and Section 9-5 of the *Construction Manual* M 41-01.

5.1.6 Documentation of equipment calibration/standardization/check shall be maintained and available on-site during laboratory review.

5.1.7 Safety equipment will be available and maintained in proper working order.

5.2 Tester Training and Records

5.2.1 The laboratory shall use personnel qualified in accordance with the appropriate sections of AASHTO R 18. WSDOT region and field laboratory personnel shall be qualified in accordance with Section 9-5 of the *Construction Manual* M 41-01.

5.2.2 The laboratory shall maintain records of training for each tester.

5.2.3 A tester's competency for performing a test procedure shall be evaluated using a checklist relating to the test procedure. The checklist shall be filed in the tester's training record.

Note: Private laboratories may use test procedure checklists from the *Materials Manual*, or may develop their own checklists similar to those found in the *Materials Manual*.

5.2.4 Testers for private laboratories shall be reviewed for qualification at the frequency stated in the *Laboratory Quality Systems Manual* (LQSM).

5.3 Manuals and Records

5.3.1 Private laboratories shall have an up-to-date LQSM meeting the requirements of AASHTO R 18 and approved by the State Materials Engineer.

5.3.2 All private laboratories shall have an up-to-date copy of the LQSM on-site and available to all testers.

5.3.3 Each tester must have access to the most current copy of the AASHTO, ASTM, and *Materials Manual*. WSDOT testers must have access to the most current copy of the *Construction Manual* M 41-01.

5.3.4 If an earlier version of the *Materials Manual* or *Construction Manual* M 41-01 is required by contract, the laboratory shall maintain an unaltered version of the required manual.

5.3.5 A file of MSDS sheets must be maintained in the laboratory and must be available to all testers.

5.3.6 Test records are required to contain sufficient information to permit verification of any test report (original observations, calculations, derived data, and identification of personnel involved in the sampling and testing).

5.3.7 Amendments to reports must be made in the manner stated in the LQSM.

5.3.8 The laboratory shall define the process used to ensure testers are performing the correct testing procedure according to the clients' contractual requirements (i.e., AASHTO, ASTM, or WSDOT test procedure as required by the contract).

5.3.9 Test reports are required to contain the following information:

- Name and address of the testing laboratory.
- Name and address of the client or identification of the project.
- Date of receipt of the test sample.
- Date of test performance.
- Identification of the standard test method used and notation of all know deviations from the test method.
- Test results and specification of the material.
- Name of tester performing the test.
- Date report was issued.
- Name of person accepting technical responsibility for test report.

6. Sampling

6.1 Test samples required for observation of test procedures shall be obtained by:

T 2 – WSDOT FOP for AASHTO for Soils and Aggregate

T 168 – WSDOT FOP for WAQTC for Hot Mix Asphalt

TM 2 – WSDOT FOP for WAQTC for Concrete

7. Sample Preparation Requirements

7.1 Prior to the performance portion of the laboratory review, for the testing being performed, samples are required to be prepared as shown in Table 1.

Test Procedure	Test	Required Preparation
Aggregate Tests		
FOP for AASHTO T 335	Fracture	Material washed, graded, and ready for counting fracture.
FOP for WAQTC T 27/T 11	Sieve Analysis of Fine and Coarse Aggregates	1. Split or quarter proper amount of the original sample and dry to constant weight. 2. Have a split of the original sample that has been washed and dried, ready for sieving. 3. Retain all weights in order to do calculations.
FOP for AASHTO T 176	Sand Equivalent Test	1. Have a sample (approximately 1000 g) of #4 minus material prepared for the moisture conditioning process (do not moisten). 2. Have two properly prepared tins ready for introduction into the SE tube.
FOP for AASHTO T 248	Reducing Sample	30 lbs dry material.
FOP for AASHTO T 304	Uncompacted Voids	1. Have sample washed and dried. 2. Sample separated into individual size fractions.
Concrete Tests		
FOP for AASHTO T 106	Compressive Strength	Three mortar cubes.
FOP for AASHTO T 22	Compressive Strength	Two cylinders.
FOP for AASHTO T 231	Capping Cylinder	1. Have capping sulfur compound heated and ready for capping. 2. Have two cylinders available for capping (can be the cylinders for T 22).
WSDOT T 810	Density of Pavement Core	Have a drilled pavement core available.
WSDOT T 812	Length of Drilled PCC Core	May use the core from T 810.
Soils Tests		
WSDOT T 417*	Resistivity and pH	1. Prepare a 100 g sample of natural #8 minus material for the pH test. 2. Prepare the soil/water slurry a minimum of 1 hour prior to test review. 3. Prepare a sample of #8 minus material that is four times the volume of the soil box for the resistivity test. 4. Add 10 percent by weight of water to the sample and allow it to stand a minimum of 12 hours in a waterproof container.
AASHTO T 84*	Specific Gravity and Absorption Fine Agg.	Prepare sample to step 6.1.2 of the procedure.
AASHTO T 85*	Specific Gravity and Absorption Coarse Agg.	Prepare sample to step 8.2 of the procedure.
AASHTO T 87*	Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test	500 g of soil aggregate air dried.
AASHTO T 88*	Particle Size Analysis	No preparation.
AASHTO T 100*	Specific Gravity Soils	No preparation.

Sample Preparation Requirements
Table 1

Test Procedure	Test	Required Preparation
AASHTO T 255	Moisture Content	No preparation.
AASHTO T 265	Moisture Content	No preparation.
FOP for AASHTO T 99/T 180	Proctor	Prepare five representative samples of #4 or ¾″ material at approximately 2 percent moisture already added to each sample starting at approximately 4 percent below optimum moisture of the material. Store in sealed containers.
WSDOT T 606	Maximum Density Curve	1. Dry and split a sample of material into coarse and fine material. 2. Prepare fine material for Test 1. 3. Prepare coarse material for either Test 2, Procedure 1 or Test 2, Procedure 2.
Hot Mix Asphalt Tests (Have HMA samples ready on the first day of review.)		
WSDOT T 712*	Reducing Sample	An adequate amount of HMA to perform all the testing required. Heat sample and have it ready to reduce. Required to split material from sample for T 308, T 312, T 329, T 209.
FOP for AASHTO T 166*	Bulk Specific Gravity	A room temperature compacted sample must be provided for this test. A gyratory sample or a core sample will suffice.
WSDOT SOP 724*	Preparation of Aggregates	Representative aggregate from stockpiles used in JMF, dried to a constant weight.
WSDOT SOP 726*	Mixing Procedure HMA	Binder used in JMF mix design heated to mixing temperature as recommended by binder supplier (typically one quart container). Aggregate representative of JMF sample size based on class of HMA heated to mixing temperature as recommended by binder supplier.

*WSDOT Laboratories only unless review of a private laboratory is requested by the project office.

Sample Preparation Requirements
Table 1 (continued)

8. Performance of Test Procedure

    8.1 All technicians must be current in their qualifications.

    8.2 The laboratory review team will evaluate the technician's testing proficiency using an approved WSDOT checklist.

    8.3 All equipment, used during the evaluation of the technician's proficiency, must be operational and have a current calibration sticker on the equipment.

    8.4 When the test is complete, the reviewer will go over the checklist with the tester and point out any deficiencies that occurred during the performance of the test procedure.

9. Termination of Review

   9.1 A laboratory review team member may choose to terminate the review of a procedure for the following reasons:

      9.1.1 Equipment is non-operational or the wrong equipment is being used.

      9.1.2 Tester is not qualified in the test procedure being reviewed.

      9.1.3 Tester makes multiple major errors in the performance of the test.

   9.2 The review of the laboratory may be terminated by the WSDOT Quality Systems Manager for the following reasons:

      9.2.1 Facility is not adequate for the test procedures being reviewed.

      9.2.2 Two or more testers fail during the proficiency portion of the review.

      9.2.3 Documentation of qualification of testers or calibration of equipment is not available for review when team arrives.

10. Failure of Review

   10.1 Rescheduling a review will require the following wait periods:

      - First Failure – Minimum of one week wait to reschedule.
      - Second Failure – Minimum of one month wait to reschedule.
      - Third Failure – Minimum of one month wait and submittal of corrective action documentation. The documents submitted must state the concerns of the review team and the corrective action taken to solve the problem.

11. Laboratory Review Team Report

   11.1 The Laboratory Review Team will review the facility, equipment, records, and testers compliance with the established requirements.

   11.2 The evaluation report will be prepared and sent to the laboratory within 30 days of the completion of the review.

   11.3 Any items that did not meet the requirements of Section 5 will be written up as "Issues."

      11.3.1 Issues resolved during the review shall be noted as "Issue Resolved No Response" necessary. If a "Resolved No Response Required" issue reoccurs in subsequent evaluations, the issue will be escalated to a "Response Required Issue."

      11.3.2 Issues that were not able to be resolved during the review will be noted as "Response Required Issue."

   11.4 During the review, members of the team may make suggestions for improvements to the performance of the test procedure or operation of equipment. These are suggestions only and will be noted in the report as "Observations." These do not require a response.

12. Response to Report

   12.1 Once the evaluation report has been received, the laboratory will have 90 days to respond in writing to all "Issues" labeled "Response Required."

   12.2 The response must be a detailed explanation stating how the laboratory has resolved the issue and what measures they have taken to prevent this issue from reoccurring in the future.

13. Approval of Laboratory

13.1 If the laboratory review report had no issues or the issues are minor and resolved at the time of the review, the laboratory may be approved to perform acceptance, Independent Assurance, or dispute resolution testing.

13.2 If the laboratory review contained Response Required Issues, the laboratory may receive a conditional approval until the deficiencies are corrected or the review team may recommend that the laboratory be disapproved for all testing until the deficiencies are corrected to the satisfaction of the WSDOT Quality System Manager.

14. Suspension of Laboratory Approval

14.1 Laboratory approvals are subject to satisfactory results from WSDOT evaluations, including Independent Assurance evaluations. If WSDOT determines an Approved Laboratory no longer meets the approval requirements a Notification of Pending Suspension will be sent to the laboratory stating the reason for the suspension.

14.1.1 The following conditions may result in suspension of a laboratory's approval status:

a. Failure to supply required information in a timely manner

b. Failure to correct deficiencies in a timely manner

c. Unsatisfactory performance report by the Independent Assurance Inspector

d. Changing the laboratory's physical location without notification to the WSDOT Quality Systems Manager

f. Delays in reporting the test data to WSDOT

g. Incomplete or inaccurate reporting

h. Using unqualified technicians to perform testing

i. Using equipment that is not calibrated, standardized or checked in accordance with AASHTO R 18

14.1.2 The laboratory will be given one week to respond to the pending suspension notice with a Letter of Correction, detailing how the suspension issue has been corrected and what measures have been enacted to prevent the issue from reoccurring. The State Materials Engineer will review the Letter of Correction and determine if the corrections are adequate or if a suspension is still required and the duration of the suspension.

14.1.3 A suspended laboratory must resolve all issues to the WSDOT's satisfaction and obtain reinstatement of qualification, prior to being allowed to test materials for a WSDOT project,

14.2 Should an approved laboratory be accused of falsifying test data or records the laboratory's approval will be suspended until the charge can be investigated. If found the approved laboratory is found to have falsified test data or records the laboratory will be disqualified from testing for a WSDOT project for a minimum of one year and be subject to further investigation and penalty under state and federal law.

Washington State Department of Transportation

WSDOT Standard Practice for HMA Mix Designs QC 8

Standard Practice for Development of Hot Mix Asphalt Mix Designs

1. Scope
    1.1. This standard specifies requirements and procedures for approval Hot Mix Asphalt mix designs for the Qualified Products List.
    1.2. This standard may involve hazardous materials, operations and equipment. It does not address all of the safety problems associated with their use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.
2. Referenced Documents
    2.1. WSDOT Standards
        2.1.1. *Standard Specifications for Road, Bridge, and Municipal Construction* M 41-10
3. Terminology
    3.1. AASHTO – American Association of State Highway and Transportation Officials
    3.2. Contractor/Producer – The Contractor, Producer or production facility that has the capacity for producing HMA meeting WSDOT *Standard Specifications*.
    3.3. ASA – Aggregate Source Approval
    3.4. ASTM – American Society of Testing and Materials
    3.5. HMA – Hot Mix Asphalt
    3.6. PGAB – Performance Graded Asphalt Binder
    3.7. QPL – Qualified Products List
    3.8. State Materials Laboratory – 1655 S. 2nd Avenue SW, Tumwater, WA 98512-6951
    3.9. WSDOT – Washington State Department of Transportation.
4. Significance and Use
    4.1. This standard specifies procedures for designing, submitting, evaluating and approving HMA mix designs for inclusion to the QPL.
5. Mix Design Development
    5.1. The Contractor/Producer or designee shall develop a HMA mix design in accordance with Section 5-04.3(7)A of the *Standard Specifications*. The HMA mix design aggregate structure, asphalt binder content, anti-stripping additive, rutting susceptibility and indirect tensile strength shall be determined in accordance with WSDOT SOP 732, FOP for AASHTO T 324 and WSDOT FOP for ASTM D 6931 and meet the requirements of Sections 9-03.8(2) and 9-03.8(6) of the *Standard Specifications*.

6. Submission to the WSDOT Qualified Products List

   6.1. Once the HMA mix design has been developed, the Contractor/Producer shall contact the QPL Engineer (www.wsdot.wa.gov/Business/MaterialsLab/QPL.htm) or 360-709-5442 to initiate the HMA mix design submittal process.

   6.2. To initiate the mix design submittal process the Contractor/Producer shall provide the following:

   - Company contact and billing information
   - A completed copy of WSDOT Form 350-042EF and test reports in accordance with Section 5-04.3(7)A1 of the *Standard Specifications*
   - A completed QPL Application
   - ASA Report for the aggregate source(s)
   - QPL Contractor/Producer Product Information page(s) for the PGAB and the anti-stripping additive

   6.3. The QPL Engineer will provide the following to the Contractor/Producer:

   - QPL evaluation tracking number
   - Initial letter detailing mix design evaluation
   - Cost sheet for mix design evaluation detailing submittal requirements and associated charges

   6.4. After payment is received for the mix design evaluation the QPL Engineer shall provide:

   - Assigned delivery date of materials and documentation to State Materials Laboratory
   - Estimated date of completion
   - Final letter indicating QPL status

   6.5. A priority queue will be established by the State Materials Laboratory for HMA mix design evaluations.

   6.6. Preference will be given to mix designs submitted for WSDOT contracts.

      6.6.1. HMA mix design evaluation for WSDOT contracts shall be completed within 25 calendar days of acceptance by the State Materials Laboratory. Acceptance will be determined when all required documentation, materials and payment have been received at the State Materials Laboratory.

      6.6.2. HMA mix design evaluations submitted that are not for WSDOT contracts will be completed within approximately 40 calendar days of acceptance by the State Materials Laboratory.

      6.6.3. The State Materials Laboratory reserves the right to limit the number of HMA mix design evaluations accepted that are not for WSDOT contracts at any given time. Workload and staffing will dictate the number of HMA mix designs accepted at one time.

7. Mix Design Evaluation

   7.1. The HMA mix design submitted by the Contractor/Producer will be evaluated by the State Materials Laboratory in accordance with Section 9-03.8(2) and 9-03.8(6) of the *Standard Specifications*.

   7.2. HMA mix designs will be placed on the QPL provided they meet the requirements of Section 9-03.8(2) and 9-03.8(6) of the *Standard Specifications*.

      7.2.1. Voids in Mineral Aggregate (VMA) must be within 1.5% of the minimum specification in accordance with Section 9-03.8(2) of the *Standard Specifications* for the class of HMA evaluated.

      7.2.2. % Gmm at N design must be within 1.5% of the specification in Section 9-03.8(2) of the *Standard Specifications* for the class of HMA evaluated.

      7.2.3. Voids Filled with Asphalt (VFA) in Section 9-03.8(2) will not be part of the mix design evaluation.

   7.3. A mix design that fails to meet the requirements listed in Section 8.2, 8.2.1 and 8.2.2 will not be accepted or placed on the QPL.

   7.4. Adjustments to mix designs will not be allowed once they have been evaluated.

   7.5. The Contractor/Producer will be issued a QPL mix design record providing the mix design is in compliance with Section 10 of this Standard Practice.

   7.6. The QPL listing for HMA mix designs will show the following information:

      - Company name
      - HMA Class
      - Aggregate Source(s)
      - PGAB Grade
      - PGAB Supplier
      - Anti-stripping additive brand and quantity (if applicable)

8. Referencing Mix Designs From The QPL

   8.1. Requests for reference HMA mix designs for non WSDOT projects will be completed on WSDOT Form 350-041EF and emailed to BituminousMaterials@wsdot.wa.gov.

   8.2. Reference HMA mix design reports will be issued for new mix designs on active and awarded WSDOT contracts once accepted and placed on the QPL.

   8.3. Reference HMA mix design reports will be issued for current mix designs on active and awarded WSDOT contracts provided the HMA production history is in compliance with *Standard Specifications* Section 5-04.3(11)D.

9. Removal From The QPL

   9.1. HMA mix designs will be automatically removed from the QPL in accordance with *Standard Specifications* Section 5-04.3(7)A.

   9.2. HMA mix designs may be removed from the QPL if found in nonconformance with the *Standard Specifications* or this Standard Practice. Causes for removal from the QPL may include, but are not limited to the following:

   - Failure to comply with requirements of Standard Practice QC 8.
   - HMA mix designs that are out of compliance in accordance with Section 5-04.3(11)D of the *Standard Specifications*.
   - Failure to notify WSDOT of changes in HMA production.
   - Removal at the request of the Contractor/Producer

10. Ignition Furnace Calibration Factor (IFCF) Samples

   10.1. Each HMA mix design submitted for evaluation will have 12 IFCF samples produced for WSDOT as part of the QPL evaluation process.

   10.2. The Contractor/Producer may elect to have 4 IFCF samples produced as part of the QPL evaluation process.

WSDOT FOP for AASHTO T 176[1]

Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

1. Scope
   1.1 This test is intended to serve as a rapid field test to show the relative proportions of fine dust or claylike material in soils or graded aggregates.
   1.2 The following applies to all specified limits in this standard: For the purpose of determining conformance with these specifications, an observed value or a calculated value shall be rounded off "to the nearest unit" in the last right-hand place of figures used in expressing the limiting value, in accordance with E 29, Using Significant Digits in Test Data to Determine Conformance With Specifications.
   1.3 The values stated in English units are to be regarded as the standard.
   1.4 Refer to R 16 for regulatory information for chemicals.
2. Reference Document
   2.1 AASHTO Standards

      M 92 – Wire-Cloth Sieves for Testing Purposes

      M 231 – Weighing Devices Used in the Testing of Materials
   2.2 ASTM Standards

      E 29 – Using Significant Digits in Test Data to Determine Conformance With Specifications
   2.3 WSDOT Standards

      T2 – FOP for Sampling of Aggregates

      T 248 – FOP for Reducing Samples of Aggregate to Testing Size
3. Significance and Use
   3.1 This test method is used to determine the proportion of detrimental fines in the portion passing the 4.75-mm (No. 4) sieve of soils or graded aggregates.
4. Apparatus
   4.1 A graduated plastic cylinder, rubber stopper, irrigator tube, weighted foot assembly, and siphon assembly, all conforming to their respective specifications and dimensions shown in Figure 1. Fit the siphon assembly to a 1 gal (4L) bottle of working calcium chloride solution (see Section 4.9) placed on a shelf 36 ± 1 in (915 ± 25 mm) above the work surface. In lieu of the specified 1 gal (4L) bottle, a glass or plastic vat having a larger capacity may be used provided the liquid level of the working solution is maintained between 36 and 46 inches (915 and 1170 mm) above the work surface.

[1]This FOP is based on AASHTO T 176-08 and has been modified per WSDOT standards. To view the redline modifications, contact the WSDOT Quality Systems Manager at 360-709-5412.

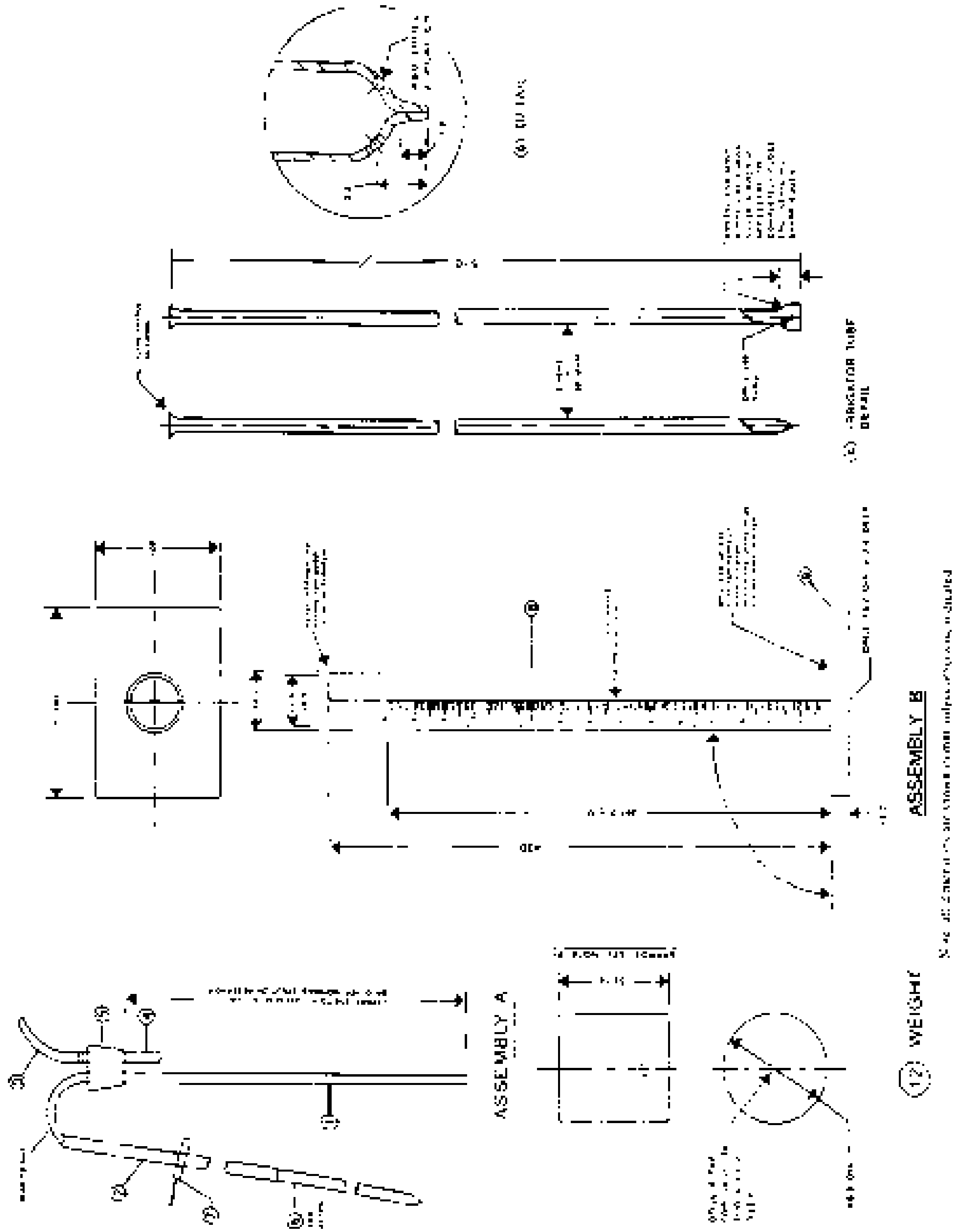


FIGURE 1 Sand Equivalent Apparatus

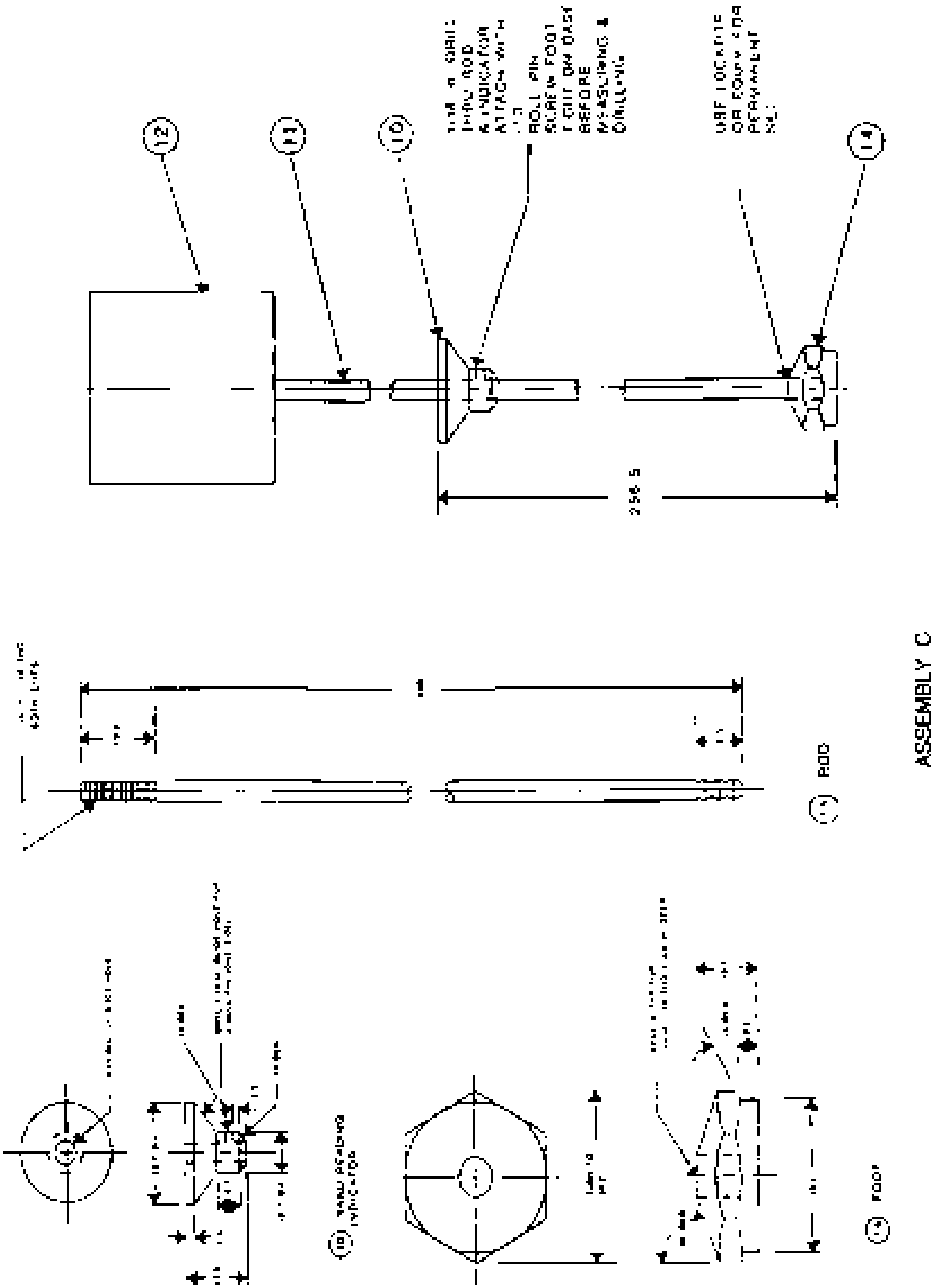


FIGURE 1 Sand Equivalent Apparatus (continued)

List of Material					
Assembly	**No. Reg.**	**Description**	**Stock size**	**Material**	**Heat Treatment**
A	**Siphon Assembly**				
	1	Siphon Tube	6.4 dia. × 400		
	2	Siphon Hose	4.6 I.D. × 1220		
	3	Blow Hose	4.8 I.D. × 50.8		
	4	Blow Tube	6.4 dia × 50.8		
	5	Two-Hole Stopper	No. 6		
	6	Irrigator Tube	6.4 O.D. 0.89 Wall × 500 Stainless Steel Tube, Type 316		
	7	Clamp	Pinchcock, Day, BKH No. 21730 or Equiv.		
B	**Graduate Assembly**				
	8	Tube	38.1 Od. × 430	Trans. Acrylic Plastic	
	9	Base	12.7 × 102 × 102	Trans. Acrylic Plastic	
C	**Weighted Foot Assembly**				
	10	Sand Reading Indicator	6.4 dia. × 14.9	Nylon 101 Type 66 Annealed	
	11	Rod	6.4 dia. × 438.2	Brass	
	12	Weight	50.8 dia. × 52.78	C.R. SH.	
	13	Roll Pin	0.16 dia. × 12.7	Steel	
	14	Foot	0.16 dia. × 13.7	Brass	
	15	Solid Stopper	No. 7	Rubber	

Notes

1. "C" Mounted Foot Assembly to weigh 1000 ± 5 g.
2. Graduations of graduate to be 2.54 mm apart and every tenth mark to be numerically designated as shown. Every fifth line should be approximately 9.5 mm long. All other lines should be approximately 5.5 mm long. Depth to be 0.4 mm. Width to be 0.8 mm across the top.
3. Accuracy of scale to be ± 0.25 mm. Error at any point on scale to be ± 0.75 mm of true distance to zero.
4. Glass or stainless steel may be substituted as a material type for the copper siphon and blow tubing.

Sand Equivalent Apparatus
Figure 1

Note 1: An older model of weighted foot assembly has a guide cap that fits over the upper end of the graduated cylinder and centers the rod in the cylinder, and the foot of the assembly has a conical upper surface and three centering screws to center it loosely in the cylinder. The older model does not have the same reading indicator affixed to the rod (Figure 1), but a slot in the centering screws of the weighted foot is used to indicate the sand reading. Apparatus with the sand reading indicator (Figure 2) is preferred for testing clayey materials.

Apparatus
Figure 2

4.2 A tinned measure, having a capacity of 3 oz (85 ± 5 mL), approximately 2.25 in (57 mm) in diameter.

4.3 A balance with sufficient capacity, readable to 0.1 percent of the sample mass, or better, and conforming to the requirements of M 231.

4.4 A wide-mouth funnel approximately 4 in (100 mm) in diameter at the mouth.

4.5 A clock or watch reading in minutes and seconds.

4.6 A mechanical shaker having a throw of 8.00 ± 0.04 in (203.2 ± 1.0 mm) and operating at 175 ± 2 cycles per minute (2.92 ± 0.03 Hz) (Note 2). Prior to use, fasten the mechanical sand equivalent shaker securely to a firm and level mount.

Note 2: The mechanical shaker shall be used when performing referee sand equivalent determinations.

4.7 A manually operated shaker capable of producing an oscillating motion at the rate of 100 complete cycles in 45 ± 5 seconds, with a hand-assisted half stroke length of 5.0 ± 0.2 in (127 ± 5 mm). The shaker shall be fastened securely to a firm and level mount by bolts or clamps.

4.8 Stock Solution

4.8.1 Prepare a calcium chloride stock solution

Ingredients: 454 g (1.0 lb) of technical grade Anhydrous Calcium Chloride
2050 g (4.515 lb) of USP Glycerin

Calcium chloride stock solution: Dissolve the 454 g (1.0 lb) of calcium chloride in 1.89 L (1/2 gal) of distilled water. Cool and filter it through ready pleated rapid filtering paper. Add the 2050 g (4.515 lb) of glycerin to the filtered solution, mix well and dilute to 3.78 L (1 gal).

Note 3: The stock solution can be stored provided the time of storage is not sufficient to promote the growth of fungi.

4.9 Working calcium chloride solution: Prepare the working calcium chloride solution by diluting one measuring tin full 3 oz. (85 ± 5 mL), or from a graduated cylinder of the stock calcium chloride solution to 1 gal (3.8 L) with water (finished product will equal 1 gallon). Use distilled or demineralized water for the normal preparation of the working solution. Record the date the working solution was made on the gallon container. Working solutions more than 30 days old shall be discarded.

4.10 A straightedge or spatula, suitable for striking off the excess soil from the tin measure.

4.11 A thermostatically controlled drying oven.

4.12 Quartering or splitting cloth, approximately 2 ft. square, nonabsorbent material such as plastic or oil cloth.

4.13 A No. 4 (4.75-mm) sieve conforming to the requirements of M 92.

4.14 Optional Handle for Irrigation Tube – A 25 mm diameter wooden dowel to aid in pushing the irrigation tube into firm materials. See Figure 1, Assembly B.

5. Temperature Control

5.1 The temperature of the working solution should be maintained at 67–77°F (22 ± 3°C) during the performance of this test. If field conditions preclude the maintenance of the temperature range, frequent reference samples should be submitted to a laboratory where proper temperature control is possible. It is also possible to establish temperature correction curves for each material being tested where proper temperature control is not possible. However, no general correction curve should be utilized for several materials even within a narrow range of sand equivalent values. Samples which meet the minimums and equivalent requirement at a working solution temperature below the recommended range need not be subject to reference testing.

6. Sampling

6.1 Obtain a sample of the material to be tested in accordance with WSDOT FOP for AASHTO T 2.

6.2 Reduce the sample in accordance with WSDOT FOP for AASHTO T 248.

6.3 Sieve the sample over No. 4 (4.75 mm) sieve using a mechanical shaker. (Make sure all large clumps of material are broken up before placing sieves in the mechanical shaker.)

6.3.1 Shake the sample in the mechanical shaker for a minimum of 10 minutes or for the minimum verified shaking time, whichever is greater.

6.3.2 The material shall be at Saturated Surface Dry (Saturated Surface Dry is defined herein as no visible free moisture, but material may still appear damp) or drier prior to sieving.

6.3.2.1 If the "as received" sample requires drying to achieve the required SSD or dryer condition prior to initial sieving, either air dry it or dry it in a thermostatically controlled oven at a temperature not to exceed 350°F.

6.3.3 Sieves may be nested above the No. 4 (4.75 mm) to prevent overloading, as defined in Table 1 of WSDOT FOP for WAQTC/AASHTO T 27/T 11, or the sample may be sieved in increments.

6.3.4 Break up any remaining clumps of fine-grained material and clean the fines from particles retained above the No. 4 (4.75 mm) sieve. Pass this material over the No. 4 (4.75 mm) sieve and include the material that passes in the total material passing the No. 4 (4.75 mm) sieve.

6.4 Split or quarter the material passing the No. 4 (4.75 mm), in accordance with WSDOT FOP for AASHTO T 248, to yield approximately 1,000 g to 1,500 g of material. Use extreme care to obtain a truly representative portion of the original sample (Note 4).

Note 4: Experiments show that as the amount of material being reduced by splitting or quartering is decreased, the accuracy of providing representative portions is decreased. It is imperative that the sample be split or quartered carefully. When it appears necessary, dampen the material before splitting or quartering to avoid segregation or loss of fines.

7. Sample Preparation

7.1 Prepare two test samples by the following method:

7.1.1 The sample must be in the proper moisture condition to achieve reliable results. Condition is determined by tightly squeezing a small portion of the thoroughly mixed sample in the palm of the hand. If the cast that is formed permits careful handling without breaking, the correct moisture range has been obtained. If the material is too dry, the cast will crumble and it will be necessary to add water and remix and retest until the material forms a cast. If the material shows any free water, it is too wet to test and must be drained and air-dried, mixing it frequently to ensure uniformity. This overly wet material will form a good cast when checked initially, so the drying process should continue until a squeeze check on the drying material gives a cast which is more fragile and delicate to handle than the original.

Place the sample on the splitting cloth and mix by alternately lifting each corner of the cloth and pulling it over the sample toward the diagonally opposite corner, causing the material to be rolled. When the material appears homogeneous, finish the mixing with the sample in a pile near the center of the cloth.

7.1.2 Fill the 3 oz (85 mL) tin measure by pushing it through the base of the pile while exerting pressure with the hand against the pile on the side opposite the measure. As the tin is moved though the pile, hold enough pressure with the hand to cause the material to fill the tin to overflowing. Press firmly with the palm of the hand, compacting the material and allowing the maximum amount to be placed in the tin. Strike off the tin measure level full with a spatula or straightedge. For the second determination, remix the sample and fill the tin again.

Dry the test sample in an oven in accordance with FOP for AASHTO T 255. The oven temperature shall not exceed 350°F (177°C). Cool to room temperature before testing. It is acceptable to place the test sample in a larger container to aid drying.

8. Procedure

8.1 Start the siphon by forcing air into the top of the solution bottle through the bent copper, glass, or stainless steel blow tube while the pinch clamp is open. The apparatus is now ready for use.

8.2 Siphon 4.0 ± 0.1 in (101.6 ± 2.5 mm) of working calcium chloride solution into the plastic cylinder. Pour the prepared test sample into the plastic cylinder using the funnel to avoid spillage (see Figure 3). Tap the bottom of the cylinder sharply on the heel of the hand several times to release air bubbles and to promote thorough wetting of the sample.

Tapping Bottom of Cylinder
Figure 3

8.3 Allow the wetted sample to stand undisturbed for 10 ± 1 minute. At the end of the 10-minute soaking period, stopper the cylinder, then loosen the material from the bottom by partially inverting the cylinder and shaking it simultaneously.

8.4 After loosening the material from the bottom of the cylinder, shake the cylinder and contents by any one of the following methods:

8.4.1 Mechanical Shaker Method – Place the stoppered cylinder in the mechanical sand equivalent shaker, set the timer, and allow the machine to shake the cylinder and contents for 45 ± 1 second.

8.4.2 Manual Shaker Method – Secure the stoppered cylinder in the three spring clamps on the carriage of the hand-operated sand equivalent shaker and reset the stroke counter to zero. Stand directly in front of the shaker and force the pointer to the stroke limit marker painted on the backboard by applying an abrupt horizontal thrust to the upper portion of the right hand spring steel strap. Then remove the hand from the strap and allow the spring action of the straps to move the carriage and cylinder in the opposite direction without assistance or hindrance. Apply enough force to the right-hand spring steel strap during the thrust portion of each stroke to move the pointer to the stroke limit marker by pushing against the strap with the ends of the fingers to maintain a smooth oscillating motion. The center of the stroke limit marker is positioned to provide the proper stroke length and its width provides the maximum allowable limits of variation. The proper shaking action is accomplished only when the tip of the point reverses direction within the marker limits. Proper shaking action can best be maintained by using only the forearm and wrist action to propel the shaker. Continue the shaking action for 100 strokes.

Manually-Operated Shaker
Figure 4

8.5 Following the shaking operation, set the cylinder upright on the work table and remove the stopper.

8.6 Irrigation Procedure – Insert the irrigator tube in the cylinder and rinse material from the cylinder walls as the irrigator is lowered. Force the irrigator through the material to the bottom of the cylinder by applying a gentle stabbing and twisting action while the working solution flows from the irrigator tip. This flushes the fine material into suspension above the coarser sand particles (see Figure 5). Continue to apply the stabbing and twisting action while flushing the fines upward until the cylinder is filled to the 15 in (381 mm) mark. Then raise the irrigator slowly without shutting off the flow so that the liquid level is maintained at about 15 in (381 mm) while the irrigator is being withdrawn. Regulate the flow just before the irrigator is entirely withdrawn and adjust the final level to 15 in (381 mm). Final level as judged by the bottom of the meniscus shall be between the top two gradations on the tube but shall not be above the 15 in (381 mm) level.

Irrigation
Figure 5

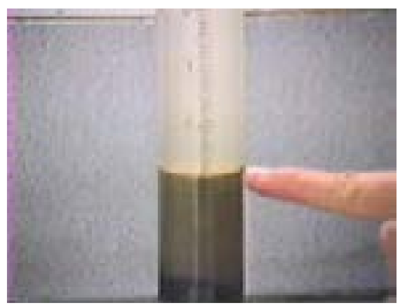
Note 5: For certain soils, particularly on crushed materials, the stabbing action may not be possible. For these materials, the irrigation technique is as follows: Continue to apply a twisting action as the irrigation tube is slowly withdrawn. As the tube is withdrawn, it is essential that as many fines as possible flushed upward until the cylinder is filled to the 15 in (381 mm) mark.

8.7 Allow the cylinder and contents to stand undisturbed for 20 minutes ± 15 seconds. Start the timing immediately after withdrawing the irrigator tube

8.8 At the end of the 20 minute sedimentation period, read and record the level of the top of the clay suspension. This is referred to as the "clay reading." If no clear line of demarcation has formed at the end of the specified 20 minute sedimentation period, allow the sample to stand undisturbed until a clear reading can be obtained, then immediately read and record the level of the top of the clay suspension and the total sedimentation time. If the total sedimentation time exceeds 30 minutes, it will be rejected.

8.9 After the clay reading has been taken, the "sand reading" shall be obtained by one of the following methods:

8.9.1 When using the weighted foot assembly having the sand indictor on the rod of the assembly, place the assembly over the cylinder and gently lower the assembly toward the sand. Do not allow the indicator to hit the mouth of the cylinder as the assembly is being lowered. As the weighted foot comes to rest on the sand, tip the assembly toward the graduations on the cylinder until the indicator touches the inside of the cylinder. Subtract 10 in (254 mm) from the level indicated by the extreme top edge of the indicator and record this value as the "sand reading" (see Figure 6).



Clay Reading
Figure 6

8.9.2 If an older model weighted foot assembly having centering screws is used, keep one of the centering screws in contact with the cylinder wall near the graduations so that it can be seen at all times while the assembly is being lowered. When the weighted foot has come to rest on the sand, read the level of the centering screw and record this value as the "sand reading."

8.10 If clay or sand readings fall between 0.1 in (2.5 mm) graduations, record the level of the higher graduation as the reading. For example, a clay reading of 7.95 would be recorded as 8.0, and a sand reading of 3.22 would be recorded as 3.3.

9. Calculations

9.1 Calculate the sand equivalent (SE) to the nearest 0.1 using the following formula:

$$SE = \frac{\text{Sand Reading} \times 100}{\text{Clay Reading}}$$

9.2 If the calculated sand equivalent is not a whole number, report it as the next higher whole number, as in the following example:

$$SE = \frac{3.3 \times 100}{8} = 41.25$$

which is reported as 42.

9.3 Average the whole number values determined as described above. If the average of these values is not a whole number, raise it to the next higher whole number, as in the following example:

Calculated SE values: 41.2, 40.9

After raising each to the next higher whole number, they become: 42, 41

The average of these values is then determined:

$$\frac{42 + 41}{2} = 41.5$$

which is reported as 42.

If the two results from the same SE sample vary by more than 8 points, the test shall be invalid and a new test completed.

9.3.1 Since the average value is not a whole number, it is raised to the next higher whole number and the reported averages and equivalent value is reported as 42.

10. Report

10.1 Report the results using one or more of the following:

- Materials Testing System (MATS)
- DOT Form 350-161, 422-022, 422-022A, or 422-022B
- Form approved in writing by the State Materials Engineer

Performance Exam Checklist

Plastic Fines in Graded Aggregates and Soils by the Use of the Sand Equivalent Test FOP for AASHTO T 176

Participant Name ______________________________ Exam Date ____________________

Procedure Element	Yes	No
Preparation		
1. The tester has a copy of the current procedure on hand?	☐	☐
2. All equipment is functioning according to the test procedure, and if required, has the current calibration/verification tags present?	☐	☐
3. Sample passed through No. 4 (4.75 mm) sieve?	☐	☐
4. Material in clods broken up and re-screened?	☐	☐
5. No fines lost?	☐	☐
6. Temperature of working solution 72 ± 5°F (22 ± 3°C)?	☐	☐
7. Working calcium chloride solution 36 ± 1 in (915 mm ± 25 mm) above the work surface?	☐	☐
8. 4 ± 0.1 in (101.6 ± 2.5 mm) working calcium chloride solution siphoned into cylinder?	☐	☐
9. Working solution dated?	☐	☐
Sample Preparation		
1. If necessary, sample sprayed with water to prevent loss of fines?	☐	☐
2. Material checked for moisture condition by tightly squeezing small portion in palm of hand and forming a cast?	☐	☐
3. Sample at proper water content?	☐	☐
a. If too dry (cast crumbles easily), water added and remixed?	☐	☐
b. If too wet (shows free water), sample drained, air dried and mixed frequently?	☐	☐
4. Sample placed on splitting cloth and mixed by alternately lifting each corner of the cloth and pulling it over the sample toward diagonally opposite corner, causing material to be rolled?	☐	☐
5. Is material thoroughly mixed?	☐	☐
6. When material appears to be homogeneous, mixing finished with sample in a pile near center of cloth?	☐	☐
7. Fill the 85 mL tin by pushing through base of pile with other hand on opposite side of pile?	☐	☐
8. Material fills tin to overflowing?	☐	☐
9. Material compacted into tin with palm of hand?	☐	☐
10. Tin struck off level full with spatula or straightedge?	☐	☐
11. Test sample dried in an oven at the correct temperature?	☐	☐
12. Sample cooled to room temperature	☐	☐

Procedure

1. Prepared sample funneled into cylinder with no loss of fines? ☐ ☐
2. Bottom of cylinder tapped sharply on heel of hand several times to release air bubbles? ☐ ☐
3. Wetted sample allowed to stand undisturbed for 10 min ± 1 min? ☐ ☐
4. Cylinder stoppered and material loosened from bottom by shaking? ☐ ☐
5. Properly performed shaking method? ☐ ☐
   - Mechanical Shaker Method ☐ ☐
   - Manual Shaker Method ☐ ☐
6. Following shaking, cylinder set vertical on work surface and stopper removed? ☐ ☐
7. Irrigator tube inserted in cylinder and material rinsed from cylinder walls as irrigator is lowered? ☐ ☐
8. Irrigator tube forced through material to bottom of cylinder by gently stabbing and twisting action? ☐ ☐
9. Stabbing and twisting motion applied until cylinder filled to 15 in (381 mm) mark? ☐ ☐
10. Liquid raised and maintained at 15 in (381 mm) mark while irrigator is being withdrawn? ☐ ☐
11. No clear solution at top of column? ☐ ☐
12. Contents let stand 20 minutes ± 15 seconds? ☐ ☐
13. Timing started immediately after withdrawal of irrigator? ☐ ☐
14. No vibration or disturbance of the sample? ☐ ☐
15. Readings taken at 20 minutes or up to 30 minutes, when a definite line appears? ☐ ☐
16. Weighted foot assembly lowered into cylinder without hitting mouth of cylinder? ☐ ☐
17. Calculations made to 0.1 and reported to the next higher whole number? ☐ ☐
18. SE is based on the average results of two samples? ☐ ☐
19. If the two SE values vary by more than 8 points, additional tests run? ☐ ☐
20. All calculations performed correctly? ☐ ☐

First Attempt: Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Signature of Examiner ______________________________________

Comments:

Washington State Department of Transportation

WSDOT Test Method T 716

Method of Random Sampling for Locations of Testing and Sampling Sites

A. Scope

1. This method outlines the procedure for selecting sampling and testing sites in accordance with accepted random sampling techniques. It is intended that all testing and sampling locations be selected in an unbiased manner based entirely on chance.
2. Testing and sampling locations and procedures are as important as testing. For test results or measurements to be meaningful, it is necessary that the sampling locations be selected at random, typically by use of a table of random numbers. Other techniques yielding a system of randomly selected locations are also acceptable.

B. Summary of Method for Selecting Random Test Location

- Method A – Determining a Random Location for Hot Mixture Asphalt (HMA) Density Tests
- Method B – Determining Random Test Location for Sampling HMA Mix, Aggregates, and Miscellaneous Materials
- Method C – Determining Random Test Location for Portland Cement Concrete
- Appendix A – Hot Mix Asphalt Density Test Locations for Irregular Paving Areas

C. Procedure for Determining Random Test/Sampling Location

Method A – Selection of Random Location for HMA Density

1. Stationing

This method outlines the procedure for determining the random location of HMA Density testing sites using stationing.

Calculate the linear foot distance for tons specified per sublot (i.e. 80 or 100 ton sublots).

Equations:

$$\textit{Sublot length (ft)} = \frac{\textit{(Sublot quantity (tons))}}{\textit{((width (ft) x depth (ft) x 0.076 tons/cf))}}$$

a. Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X value to determine the test station. A new X value is required for every test.

Note 1: To use the stopwatch method, randomly start and stop the stopwatch 10 or more times, then use the decimal part of the seconds as your entry point.

b. Determine the test station as follows:

Test Station = (sublot length × “X” multiplier) + beginning station of paving

c. Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 2. Use the corresponding “Y” multiplier to determine the offset. A new “Y” multiplier is required for every test.

d. Determine the offset as follows:

Offset = (width of pavement × "Y" multiplier)

Offset may be figured from the right or left edge of pavement. Tester shall indicate in MATS or approved density form from which edge the offset is measured.

e. When a testing location needs to be moved (i.e. for an obstruction or safety) the tester will adjust the location as follows:

i. For an adjusted of more than 2 ft, pick a new random number for the offset and recalculate the offset. Document the new location and the reason the testing location was changed.

ii. For adjustment of 2 ft or less move the gauge the required distance. Document the new location and the reason the testing location was changed.

Example for 100 ton sublot:
Given:
Paving width = 12 ft
Paving depth = 0.15 ft
Beginning Station = 10 + 00
Offset from left edge of pavement

Calculations:

$$\text{Sublot length (mile)} = \frac{100}{(12 \times 0.15 \times 0.076\,)} = 730\ lf$$

Ending Station = (Beginning Station + Sublot length) = (1000 + 730) = 17+30
Random generated number = X=25, Y=10
Beginning Test Location
Enter Table 1 at (25): "X" multiplier = 0.080
Enter Table 2 at (10): "Y" multiplier 0.167
Testing Station = (730 × 0.080) + 1000 =1058.4 = 10 + 58
Offset = (12 × 0.167) = 2.00 = 2 ft left of pavement edge

2. Milepost

This method outlines the procedure for determining the random location of HMA Density testing sites using mileposts.

a. Convert to tons per mile using the roadway area based on the roadway width and depth.

Equations:

$$\text{Sublot length (mile)} = \frac{\text{sublot quantity (tons)}}{\text{width (ft)} \times \text{depth (ft)} \times 401.28\ \frac{\text{tons}}{\text{sqftmile}}}$$

Round sublot length to the nearest thousandth (0.001) of a mile

Calculate the location of the test site and offset using the same method as described in Method A Stationing except use tons per mile instead of the tons per lf.

Test site = (sublot length x "X" multiplier) + beginning milepost

Offset = (width x "Y" multiplier)

Example for 100-ton sublot:

Given:

Paving width = 12 ft

Paving depth = 0.15 ft

Beginning Milepost (MP) = 1.00

Offset determined from right side of pavement

Calculations:

$$\text{Sublot length} = \frac{100}{(12 \times 0.15 \times 401.28\ )} = 0.138$$

Ending MP = (Beginning MP + Sublot length) = (1.00 + 0.138) = 1.138

Random generated number = X=25, Y=90

Beginning Test Location

Enter Table 1 at (25): "X" multiplier = 0.080

Enter Table 2 at (90): "Y" multiplier = 0.060

Testing MP = (.138 × 0.080) + 1.00 = 1.011

Offset = (12 × 0.060) = 0.72 = 0.7 ft right of edge of pavement

Random #	X	Random #	X	Random #	X	Random #	X
1	0.794	26	0.526	51	0.304	76	0.617
2	0.500	27	0.519	52	0.167	77	0.584
3	0.393	28	0.446	53	0.308	78	0.591
4	0.427	29	0.219	54	0.570	79	0.563
5	0.165	30	0.780	55	0.322	80	0.482
6	0.821	31	0.574	56	0.491	81	0.499
7	0.562	32	0.730	57	0.349	82	0.227
8	0.284	33	0.435	58	0.681	83	0.476
9	0.704	34	0.338	59	0.858	84	0.258
10	0.988	35	0.515	60	0.716	85	0.227
11	0.692	36	0.751	61	0.521	86	0.364
12	0.491	37	0.063	62	0.568	87	0.186
13	0.769	38	0.269	63	0.168	88	0.791
14	0.675	39	0.357	64	0.460	89	0.985
15	0.205	40	0.555	65	0.708	90	0.562
16	0.187	41	0.837	66	0.453	91	0.753
17	0.238	42	0.699	67	0.778	92	0.097
18	0.400	43	0.456	68	0.484	93	0.723
19	0.263	44	0.730	69	0.609	94	0.214
20	0.545	45	0.314	70	0.949	95	0.215
21	0.230	46	0.179	71	0.575	96	0.428
22	0.700	47	0.152	72	0.263	97	0.647
23	0.616	48	0.334	73	0.192	98	0.794
24	0.179	49	0.284	74	0.845	99	0.154
25	0.080	50	0.819	75	0.095	100	0.964

Random Number - X

Table 1

Random #	Y	Random #	Y	Random #	Y	Random #	Y
1	0.823	26	0.755	51	0.068	76	0.298
2	0.646	27	0.922	52	0.709	77	0.217
3	0.928	28	0.299	53	0.742	78	0.662
4	0.247	29	0.855	54	0.704	79	0.709
5	0.742	30	0.270	55	0.230	80	0.634
6	0.666	31	0.875	56	0.584	81	0.245
7	0.624	32	0.076	57	0.663	82	0.672
8	0.553	33	0.393	58	0.727	83	0.620
9	0.311	34	0.366	59	0.559	84	0.580
10	0.167	35	0.860	60	0.907	85	0.452
11	0.198	36	0.605	61	0.311	86	0.141
12	0.814	37	0.239	62	0.665	87	0.937
13	0.876	38	0.349	63	0.134	88	0.228
14	0.356	39	0.201	64	0.241	89	0.225
15	0.898	40	0.650	65	0.384	90	0.060
16	0.141	41	0.822	66	0.268	91	0.820
17	0.913	42	0.157	67	0.629	92	0.883
18	0.384	43	0.799	68	0.227	93	0.528
19	0.815	44	0.340	69	0.187	94	0.749
20	0.761	45	0.479	70	0.167	95	0.441
21	0.370	46	0.925	71	0.127	96	0.221
22	0.156	47	0.494	72	0.288	97	0.863
23	0.397	48	0.833	73	0.436	98	0.082
24	0.416	49	0.128	74	0.913	99	0.467
25	0.705	50	0.294	75	0.665	100	0.828

Random Number - Y

Table 2

Method B – Hot Mix Asphalt (HMA) Pavement Mixture or Aggregates

1. Determine the sublot increment of the material.
2. Use a random number generator (i.e. calculator, computer, etc) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X multiplier to determine the offset.
3. A new X multiplier is required for every sublot.
4. Random sample tonnage may be adjusted per sublot to accommodate field testing. Adjustments to random sample tonnage must be documented.
5. Calculate the location of the sampling site as follows:

Equations:

First Sample Site = Sublot increment × "X" multiplier (Table 1)
Subsequent Sites= (sublot increment + (Sublot increment × "X" multiplier)

Aggregate Sample Example:

Given: Crushed Surfacing Base Coarse
Random sample frequency per 9-3.7 =1 per 2,000 tons.
Calculate the location of the first random sample site as follows:

The computer-generated number is 22.
Sublot Increment (Frequency of sampling) = 2,000 tons
Enter Table 1 at (22) "X" = 0.700
Sampling Site = 2000 × 0.700= 1400 tons

Calculate subsequent sample sites as follows:

The computer-generated number is (53).
Sublot Increment (Frequency of sampling) = 2,000 tons
Enter Table 1at 53 "X" = 0.308
Sampling Site = 2000 + (2000 × 0.308) = 2616 tons

Method C Portland Cement (PCC)

1. Determine subsequent random sampling locations as follows:
   a. Example for less than 10 truckloads remaining after reducing frequency:
      (1) Determine amount of pour remaining this will be the sublot increment
      (2) Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X multiplier to determine the test station. A new X multiplier is required for every test.
      (3) Determine the sample location as follows:

      Sampling Location = Concrete remaining × "X" multiplier (Table 2)

      Given:

      Total cubic yards (cy) of concrete placement = 80 cy
      Truckload = 10 cy
      Given: First two trucks are in specification = 20 cy
      Remaining cubic yards = 80 cy-20 cy= 60 cy< 100 cy
      Sublot increment =60 cy
      Random number =30
      Sampling Location = 60 cy × 0.780 = 46.8= 47 cy or 7th truck

   b. Example for greater than 10 truckloads remaining after reducing frequency
      (1) Determine the sublot increment for the random test sample.

      Sublot increment = cubic yards per truck × 10 truckloads

      Given:

      Pour = 130 cy
      Each truck carries 8 cy of concrete
      First two trucks are in specification = 16 cy
      Remaining cubic yards = 130 - 16 = 114 > 80 cy
      Sublot Increment = 8 cy × 10 trucks = 80 cy

      Use a random number generator (i.e. calculator, computer) or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X value to determine the test station. A new X value is required for every test.

      Determine the sample location as follows:

      Sampling Location = Sublot increment × "X" multiplier (Table 1)

Example:

Random number = 15 “X”= 0.205
Sample location = 80 cy × 0.205 = 16.4
Determine where the first sample will be taken:
Testing location = (accumulated cy of last truck sampled) + sample yardage

Example:

First Sample Location:

Accumulated cy successive trucks = 8 × 2 =16
Sample location = 16 cy + 16.4 cy = 32.4 cy
Truck load = 32/8 = 4
Sampling = first half of 4th truck

Determine subsequent sampling locations as follows:

Sublot increment = total pour – (initial loads tested to get two consecutive loads in specification)-(first sublot increment)
Sublot increment = 130 cy – (16 cy) – (80 cy) = 34 cy
Random number = 70 “X” = 0.167
Testing location = (initial loads tested to get two consecutive loads in specification) + (first sublot increment) +(testing location within the second sublot)
Testing location = (16 cy)+(80 cy)+(0.167 × 34 cy)
Testing location = 101.67 cy or 101.67/8 cy per truck = 12.7 = 13th truck

3. Report
   1. Report the random number used to determine station and offset
   2. Document any changes in station or offset of random testing location
   3. Use one of the following to report random location information:
      - Materials Testing System (MATS)
      - Form approved in writing by the State Materials Engineer

Appendix A

Hot Mix Asphalt Density Test Locations for Irregular Paving Areas

A. Track tonnage placed in the irregular shaped area until specified tons are placed, note the stationing.

B. Measure back to the beginning of the paving or end of the previous lot to obtain the length (this is also your beginning station).

C. Use a computer-generated random number or a random number determined by a stopwatch (See Note 1) to enter Table 1. Use the corresponding X value to determine the test station. A new X value is required for every test.

D. Multiply the length by the "X" value and add to the beginning station to locate your testing site.

E. Use a computer-generated random number or a random number determined by a stopwatch (See Note 1) to enter Table 2. Use the corresponding Y value to determine the offset. A new Y value is required for every test.

F. Measure the width at the testing station and multiply the width time the "Y" value to determine the offset of the testing site.

G. Make a sketch of the area to document the test location in the event a retest is required.

Example:

Paving began at Station 101 + 00.

The tester determined Station 105 + 75 was the end of the 100 ton lot.

The width of the pavement began at 0 and transitioned to 12.

Testing Station

Sta 105 + 75 – Sta 101 + 00 = 475 ft
Random number = 45, "X" value = 0.314
475 ft × 0.314= 149.15= 149 Testing station = 10100 + 149 =102 + 49

Testing Offset

Measure width at station 102 + 49
Width = 3.76
Random # 65 "Y" value = 0.384
Offset = 3.76 × 0.384 = 1.44 = 1.4 ft from right edge