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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.

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

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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Tom Baker	/s/
Approved By	Signature

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Materials Laboratory

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D 5311	ASTM			Standard Test Method for Load Controlled Cyclic Triaxial Strength of Soil
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Procedure Number	Owner	Field Use	In Manual	Test Method
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T 925	WSDOT		✓	Standard Practice for Determination of Long-Term Strength for Geosynthetic Reinforcement
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D 1475	ASTM			Test Method for Density of Paint and Related Products
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Procedure Number	Owner	Field Use	In Manual	Test Method
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4122	FTMS			Method for Determination of Hiding Power (Contrast Ratio)
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T 606	WSDOT		✓	Method of Test for Compaction Control of Granular Materials
T 610	WSDOT		✓	Method of Test for the Capillary Rise of Soils
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QC 5	WSDOT		✓	Standard Practice for Ground Granulated Blast-Furnace Slag Producers/Importers/Distributors That Certify Ground Granulated Blast-Furnace Slag
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Procedure Number	Owner	Field Use	In Manual	Test Method
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QC 2	WSDOT		✓	Standard Practice for Asphalt Suppliers That Certify Performance Graded Asphalts
QC 3	WSDOT		✓	Quality System Laboratory Review
QC 4	WSDOT		✓	Standard Practice for Fly Ash Producers/Importers/Distributors That Certify Fly Ash
QC 5	WSDOT		✓	Standard Practice for Ground Granulated Blast-Furnace Slag Producers/Importers/Distributors That Certify Ground Granulated Blast-Furnace Slag
QC 6	WSDOT		✓	Standard Practice for Annual Prestressed Plant Review and Approval Process
T 2	WSDOT	✓	✓	FOP for AASHTO for Sampling of Aggregate
TM 2	WAQTC	✓	✓	FOP for WAQTC for Sampling Freshly Mixed Concrete
TM 8	WAQTC	✓	✓	FOP for WAQTC for In-Place Density of Hot Mix Asphalt Using the Nuclear Moisture-Density Gauge
T 11	AASHTO			Materials Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing
E 18	ASTM			Standard Test Methods for Rockwell Hardness of Metallic Materials
T 19	AASHTO	✓	✓	Unit Weight and Voids in Aggregates (Checklist Only)
T 21	AASHTO			Organic Impurities in Fine Aggregates for Concrete
T 22	AASHTO			Compressive Strength of Cylindrical Concrete Specimens
T 22	WSDOT	✓	✓	FOP for AASHTO for Compressive Strength of Cylindrical Concrete Specimens
T 23	AASHTO			Making and Curing Concrete test Specimens in the Field
T 23	WSDOT	✓	✓	FOP for AASHTO for Making and Curing Concrete test Specimens in the Field
T 27	AASHTO			Sieve Analysis of Fine and Coarse Aggregates
T 27/11	WSDOT	✓	✓	FOP for WAQTC/AASHTO for Sieve Analysis of Fine and Coarse Aggregates
R 28	AASHTO			Practice of Accelerated Aging of Asphalt Binder Using a Pressurized Aging Vessel
R 29	AASHTO			Practice for Grading or Verifying the Performance Grade of an Asphalt Binder
R 30	AASHTO			Practice for Short and Long Term Aging of Hot Mix Asphalt (HMA)
T 30	AASHTO			Mechanical Analysis of Extracted Aggregate
T 37	AASHTO			Sieve Analysis of Mineral Filler
R 39	AASHTO			Making and curing Concrete Test Specimens in the Laboratory
T 40	AASHTO			Method of Test for Determination of the Density of Portland Cement Concrete Pavement Cores
T 40	WSDOT	✓	✓	FOP for WAQTC/AASHTO for Sampling Bituminous Materials
T 44	AASHTO			Solubility of Bituminous Materials
T 48	AASHTO			Flash and Fire Points by Cleveland Cup

Procedure Number	Owner	Field Use	In Manual	Test Method
T 49	AASHTO			Penetration of Bituminous Materials
T 50	AASHTO			Float Test for Bituminous Materials
T 51	AASHTO			Ductility of Bituminous Materials
T 53	AASHTO			Softening point of Bituminous (Ring and Ball Apparatus)
T 59	AASHTO			Emulsified Asphalts
T 65	AASHTO			Mass (Weight) of Coating on Iron and Steel Articles With Zinc or Zinc-Alloy Coatings
T 71	AASHTO			Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
T 72	AASHTO			Saybolt Viscosity
IP 78-16	FHWA			Signal Controller Evaluation
T 79	AASHTO			Flash Point With Tag Open-Cup Apparatus for Use With Materials Having a Flash Less Than 93.3°C (200°F) 207
T 84	AASHTO			Specific Gravity and Absorption of Fine Aggregates
T 85	AASHTO			Specific Gravity and Absorption of Coarse Aggregates
T 87	AASHTO			Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test
T 88	AASHTO			Particle Size Analysis of Soils
T 89	AASHTO			Determining the Liquid Limit of Soils
T 90	AASHTO		✓	Determining the Plastic Limit and Plasticity Index of Soils (Checklist Only)
T 96	AASHTO			Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
T 99	AASHTO			Moisture-Density Relations of Soils Using a 2.5 kg (5.5 lb) Rammer and a 305 mm (12 in) Drop
T 99	WSDOT	✓	✓	FOP for AASHTO for Moisture-Density Relations of Soils Using a 5.5 lb (2.5 kg) Rammer and a 12 in (305 mm) Drop
T 100	AASHTO			Specific Gravity of Soil
T 105	AASHTO			Chemical Analysis of Hydraulic Cement
T 106	AASHTO			Compressive Strength of Hydraulic Cement Mortar (Using 50 mm or 2 in Cube Specimens)
T 106	WSDOT	✓	✓	FOP for AASHTO for Compressive Strength of Hydraulic Cement Mortars (Using 2 in or (50 mm) Cube Specimens)
T 107	AASHTO			Autoclave Expansion of Hydraulic Cement
T 113	WSDOT		✓	Method of Test for Determination of Degradation Value
T 119	AASHTO			Slump of Hydraulic Cement Concrete
T 119	WSDOT	✓	✓	FOP for AASHTO for Standard Test Method for Slump of Hydraulic-Cement Concrete
T 121	AASHTO			Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
T 123	WSDOT	✓	✓	Method of Test for Bark Mulch
T 124	WSDOT			Method of Testing Top Soils
T 125	WSDOT		✓	Determination of Fiber Length Percentages in Wood Strand Mulch
T 126	WSDOT		✓	Determination of Fiber Length Percentages in Hydraulically-Applied Erosion Control Products
T 127	WSDOT		✓	Preparation of Leachate Sample for Testing Toxicity of HECP Effluent

Procedure Number	Owner	Field Use	In Manual	Test Method
SOP 128	WSDOT	✓	✓	Sampling for Aggregate Source Approval
T 129	AASHTO			Normal Consistency of Hydraulic Cement
T 131	AASHTO			Time of Setting of Hydraulic Cement by Vicat Needle
T 133	AASHTO			Density of Hydraulic Cement
T 137	AASHTO			Air Content of Hydraulic Cement Mortar
C 140	ASTM			Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
T 141	AASHTO			Sampling Freshly Mixed Concrete
A 143	ASTM			Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
T 152	AASHTO			Air Content of Freshly Mixed Concrete by the Pressure Method
T 152	WSDOT	✓	✓	FOP for WAQTC for Air Content of Freshly Mixed Concrete by the Pressure Method
T 153	AASHTO			Fineness of Hydraulic Cement by Air Permeability Apparatus
T 154	AASHTO			Time of Setting of Hydraulic Cement by Gillmore Needle
T 162	AASHTO			Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
T 166	AASHTO			Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
T 166	WSDOT	✓	✓	FOP for AASHTO for Bulk Specific Gravity of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
T 168	AASHTO			Sampling Bituminous Paving Mixtures
T 168	WSDOT	✓	✓	FOP for WAQTC for Sampling Hot Mix Asphalt
T 176	AASHTO			Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
T 176	WSDOT	✓	✓	FOP for AASHTO for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
T 177	AASHTO			Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading)
T 180	WSDOT	✓	✓	FOP for AASHTO for Moisture-Density Relations of Soils Using a 10 lb (4.54 kg) Rammer and an 18 in (457 mm) Drop
D 185	ASTM			Standard Test Methods for Coarse Particles in Pigments, Pastes, and Paints
T 196	AASHTO		✓	Air Content of Freshly Mixed Concrete by Volumetric Method (Checklist Only)
T 197	AASHTO			Time of Setting of Concrete Mixtures by Penetration Resistance
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 Method of Test for Maximum Specific Gravity of Hot Mix Asphalt — “Rice Density”

Procedure Number	Owner	Field Use	In Manual	Test Method
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
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 Moisture Content of Aggregate by Drying
T 257	AASHTO			Instrumental Photometeric Measurements of Retroreflectivie Material and Retroreflectiv
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 Testing
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 Resilient Modulus of Soils and Aggregate Materials

Procedure Number	Owner	Field Use	In Manual	Test Method
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 and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
T 313	WSDOT		✓	Method of Test for Cement-Latex Compatibility
T 313	AASHTO			Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)
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 329	WSDOT	✓	✓	FOP for WSDOT for Moisture Content of Hot Mix Asphalt (HMA) by Oven Method
T 330	WSDOT		✓	Method for Coatings (Pigmented Sealers) Used on Concrete Structures
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
T 404	WSDOT		✓	Method of Test for Compressive Strength of Epoxy Resins
T 408	WSDOT		✓	Method of Test for Quality of Water to be Used in Mixing Concrete
T 411	WSDOT		✓	Method of Test for Water Absorption and Moisture Vapor Transpiration
D 412	ASTM			Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
T 412	WSDOT		✓	Bond Test for Joint Sealants
T 413	WSDOT	✓	✓	Method of Test for Evaluating Waterproofing Efectiveness of Membrane and Membrane-Pavement Systems
T 414	WSDOT		✓	Method of Test for Total Chloride Ion in Concrete

Procedure Number	Owner	Field Use	In Manual	Test Method
T 415	WSDOT		✓	Method of Test for Fertilizer
T 417	WSDOT		✓	Method of Test for Determining Minimum Resistivily and pH of Soil and Water
T 418	WSDOT		✓	Method of test for Corrosion of Deicing Materials
T 419	WSDOT		✓	Test Method for Cold Temperature Impact Resistance of the Plastic Coating on Reinforcing Bar Chair Feet
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		✓	Traffic Controller Conflict Monitor Testing
T 424	WSDOT		✓	Traffic Controller Power Interruption Test Procedure
T 425	WSDOT		✓	Traffic Controller NEM and 170 Type Environmental Chamber Test
T 426	WSDOT		✓	Pull-Off Test for Hot Melt Traffic Button Adhesive
T 427	WSDOT		✓	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 430	WSDOT		✓	Method of Testing for the Presence of Adhesion Coating in Glass Beads
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
D 562	ASTM			Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
T 606	WSDOT		✓	Method of Test for Compaction Control of Granular Materials
F 606	ASTM			Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets
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 Mixes
T 716	WSDOT	✓	✓	Method of Random Sampling for Location of Testing and Sampling Sites
T 718	WSDOT		✓	Method of Test for Determining Stripping of Hot Mix Asphalt (HMA)
T 720	WSDOT		✓	Method of Test for Thickness Measurement of Hot Mix Asphalt Cores

Procedure Number	Owner	Field Use	In Manual	Test Method
SOP 723	WSDOT		✓	Standard Operating Procedure for Submitting Hot Mix Asphalt Mix Designs for Verification
T 724	WSDOT	✓	✓	Method for Preparation of Aggregate for HMA Job Mix Design
T 726	WSDOT	✓	✓	Mixing Procedure for Hot Mix Asphalt
SOP 728	WSDOT	✓	✓	Standard Operating Procedure for Determining the Ignition Furnace Calibration Factor (IFCF) for Hot Mix Asphalt (HMA)
SOP 729	WSDOT	✓	✓	Determination of the Moving Average of Theoretical Maximum Density
SOP 730	WSDOT	✓	✓	Standard Operating Procedure for Correlation of Nuclear Gauge Determined Density With Asphalt Concrete Pavement Cores
SOP 731	WSDOT	✓	✓	Method for Determining Volumetric Properties of Asphalt Concrete Pavement Class Superpave
SOP 732	WSDOT	✓	✓	Standard Operating Procedure for Superpave 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
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 Profile
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 882	ASTM		✓	Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear
T 914	WSDOT	✓	✓	Practice for Sampling of Geotextiles for Testing

Procedure Number	Owner	Field Use	In Manual	Test Method
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
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	✓	✓	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 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	✓		Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements (Checklist Only)

Procedure Number	Owner	Field Use	In Manual	Test Method
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
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 4791	WSDOT	✓	✓	FOP for ASTM 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			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

Procedure Number	Owner	Field Use	In Manual	Test Method
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 7012	ASTM		✓	Standard Test Method for Compressive Strength and Elastic Moduli of Intact Rock Core Specimens under Varying States of Stress and Temperatures
D 7091	ASTM	✓	✓	Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals (Checklist Only)
D 7585	ASTM			Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments

WSDOT FOP for C 805[1]

Rebound Hammer Determination of Compressive Strength of Hardened Concrete

1. Scope

    1.1 This test method covers the determination of a rebound number of hardened concrete using a spring-driven steel hammer.

    1.2 The values stated in inch-pound units are to be regarded as the standard.

    1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

    2.1 ASTM Standards

    C 125 Terminology Relating to Concrete and Concrete Aggregates

    C 670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

    E 18 Test Methods for Rockwell and Rockwell Superficial Hardness of Metallic Materials

3. Significance and Use

    3.1 This test method is not intended as the basis for acceptance or rejection of concrete because of the inherent uncertainty in the estimated strength.

4. Apparatus

    4.1 Rebound Hammer – Consisting of a spring-loaded steel hammer that when released strikes a steel plunger in contact with the concrete surface. The spring-loaded hammer must travel with a consistent and reproducible velocity. The rebound distance of the steel hammer from the steel plunger is measured on a linear scale attached to the frame of the instrument.

    Note 1: Use type N rebound hammers that are commercially available to accommodate testing of various sizes and types of concrete construction.

    4.2 Abrasive Stone – Consisting of medium-grain texture silicon carbide or equivalent material.

    4.3 Test Anvil – Approximately 150 mm (6 in) diameter by 150 mm (6 in) high cylinder made of tool steel with an impact area hardened to 66 ± 2 HRC as measured by test method ASTM E 18. An instrument guide is provided to center the rebound hammer over the impact area and keep the instrument perpendicular to the surface.

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[1]This FOP is based on AASHTO C 805 and has been modified per WSDOT standards. To view the redline modifications, contact the WSDOT Quality Systems Manager at 360-709-5412.

4.4 Verification – Rebound hammers shall be serviced and verified annually and whenever there is reason to question their proper operation. Verify the functional operation of a rebound hammer using the test anvil described in Section 4.3. During verification, support the test anvil on a bare concrete floor or slab. The manufacturer shall report the rebound number to be obtained by a properly operating instrument when tested on an anvil of specified hardness.

Note 2: Typically, a rebound hammer will result in a rebound number of 80 ± 2 when tested on the anvil described in Section 4.3. The test anvil needs to be supported on a rigid base to obtain reliable rebound numbers. Verification on the test anvil does not guarantee that the hammer will yield repeatable data at other points on the scale. The hammer can be verified at lower rebound numbers by using blocks of polished stone having uniform hardness. Some users compare several hammers on concrete or stone surfaces encompassing the usual range of rebound numbers encountered in the field.

5. Test Area and Interferences

5.1 Selection of Test Surface – Concrete members to be tested shall be at least 100 mm (4 in) thick and fixed within a structure. Smaller specimens must be rigidly supported. Avoid areas exhibiting honeycombing, scaling, or high porosity. Do not compare test results if the form material against which the concrete was placed is not similar. Troweled surfaces generally exhibit higher rebound numbers than screeded or formed finishes. If possible, test structural slabs from the underside to avoid finished surfaces.

5.2 Preparation of Test Surface – A test area shall be at least 150 mm (6 in) in diameter. Heavily textured, soft, or surfaces with loose mortar shall be ground flat with the abrasive stone described in Section 4.2. Smooth-formed or troweled surfaces do not have to be ground prior to testing. Do not compare results from ground and unground surfaces.

5.3 Do not test frozen concrete.

Note 3: Moist concrete at 0°C (32°F) or less may exhibit high rebound values. Concrete should be tested only after it has thawed. The temperatures of the rebound hammer itself may affect the rebound number. Rebound hammers at -18°C (0°F) may exhibit rebound numbers reduced by as much as two or three units (1 unit = 1 whole number).

5.4 For readings to be compared, the direction of impact, horizontal, downward, upward, or at another angle, must be the same or established correction factors shall be applied to the readings.

5.5 Do not conduct tests directly over reinforcing bars with cover less than 0.75 in (20 mm).

***Note 4*:** The location of reinforcement may be established using reinforcement locators or metal detectors. Follow the manufacturer's instructions for proper operation of such devices.

6. Procedure

6.1 Hold the instrument firmly so that the plunger is perpendicular to the test surface. Gradually push the instrument toward the test surface until the hammer impacts. After impact, maintain pressure on the instrument and, if necessary, depress the button on the side of the instrument to lock the plunger in its retracted position. Read the rebound number on the scale to the nearest whole number and record the rebound number. Take ten readings from each test area. No two impact tests shall be closer together than 25 mm (1 in). Examine the impression made on the surface after impact, and if the impact crushes or breaks through a near-surface air void disregard the reading and take another reading.

7. Calculation

7.1 Discard readings differing from the average of ten readings by more than six units and determine the average of the remaining readings. If more than two readings differ from the average by six units, discard the entire set of readings and determine rebound numbers at ten new locations within the test area.

8. Report

8.1 Report the following information for each test area:

8.1.1 Date and time of testing.

8.1.2 Identification of location tested in the concrete construction and the type and size of member tested.

8.1.2.1 Description of the concrete mixture proportions including type of coarse aggregates if known.

8.1.2.2 Design strength of concrete tested.

8.1.3 Description of the test area including:

8.1.3.1 Surface characteristics (trowelled, screeded) of area.

8.1.3.2 If surface was ground and depth of grinding.

8.1.3.3 Type of form material used for test area.

8.1.3.4 Curing conditions of test area.

8.1.3.5 Type of exposure to the environment.

8.1.4 Hammer identification and serial number.

8.1.4.1 Air temperature at the time of testing.

8.1.4.2 Orientation of hammer during test.

8.1.5 Average rebound number for test area.

8.1.5.1 Remarks regarding discarded readings of test data or any unusual conditions.

10. Precision and Bias

See ASTM C 805 Precision and Bias.

Performance Exam Checklist

Rebound Hammer Determination of Compressive Strength of Hardened Concrete FOP for ASTM C 805

Participant Name ______________________ Exam Date ______________

Procedure Element

Preparation

		Yes	No
1.	Copy of current procedure available at test site?	❒	❒
2.	Hammer properly serviced and calibrated or verified?	❒	❒
3.	Test location properly prepared?	❒	❒
4.	Test location meets minimum size requirement?	❒	❒
5.	Ten acceptable readings taken in each test area?	❒	❒
6.	Readings properly spaced in test area?	❒	❒
7.	Test readings properly converted to estimated strength?	❒	❒
8.	Test information properly recorded?	❒	❒
9.	All calculations performed correctly?	❒	❒
Equipment			
10.	Are calibration/verifications tags present on equipment used in this procedure?	❒	❒
11.	All equipment functions according to the requirements of this procedure?	❒	❒

First Attempt: Pass ❒ Fail ❒ Second Attempt: Pass ❒ Fail ❒

Signature of Examiner ______________________

Comments:

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

PP 57 – 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 PP 57.

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 PP 57. 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 onsite 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 WSDOT *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's *Quality Systems Manual*.

5.3 Manuals and Records

5.3.1 Private laboratories shall have an up-to-date *Laboratory Quality Systems Manual* (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 the *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 27/11	Sieve Analysis of Fine and Coarse Aggregates	Split or quarter proper amount of the original sample and dry to constant weight. Have a duplicate sample that has been washed and dried, ready for sieving. Retain all weights in order to do calculations.
FOP for AASHTO T 176	Sand Equivalent Test	Split or quarter enough of the original sample to yield approx. 1000 g of #4 minus. Do not sieve over the #4. Have 2 tins that have been properly prepared ready for introduction into the SE tube.
FOP for AASHTO T 248	Reducing Sample	30 lbs dry material
Concrete Tests		
FOP for AASHTO T 106	Compressive Strength	3 mortar cubes
FOP for AASHTO T 22	Compressive Strength	2 cylinders
FOP for AASHTO T 231	Capping Cylinder	Capping compound ready to perform capping. Have 2 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	1500 g of #8 minus soil
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
AASHTO T 255	Moisture Content	No preparation

Sample Preparation Requirements
Table 1

Test Procedure	Test	Required Preparation
AASHTO T 265	Moisture Content	No preparation
FOP for AASHTO T 99/T 180	Proctor	Enough #4 or ¾" material prepared for a five point proctor determination. Prepare five representative samples with approximately 2 percent moisture already added to each sample and starting at approximately 4 percent below optimum moisture of the material. Store in sealed containers.
WSDOT T 606	Maximum Density Curve	Split a sample of material into coarse and fine material. Prepare material to step 1.3e of Test No. 1. Also, prepare material to either 2.3a of Test 2, Procedure 1 or step 2.5b of Test 2, Procedure 2.
Hot Mix Asphalt Tests		
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.

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.

WSDOT FOP for WAQTC/AASHTO T 40

Sampling Bituminous Materials

Significance

Sampling is as important as testing and precautions shall be taken to obtain samples to show the true nature and condition of the materials. Because of the numerous types and grades of bituminous materials that are alternately shipped and stored in the same or similar containers, the opportunity for contaminating these containers with residues, precipitates, or cleaning solvents is ever present. Numerous opportunities also exist for obtaining samples which are not strictly representative of the material or are contaminated after removal. Therefore it is incumbent upon the producer, transporter, user and sampler to exercise continuous precaution in the sampling and handling of these materials.

This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of the standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Scope

This practice applies to the sampling of liquid bituminous materials in accordance with AASHTO T 40. Sampling of solid and semi-solid bituminous materials (included in AASHTO T 40) is not covered here.

Agencies may be more specific on exactly who obtains the samples, where to sample, and what type of sampling device to use.

WSDOT personnel will observe the contractor's personnel obtaining the samples to assure that proper sampling procedures are followed. If proper sampling procedures are not followed the Contractor's personnel shall resample.

Procedure

1. Coordinate sampling with the contractor or supplier.
2. Use appropriate safety equipment and precautions.
3. A minimum of 1 gal (4 L) of the product shall be drawn and discarded or reintroduced to the tank before obtaining samples.
4. Sampling Asphalt Binder – Obtain samples at the asphalt mixing plant from the valve in either the storage tank or in the supply line to the mixer while the plant is in operation.
5. Sampling Emulsified Asphalt – Obtain samples from the distributor spray bar or application device just before or during application.

Containers

Sample containers must be new, and the inside may not be washed or rinsed. The outside may be wiped with a clean, dry cloth.

All samples shall be put in 1 qt (1 L) containers and properly identified on the outside of the container with contract number, date sampled, data sheet number, brand and grade of material, and sample number. Include lot and sublot numbers when appropriate.

All samples shall be protected from freezing.

Note: The filled sample container shall not be submerged in solvent, nor shall it be wiped with a solvent saturated cloth. If cleaning is necessary, use a clean dry cloth.

- **Asphalt Binder** – Use metal cans.
- **Emulsified Asphalt** – Use wide-mouth plastic jars with screw caps. Place tape around the seam of the cap to keep the cap from loosening and spilling the contents.

Standard sample labels (WSDOT Form 350-016) shall be completely filled out and attached to each sample container.

Performance Exam Checklist

Sampling Bituminous Materials
WAQTC FOP for AASHTO T 40

Participant Name ______________________________ Exam Date ____________________

Procedure Element	Yes	No
1. The tester has a copy of the current procedure on hand?	❐	❐
2. Appropriate containers used?		
a. Metal cans (all other bituminous liquids).	❐	❐
b. Wide-mouth plastic containers (emulsified).	❐	❐
3. Containers not washed or rinsed on inside?	❐	❐
4. Minimum of 1 gallon allowed to flow before sample taken?	❐	❐
5. Material obtained at correct location?		
a. Line between storage tank and mixing plant or the storage tank (HMA plants).	❐	❐
b. Spray bar or application device, if not diluted (distributors).	❐	❐
c. From delivery vehicle or prior to dilution, if diluted (distributors).	❐	❐

Sample Taken By: Contractor ❐

First Attempt: Pass ❐ Fail ❐ Second Attempt: Pass ❐ Fail ❐

Signature of Examiner __________________________________

Comments:

WSDOT Test Method T 606

Method of Test for Compaction Control of Granular Materials

1. Scope

   This test method is used to establish the theoretical maximum density of granular materials and non-granular materials with more than 30 percent by weight of the original specimen is retained on the No. 4 Sieve or more than 30 percent by weight of the original specimen is retained on the ¾ in sieve.

2. Reference Documents

   2.1 AASHTO Standards

   T 99 – Moisture-Density Relations of Soils Using a 5.5 lb (2.5 kg) Rammer and a 12 in (305 mm) Drop (Method A only)

   M 92 – Standard Specification for Wire-Cloth Sieves for Testing Purposes

   M 231 – Standard Specification for Weighing Devices Used in the Testing of Materials

   2.2 WSDOT Standards

   T 2 – FOP for AASHTO Standard Practice for Sampling Aggregates

   T 248 – FOP for AASHTO Reducing Samples of Aggregate to Testing Size

   T 255 – FOP for AASHTO Total Moisture Content of Aggregate by Drying

3. Definitions

   3.1 Fine Aggregate Portion-Material passing the No. 4 Sieve

   3.2 Coarse Aggregate Portion-Material retained on the No. 4 Sieve

4. Significance and Use

   This test method consists of three separate tests which present a method for establishing the proper theoretical maximum density values to be used for controlling the compaction of granular materials. In general, this test method is applicable to granular materials having 30 to 70 percent of the material passing the No. 4 (4.75 mm) sieve. These methods account for variations of maximum obtainable density of a given material for a given compactive effort, due to fluctuations in gradation.

5. Apparatus

   5.1 A vibratory spring-loaded compactor. Information on where to obtain this equipment will be provided by the State Materials Laboratory.

   5.2 Standard mold and base with a piston to fit inside the mold with a maximum 1⁄16 in clearance between piston and mold.

5.3 A ½ ft^3 mold with a piston to fit inside mold having a maximum 1⁄16 in clearance between piston and mold.

5.3.1 The molds and pistons will be constructed of metal of such dimensions as to remain rigid and inflexible under test conditions.

5.4 Spacer blocks of varying heights compatible with the compactor and pistons.

5.5 Measuring device, accurate and readable to 0.01 in with a minimum 6 in length.

5.6 Pycnometer calibrated at the test temperature having a capacity of at least 1 quart (100 ml). Glass pycnometers shall be used to determine the specific gravity of the fine particles. The glass pycnometer shall have a companion glass plate large enough to cover the jar's opening when calibrating or weighing the pycnometer.

5.7 One vacuum pump or aspirator (pressure not to exceed 100 mm mercury).

5.8 One balance accurate to 0.1 g.

5.9 3 in (75 mm), ¾ in (19 mm), and a No. 4 (4.75 mm) sieve conforming to AASHTO M 92 requirements.

5.10 Balance or scale: capacity sufficient for the principle sample mass, readable to 0.1 percent or 0.1 g, and meeting the requirements of AASHTO M 231.

5.11 Manually Operated Metal Rammer – As specified in AASHTO T 99, Apparatus.

5.12 Tamping rod of straight steel, ⅝ in (16 mm) in diameter and approximately 24 in (400 mm) long having at least one end rounded to a hemispherical tip.

5.13 Graduated cylinder.

5.14 A stopwatch or timer readable to 1 second.

6. Selection of T 606 Test and Procedure

To select the proper method for determining the maximum density of the Fine Aggregate portion of the sample, refer to the "Fine Aggregate Split of Original Sample" section of Table 1.

To select the proper procedure in Test 2 for determining the maximum density of the Coarse Aggregate portion of the sample, refer to the "Coarse Aggregate Split of Original Sample" section of Table 1.

Test Selection Table 1

Fine Aggregate Split of Original Sample	
Soil Type	**Test Method**
Sandy, non-plastic, permeable soils or non-cohesive soils.	T 606 Test 1
Silt, some plasticity, low permeability.	T 99 Method A
Sandy/silt, some plasticity, permeable.	T 606 Test 1/T 99 Method A (use highest results)
Coarse Aggregate Split of Original Sample	
No more than 15 percent by weight of the original aggregate specimen exceeds ¾ in.	T 606 Test 2 Procedure 1
15 percent or more by weight of the original aggregate specimen is greater than ¾ in (19 mm), but does not exceed 3 in (76 mm).	T 606 Test 2 Procedure 2

7. Sampling Material

7.1 Sample the material in accordance with WSDOT FOP for AASHTO T 2.

7.2 Native soils within the contract limits to be used for embankment construction and/or backfill material do not require sampling by a qualified tester.

7.3 For material that requires gradation testing such as but not limited to manufactured aggregates and gravel borrow, sampling shall be performed by a qualified testers.

8. Sample Preparation

8.1 Prepare the field sample by splitting out a representative portion in accordance with WSDOT FOP for AASHTO T 248.

8.2 Dry the compaction sample to constant mass in accordance with WSDOT FOP for AASHTO T 255.

8.3 Scalp the plus 75 mm (3 in) material from the compaction sample and discard, if not required for other tests. Separate the remainder of the compaction sample into coarse (minus 3 in (75 mm) to No. 4 (4.75 mm)) and fine (minus No. 4 (4.75 mm)) aggregate portions.

8.4 The quantity of material necessary to complete tests on both fractions is:

8.4.1 Fine aggregate, minimum of three portions approximately 13 lb (6 kg) each.

8.5 Coarse Aggregate

8.5.1 Procedure 1 (Aggregate Size: No. 4 to ¾ in (19 mm) – Separate a representative specimen of 10 to 11 lbs (4.5 to 5 kg) and weigh to 0.01 lbs (5 g) or less if using a balance that is more accurate than 0.1 lbs.

8.5.2 Procedure 2 (Aggregate Size: No. 4 to 3in (76 mm) – Separate a representative specimen of 45 lb. (20 kg) and weigh to 0.1 1b. (50 g) or less if using a balance that is more accurate than 0.1 lbs.

9. Procedure

9.1 Test No. 1 – Compaction Test of the Fine Fraction (No. 4 minus material)

9.1.1 Assemble the small mold and determine its mass, along with the piston, to the nearest 0.01 lb (5 g). Record this as the Mass of Mold Assembly.

9.1.2 Using one of the fine aggregate portions, add an amount of water estimated to produce a saturated sample when compacted and mix thoroughly.

Note 1: When the material is at its saturation point, free water (a drop or two) will show at the base of the mold between the 500 and 1,000 lbs load of the first compression run. Most materials will yield the highest density at that moisture content. Some materials may continue to gain density at higher moisture contents; however, this is due to the washing out of fines, which will alter the character of the sample. Therefore, if severe washing-out or pumping of fines occurs (as evidenced by dirty water flooding off of the base or pumped on top of the piston), the sample is beyond the saturation point. Discard and try a lower moisture content for the saturation point.

9.1.3 Set the piston aside and place the sample in the mold in three approximately equal layers. Consolidate each lift by 25 strokes of the tamping rod followed by 25 blows of the manually operated metal rammer. The surface of the top lift should be finished as level as possible.

9.1.4 Place the piston on top of the sample and mount the mold on the jack platform in the compactor. Spacers between the load spring and piston must be used to adjust the elevation of the mold so the hammers strike the mold in the center of the lift area. Elevate the mold until the loading head seats on top of the piston. Apply an initial seating load of approximately 100 lbs on the sample.

9.1.5 Start the compactor hammers and, by elevating the jack, begin the loading procedure. The load is applied as follows:

Load Application Rate	
Load	Time
0 to 500 lb	1 minute
500 lb to 1,000 lb	30 sec
1000 lb to 2,000 lb	30 sec

9.1.6 Upon reaching the 2,000 lb load at the end of the 2-minute cycle, stop the hammers, release the load on the jack, and return to zero pressure.

9.1.7 Repeat Steps 9.1.4 through 9.1.6 four additional times. After the last run, remove the mold from the compactor.

9.1.8 Measure the height of the compacted sample to the nearest 0.01 in (0.1 mm). Record as the Depth.

9.1.9 Determine the mass of the specimen in the mold to the nearest 0.01 lb (5g). Record this as: Mass of Mold + Sample

9.1.10 Remove the specimen from the mold and determine the moisture content in accordance with WSDOT FOP for AASHTO T 255.

9.1.11 Vertically slice through the center of the specimen, take a representative specimen (at least 1.1 lbs (500 g)) of the materials from one of the cut faces (using the entire specimen is acceptable), weigh immediately, and dry in accordance with AASHTO T 255 to determine the moisture content, and record the results.

9.1.12 Calculate and record the dry density of fine fraction.

9.2 Test No. 2 – Compaction Test of the Coarse Fraction

9.2.1 Procedure 1 – No. 4 (4.75 mm) to ¾ in (19 mm) Aggregates

9.2.1.1 Determine the mass of the coarse aggregate to the nearest 0.01 lb (5g).

9.2.1.2 Add 2.5 percent moisture to the sample, mix thoroughly.

9.2.1.3 Place in 0.1 ft^3 (0.0028 m^3) mold in approximately three equal lifts. Tamp each lift lightly to consolidate material and achieve a level surface. Avoid the loss of any material during placement.

9.2.1.4 Follow steps 9.1.4 through 9.1.8.

9.2.1.5 Calculate and record the dry density of coarse fraction.

9.2.2 Procedure 2 – No. 4 to 3in (76 mm) Aggregates

9.2.2.1 Determine the mass of the coarse aggregate to the nearest 0.01 lb (5g) or better.

9.2.2.2 Divide the sample into five representative, approximately equal portions.

9.2.2.3 Place one of the portions into the ½ ft^3 (0.014 m^3) mold and level the surface.

9.2.2.4 Position the piston on the material, mount the mold in the compactor, and compact as described in steps 9.1.4 through 9.1.6.

Note: Spacers may be needed between the load spring and piston to adjust the elevation of the mold to the height of the lift being compacted.

9.2.2.5 Repeat 9.2.2.3 and 9.2.2.4 for the remaining four portions of material.

9.2.2.6 After the final portion is compacted, determine the height of the compacted sample.

9.2.2.7 Calculate and record the dry density of coarse fraction (see Calculations section).

9.3 Test No. 3 – Specific Gravity Determination for Maximum Density Test

9.3.1 Material

9.3.1.1 Fine fraction No. 4 (4.75 mm) minus 1.1 lbs (500 g) minimum.

9.3.1.2 Coarse fraction No. 4 (4.75 mm) plus 2.2 lbs (1,000 g) minimum.

9.3.2 Procedure

9.3.2.1 Place dry materials, either fine or coarse fraction, in pycnometer.

9.3.2.2 Fill the pycnometer approximately ¾ full with 68°F (20°C) water.

9.3.2.3 Connect the pycnometer to the vacuum system; apply a partial vacuum of 30 ml Hg or less absolute pressure for a period of 20 minutes.

9.3.2.4 Agitate container either continuously by mechanical device or manually by vigorous shaking at 2 minute intervals.

9.3.2.5 Release vacuum and disconnect the hoses.

9.3.2.6 Fill pycnometer with water. Water temperature during test should be maintained as close to 68° ± 1°F (20° ± 0.5°C) as possible.

Note: It may be necessary to place the pycnometer in a water bath for 10 minutes, after release of vacuum, to bring the water temperature back to 68° ± 1°F (20° ± 0.5°C).

9.3.2.6.1 Metal Pycnometer (Coarse Specific Gravity Only) – Fill the vessel, according to the manufacturer's instructions, with 68° ± 1°F (20o ± 0.5°C) water. Dry the outside of the vessel and weigh to the nearest 0.1g. Record the weight.

9.3.2.6.2 Glass Pynometer (Fine or Coarse Specific Gravity) – Completely fill the pycnometer with 68° ± 1°F (20° ± 0.5°C) water then, slide the calibrated glass plate over the mouth of the jar making sure, air bubbles are not trapped under the glass plate. Dry the outside of the pycnometer and glass plate and weigh to the nearest 0.1g. Record the weight.

Calculations

10. Determine the dry density of each of the fine aggregate points as follows:

    10.1 Calculate Specific Gravity as follows:

    $$\text{Sp. Gr.} = \frac{a}{(a+b-c)}$$

    Where:

    a = Weight of dry material, grams
    b = Weight of pycnometer + water, grams
    c = Weight of pycnometer + material + water, grams

    10.2 Calculate the wet sample weight:

    $$e = c - d$$

    Where:

    e = Wet sample weight, g
    c = mold and sample weight
    d = Tare of mold assembly

    10.3 Calculate the wet density by:

    $$g = \frac{e \times b}{f}$$

    Where:

    g = wet density, lb/ft^3
    e = wet sample weight
    b = mold constant, in/ft^3
    f = height of sample, in (height constant-depth)

    10.4 Calculate the dry density of each of the fine fraction specimens as follows:

    $$h = \frac{g}{1 + n}$$

    Where:

    h = dry density, lb/ft^3
    g = wet density, lb/ft^3
    n = moisture content, expressed as a decimal

11. Reports

    11.1 Enter information into the WSDOT Materials Testing System (MATS) or other form approved in writing by the State Materials Engineer to obtain the theoretical maximum density curve.

Performance Exam Checklist

Method of Test for Compaction Control of Granular Materials
WSDOT Test Method T 606

Participant Name ______________________________ Exam Date ____________________

Procedure Element	**Yes**	**No**
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?	❐	❐
Fine Fraction — 100% Passing the No. 4 (4.75 mm) Sieve		
Specimen Preparation		
1. Has the specimen been oven-dried?	❐	❐
2. Has the specimen been separated on the No. 4 (4.75 mm) sieve?	❐	❐
3. Is the specimen weight approximately 13 lbs?	❐	❐
Procedure		
1. Is specimen saturated when compacted?	❐	❐
2. Has specimen been placed in three layers, rodded 25, and tamped 25 times, each layer?	❐	❐
3. Is the hammer blow approximately a 12 in free fall to prevent severe displacement of the specimen?	❐	❐
4. The specimen is as level as possible?	❐	❐
5. Has piston been placed on top of the specimen?	❐	❐
6. Has the mold been mounted on the jack in the compactor?	❐	❐
7. Has the mold been elevated until the load-spring retainer sits on top of the piston?	❐	❐
8. Has the initial load been set at 100 pounds?	❐	❐
9. Is the loading rate applied as specified in the test procedure?	❐	❐
10. Has the hammer been stopped, jack released, and pressure returned to zero when 2,000 lbs pressure was reached?	❐	❐
11. Steps 7 through 10 repeated four additional times?	❐	❐
12. Is free water present at the base of the mold within 1½ minutes of the start of the first compression run?	❐	❐
13. The mold removed from the compactor?	❐	❐
14. Has the height of the specimen been determined?	❐	❐

Procedure Element	**Yes**	**No**
15. Has specimen been weighed?	❒	❒
16. Has specimen been removed from mold and a representative portion immediately weighted and the moisture percentage determined?	❒	❒
17. Moisture content, dry density determined and entered on the testing sheet?	❒	❒
18. Theoretical maximum density determined by testing fresh specimens, as necessary, at different moisture contents and entered on the testing sheets?	❒	❒

Aggregate Size: No. 4 to ¾ in (19 mm)

Specimen Preparation

1. Has the specimen been oven-dried?	❒	❒
2. Has the specimen been separated on the No. 4 (4.75 mm) sieve?	❒	❒
3. Does more than 85 percent of the material pass the ¾ in (19 mm) sieve?	❒	❒

Procedure

1. Weight and record specimen weight?	❒	❒
2. Has the specimen been dampened to 2½ percent and placed in three lifts in a 0.1 ft^3 mold?	❒	❒
3. Specimen lightly tamped to archive a level surface?	❒	❒
4. Piston placed on top of specimen and mold mounted on jack in compactor?	❒	❒
5. Mold elevated until the load-spring retainer sits on top of the piston?	❒	❒
6. Initial load of 100 lbs set prior to starting machine?	❒	❒
7. Is the load rate applied as specified in the test procedure?	❒	❒
8. Hammers stopped, jack released, and pressure returned to 100 lbs when 2,000 lb load has been reached?	❒	❒
9. Steps 5 and 6 repeated four additional times?	❒	❒
10. The mold removed from the compactor and the height measured?	❒	❒
11. Dry density calculated and entered on the testing sheets?	❒	❒

Aggregate Size: No. 4 to 3 in

Specimen Preparation

1. Has the specimen been oven-dried?	❒	❒
2. Has the specimen been separated on the No. 4 (4.75 mm) sieve?	❒	❒
3. Is the specimen weight approximately 45 lbs?	❒	❒
4. Does the specimen contain 15 percent or more ¾ + material?	❒	❒
5. Has material greater than 3 in (76 mm) been removed?	❒	❒
6. Specimen separated into five approximately equal parts?	❒	❒

Procedure Element	**Yes**	**No**
Procedure		
1. Specimen placed in the mold in five separate lifts?	❐	❐
2. The specimen is as level as possible?	❐	❐
3. After each lift, mold placed in compactor and compacted according to test procedure?	❐	❐
4. After compacting final lift, specimen removed from compactor and volume determined?	❐	❐
5. Dry density determined calculated and entered onto testing sheet?	❐	❐
Specific Gravity Determination for Theoretical Maximum Density Test		
Specimen Preparation		
1. Has the specimen been oven-dried?	❐	❐
2. Has the specimen been separated on the No. 4 (4.75 mm) sieve?	❐	❐
3. Weight of fine fraction approximately 500 g?	❐	❐
4. Weight of coarse fraction approximately 1000 g?	❐	❐
Procedure		
1. Material placed in pycnometer and water at 68°F added?	❐	❐
2. Vacuum applied for at least 20 minutes?	❐	❐
3. Container and contents agitated manually by shaking at intervals of about 2 to 5 minutes?	❐	❐
4. Pycnometer filled with water at 68°F?	❐	❐
5. Pycnometer dried, weighted, and recorded on testing sheet?	❐	❐
6. Specific Gravity calculated and entered onto testing sheet?	❐	❐

First Attempt: Pass ❐ Fail ❐ Second Attempt: Pass ❐ Fail ❐

Signature of Examiner ____

Comments:

Washington State
Department of Transportation

WSDOT Test Method T 813

Field Method of Fabrication of 2 in (50 mm) Cube Specimens for Compressive Strength Testing of Grouts and Mortars

1. Scope

   This method covers the fabrication of 2 in (50 mm) cube specimens for compressive strength testing of grouts and mortars.

2. Equipment

   a. Specimen Molds – Specimen molds for the 2 in (50 mm) cube specimens shall be tight fitting. The molds shall not have more than three cube compartments and shall not be separable into more than two parts. The parts of the molds, when assembled, shall be positively held together. The molds shall be made of hard metal not attacked by the cement mortar. For new molds, the Rockwell hardness number shall not be less than HRB 55. The sides of the molds shall be sufficiently rigid to prevent spreading or warping. The interior faces of the molds shall conform to the tolerances of Table 1.

Parameter	2 in Cube Molds		50 mm Cube Molds	
	New	In Use	New	In Use
Planeness of Sides	<0.001 in	<0.002 in	<0.025 mm	<0.05 mm
Distance Between Opposite Sides	2 in ± 0.005 in	2 in ± 0.02 in	50 mm + 0.13 mm	50 mm + 0.50 mm
Height of Each Compartment	2 in + 0.001 in to -0.005 in	2 in + 0.01 in to -0.015 in	50 mm + 0.25 mm to -0.013 mm	50 mm + 0.25 mm to -0.38 mm
Angle Between Adjacent Faces*	90 + 0.5°	90 + 0.5°	90 + 0.5°	90 + 0.5°

*Measured at points slightly removed from the intersection. Measured separately for each compartment between all the interior faces and the adjacent face and between interior faces and top and bottom planes of the mold.

Permissible Variations of Specimen Molds
Table 1

   b. Base Plates – Base plates shall be made of a hard metal not attacked by cement mortar. The working surface shall be plane and shall be positively attached to the mold with screws into the side walls of the mold.

   c. Cover Plates – Cover plates shall be made of a hard metal or glass not attacked by cement mortar. The surface shall be relatively plane.

   d. Tamper – The tamper shall be made of a nonabsorptive, nonabrasive, nonbrittle material such as a rubber compound having a Shore A durometer hardness of 80 + 10, or seasoned oak wood rendered nonabsorptive by immersion for 15 minutes in paraffin at approximately 392°F (200°C), and shall have a cross-section of ½ in × 1 in (13 mm × 25 mm) and a length of about 5 to 6 in (125 to 150 mm). The tamping face shall be flat and at right angles to the length of the tamper.

e. Trowel – A trowel which has a steel blade 4 to 6 in (100 to 150 mm) in length, with straightedges.

3. Field Procedure

a. Three or more specimens shall be made for each period of test specified.

b. All joints shall be water tight. If not water tight, seal the surfaces where the halves of the mold join by applying a coating of light cup grease. The amount should be sufficient to extrude slightly when the halves are tightened together. Repeat this process for attaching the mold to the base plate. Remove any excess grease.

c. Apply a thin coating of release agent to the interior faces of the mold and base plate. (WD-40 has been found to work well as a release agent.) Wipe the mold faces and base plate as necessary to remove any excess release agent and to achieve a thin, even coating on the interior surfaces. Adequate coating is that which is just sufficient to allow a distinct fingerprint to remain following light finger pressure.

d. Begin molding the specimens within an elapsed time of not more than 2½ minutes from completion of the mixing.

e. For plastic mixes, place a first layer of mortar about 1 in (25 mm) deep in all the cube compartments (about one-half the depth of the mold). Tamp the mortar in each cube compartment 32 times in about 10 seconds making four rounds, each round perpendicular to the other and consisting of eight adjoining strokes over the surface of the specimen, as illustrated in Figure 1, below. The tamping pressure should be just sufficient to ensure uniform filling of the molds. The four rounds of tamping (32 strokes) shall be completed in one cube before going on to the next. When the tamping of the first layer is completed, slightly over fill the compartments with the remaining mortar and then tamp as specified for the first layer. During tamping of the second layer, bring in the mortar forced out onto the tops of the molds after each round of tamping, by means of gloved fingers and the tamper, before starting the next round of tamping. On completion of tamping, the tops of all the cubes should extend slightly above the tops of the molds.

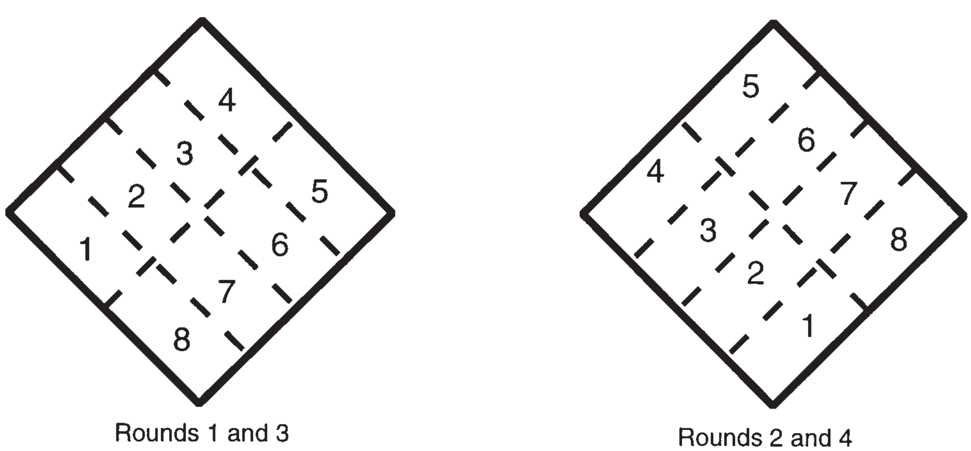

Figure 1

f. Bring in the mortar that has been forced out onto the tops of the molds with a trowel and smooth off the cubes by drawing the flat side of the trowel (with the leading edge slightly raised) once across the top of each cube at right angles to the length of the mold. Then, for the purpose of leveling the mortar and making the mortar that protrudes above the top of the mold of more uniform thickness, draw the flat trailing edge of the trowel (with leading edge slightly raised) once lightly along the length of the mold. Cut off the mortar to a plane surface flush with the top of the mold by drawing the straight edge of the trowel (held nearly perpendicular to the mold) with a sawing motion over the length of the mold.

g. When fabricating fluid mixes, steps e. and f. need not be followed. Instead, the cube mold is filled with mortar and cut off to a plane surface with a sawing motion over the length of the mold.

h. Immediately after molding, place cover plate on top of the mold, cover the sample with wet burlap, towels, or rags, seal it in a plastic sack in a level location out of direct sunlight, avoid freezing of cubes and record the time. Allow the sample to set undisturbed, away from vibration, for a minimum of four hours before moving.

i. Deliver the sample to the Regional or State Materials Laboratory **in the mold** with the cover plate in wet burlap, towels or rags sealed in a plastic bag within 24 hours. **Time of molding MUST be recorded on the Concrete Transmittal.** If delivery within 24 hours is unachievable, contact the Laboratory for instructions on caring for the cubes.

j. Once received in the lab, the molded sample is to be immediately placed in a moist curing room, with the upper surfaces exposed to the moist air but protected from dripping until the sample is a minimum of 20 hours old or has cured sufficiently that removal from the mold will not damage the cube. If the specimens are removed from the mold before they are 24 hours old they are to be kept on the shelves of the moist curing room until they are 24 to 36 hours old.

k. When the specimens are 24 to 36 hours old, immerse them in a lime-saturated water storage tank (Note 1). The specimens are to remain in the storage tank until time of test. (Curing test specimens of material other than hydraulic cement shall be in conformance with the manufacturer's recommendations.)

Note 1: The storage tank shall be made of noncorroding materials. The water shall be saturated with calcium hydroxide such that excess is present. Stir the lime-saturated water once a month and clean the bath as required by AASHTO M 201.

Performance Exam Checklist

Field Method of Fabrication of 2 in (50 mm) Cube Specimens for Compressive Strength Testing of Grouts and Mortars
WSDOT Test Method T 813

Participant Name ______________________________ Exam Date ______________________

Procedure Element	**Yes**	**No**
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. Three cubes made for each time period of test?	❒	❒
4. All joints (mold halves, mold to base plate) shall be water tight?	❒	❒
5. Adequate coating of release agent applied to interior surfaces of the mold?	❒	❒
6. Molding began within 2½ minutes from completion of mixing?	❒	❒
7. Molding performed in two lifts? (Not necessary if mix is fluid.)	❒	❒
8. Lifts tamped 32 times, made up of 4 rounds of 8, each perpendicular to the other? (Not required if mix is fluid.)	❒	❒
9. For second layer, mortar forced out of the mold brought back in before each round? (Not required if mix is fluid.)	❒	❒
10. Mix extends slightly above the mold at the completion of tamping?	❒	❒
11. Mortar smoothed by drawing flat side of trowel across each cube at right angles?	❒	❒
12. Mortar leveled by drawing the flat side of trowel lightly along the length of mold?	❒	❒
13. Mortar cut off flush with mold with edge of trowel using sawing motion?	❒	❒
14. Time of molding recorded?	❒	❒
15. Cover plate placed on top of the mold and covered with wet burlap, towel or rag?	❒	❒
16. Covered sample sealed in a plastic sack in a level location out of sunlight?	❒	❒
17. Sample delivered to the laboratory in the mold within 24 hours?	❒	❒
18. Transmittal includes the time of molding?	❒	❒

First Attempt: Pass ❒ Fail ❒ Second Attempt: Pass ❒ Fail ❒

Signature of Examiner ___________________________________

Comments:

WSDOT FOP for WAQTC TM 8

In-Place Density of Bituminous Mixes Using the Nuclear Moisture-Density Gauge

Scope

This test method describes a test procedure for determining the density of Hot Mix Asphalt (HMA) by means of a nuclear density gauge employing either direct transmission or backscatter (thin layer only) methods. Correlation with densities determined under SOP 730 is required.

Apparatus

- Nuclear density gauge with the factory matched standard reference block.
- Drive pin, guide, scraper plate, and hammer for testing in direct transmission mode.
- Transport case for properly shipping and housing the gauge and tools.
- Instruction manual for the specific make and model of gauge.
- Radioactive materials information and calibration packet containing:
  - Daily Standard Count Log
  - Factory and Laboratory Calibration Data Sheet
  - Leak Test Certificate
  - Shippers Declaration for Dangerous Goods
  - Procedure Memo for Storing, Transporting and Handling Nuclear Testing Equipment
  - Other radioactive materials documentation as required by local regulatory requirements.

Material

WSDOT does not use filler material.

Radiation Safety

This method does not purport to address the safety concerns, if any, associated with its use. This test method involves potentially hazardous materials. The gauge utilizes radioactive materials that may be hazardous to the health of the user unless proper precautions are taken. Users of this gauge must become familiar with the applicable safety procedures and governmental regulations. All operators will be trained in radiation safety prior to operating nuclear density gauges. Some agencies require the use of personal monitoring devices such as a thermoluminescent dosimeter or film badge. Effective instructions together with routine safety procedures such as source leak tests, recording and evaluation of personal monitoring device data, etc., are a recommended part of the operation and storage of this gauge.

Calibration

WSDOT performs calibrations according to the manufacturer’s Operators Manual.

Standardization

1. Turn the gauge on and allow it to stabilize (approximately 10 to 20 minutes) prior to standardization. Leave the power on during the day's testing.
2. Standardize the gauge at the construction site at the start of each day's work and as often as deemed necessary by the operator or agency. Daily variations in standard count shall not exceed the daily variations established by the manufacturer of the gauge. If the daily variations are exceeded after repeating the standardization procedure, the gauge should be repaired and or recalibrated.
3. Record the standard count for both density and moisture in the Daily Standard Count Log. The exact procedure for standard count is listed in the manufacturer's Operators Manual.

Test Site Location

1. Select a test location(s) randomly and in accordance with WSDOT Test Method T 716. Test sites should be relatively smooth and flat and meet the following conditions:
   a. At least 33 ft (10 m) away from other sources of radioactivity.
   b. At least 10 ft (3 m) away from large objects (i.e., vehicles).
   c. No closer than 24 in (600 mm) to any vertical mass, or less than 6 in (152.0 mm) from a vertical pavement edge.

Overview

There are two methods for determining in-place density of HMA.

- Direct Transmission – The standard for WSDOT when the depth of Hot Mix Asphalt is 0.15 foot or greater.
- Backscatter – Optional standard for WSDOT when the depth of Hot Mix Asphalt is 0.10 foot or greater. Only gauges with two sets of photon detectors operating in "Thin Layer Mode" will be allowed.

Note: When a density lot is started in thin layer mode it must remain in thin layer mode until the lot is completed. If a density lot is started in direct transmission the lot must be completed in direct transmission unless the pavement depth falls below 0.15 feet.

Procedure

Direct Transmission

1. Maintaining maximum contact between the base of the gauge and the surface of the material under test is critical.
2. Use the guide and scraper plate as a template and drill a hole to a depth of at least ¼ in (7 mm) deeper than the measurement depth required for the gauge.

3. Place the gauge on the prepared surface so the source rod can enter the hole. Insert the probe in the hole and lower the source rod to the desired test depth using the handle and trigger mechanism. Position the gauge with the long axis of the gauge parallel to the direction of paving. Pull the gauge so that the probe is firmly against the side of the hole.

   WSDOT Note: For alignment purposes, the user may expose the source rod for a maximum of 10 seconds.

4. Take one 4-minute test and record the wet density (WD) reading.

Thin Layer Gauge or Mode

1. A thin layer gauge (i.e., Troxler 4640) or a moisture density and thin layer gauge that has a thin layer mode setting (i.e., Troxler 3450) is required to perform this testing.
2. Take test in accordance with manufacturer's recommendation.
3. Take one 4-minute test and record the density (D) reading.

Calculation of Percent of Compaction

The percent compaction is determined by comparing the in-place wet density (WD) or density (D), as determined by this method, to the Average Theoretical Maximum Density of the HMA as determined by the WSDOT SOP 729.

The density gauge operator will receive a new average Theoretical Maximum Density from the tester at the HMA plant each day that production requires a mix test. The density gauge operator will continue to use the previous moving average until a new moving average is received from the tester at the HMA plant.

Each gauge shall be correlated in accordance with WSDOT SOP 730. A correlation factor will be provided to the density gauge operator for each gauge.

Use the following equations to calculate the percent of compaction:

1. Calculate the corrected gauge reading to the nearest tenth of a percent as follows:

   Corrected Gauge Reading = WD x CF or D x CF

   WD = moisture density gauge wet density reading

   D = HMA Density reading for thin layer mode gauge

   CF = gauge correlation factor (WSDOT SOP 730)

2. Calculate the percent compaction as follows.

$$\text{Percent Compaction} = \frac{\text{Corrected Gauge Reading}}{\text{Average Theoretical Maximum Density}} \times 100$$

Correlation With Cores

WSDOT has deleted this section, refer to WSDOT SOP 730.

Report

Report the results using one of the following:

- Materials Testing System (MATS)
- WSDOT Forms 350-092 and 350-157
- Form approved in writing by the State Materials Engineer

Report the percent compaction to the nearest tenth of a percent (0.1 percent).

Tester Qualification Practical Exam Checklist

In-Place Density of Hot Mix Asphalt (HMA) Using the Nuclear Moisture-Density Gauge FOP for WAQTC TM 8

Participant Name ______________________________ Exam Date ____________________

Procedure Element	Yes	No
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. Gauge turned on?	❐	❐
4. Gauge standardized and standard count recorded?	❐	❐
5. Test location selected appropriately?	❐	❐
6. Direct Transmission Mode:		
a. Hole made a minimum of ¼ inch deeper than measurement depth?	❐	❐
b. Gauge placed parallel to direction of paving, probe extended, gauge pulled back so probe against hole?	❐	❐
c. For alignment purposes did not expose the source rod for more than 10 seconds.	❐	❐
d. One 4-minute test made?	❐	❐
e. Wet density recorded?	❐	❐
7. Thin Layer Gauge or Gauge in Thin Layer Mode:		
a. Gauge placed, probe extended to backscatter position?	❐	❐
b. One 4-minute test made; gauge placed as described in the manufacturer recommendations?	❐	❐
c. Density (D) recorded?	❐	❐
8. All calculations performed correctly?	❐	❐
9. Nuclear Gauge secured in a manner consistent with current DOH requirements?	❐	❐

First Attempt: Pass ❐ Fail ❐ Second Attempt: Pass ❐ Fail ❐

Signature of Examiner

Comments: