WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

GUIDE TO DESIGNING ASPHALT MIXTURES USING THE SUPERPAVE VOLUMETRIC DESIGN METHOD

1. PURPOSE

1.1 To establish an approved Asphalt Mixture design or Job Mix Formula (JMF) using the Superpave volumetric design to be used for construction of an asphalt pavement. To outline test methods and procedures and to establish evaluation criteria for Superpave asphalt mixtures.

2. SCOPE

2.1 This procedure is applicable to design tests conducted for the purpose of establishing mixture proportions for asphalt mixtures using the Superpave mix design method. JMFs approved prior to June 2025 may continue to be used only if they can meet the current volumetric, aggregate and gradation parameters of Table 1, Table 2, Table 3 and Table 4, as well as the quality control requirements of MP 401.02.29 can be maintained. Such JMFs should be sent to the Division for reapproval and issuance of a new JMF number.

2.2 If reclaimed asphalt pavement (RAP) is used in the design, refer to Materials Procedure MP 401.02.24 for additional guidelines.

2.3 The Division may, at any point, revoke the approval of a JMF which exhibits poor field and/or laboratory performance. See MP 401.02.29 for details on steps to revoke a JMF.

2.4 Multiple factors of mixture design are based upon a project 20-year design traffic Equivalent Single Axel Loads (ESAL) counts. ESAL counts are to be provided by WVDOH within the project's contract documents. If values are not indicated contact District Construction to obtain this information.

3. REFERENCED DOCUMENTS

3.1 AASHTO Standards:

- M 323, Superpave Volumetric Mix Design
- R 30, Mixture Conditioning of Asphalt Mixtures
- R 35, Standard Practice for Superpave Volumetric Design for Asphalt Mixtures
- T 11, Materials Finer Than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
- T 27, Sieve Analysis of Fine and Coarse Aggregates
- T 30, Mechanical Analysis of Extracted Aggregate
- T 84, Specific Gravity and Absorption of Fine Aggregate
- T 85, Specific Gravity and Absorption of Coarse Aggregate
- T 164, Standard Method of Test for Quantitative Extraction of Asphalt Binder from

Asphalt Mixtures

- T 166, Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
- T 176, Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- T 209, Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures
- T 269, Percent Air Voids in Compacted Dense and Open Asphalt Mixtures
- T 283, Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
- T 304, Uncompacted Void Content of Fine Aggregate
- T 308, Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method (Test Method A)
- T 312, Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

3.2 ASTM Standards

- D 4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- D 5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

3.3 Material Procedures

- MP 401.02.24, Guide to Designing Asphalt Mixtures with Reclaimed Asphalt Pavement
- MP 401.02.29, Guide for Quality Control and Acceptance Requirements for Superpave Asphalt Mixtures

3.4 WVDOH Webpage Form

3.4.1 Current version of the WVDOH T-400 Form, available at the WVDOH MCS&T Toolbox[1].

4. LABORATORY AND TECHNICIAN REQUIREMENTS

4.1 The laboratory performing the design shall be a Division approved laboratory. In order to obtain Division approval, a laboratory must demonstrate they are equipped, staffed, and managed for batching and testing asphalt mixtures in accordance with this MP. This shall be accomplished by submitting a copy of their latest report of inspection by AASHTO re:source to the District Materials Section. The laboratory must also submit a letter detailing all actions taken to correct deficiencies noted during said inspection. The inspection shall include the test procedures listed below. The District will forward this information to Materials Control, Soils and Testing Division (MCS&T). To maintain Division approval a design laboratory shall be routinely inspected by AASHTO re:source. Subsequent inspections shall take place on a roughly 24-month cycle, depending on AASHTO re:source's availability. MCS&T will maintain a list of the approved design

[1] https://transportation.wv.gov/highways/mcst/Pages/tbox.aspx

laboratories.

4.1.1 A design laboratories AASHTO re:source inspection shall include a minimum of the following AASHTO Test Procedures

- T 30, Mechanical Analysis of Extracted Aggregate
- T 84, Specific Gravity and Absorption of Fine Aggregate
- T 85, Specific Gravity and Absorption of Coarse Aggregate
- T 166, Bulk Specific Gravity of Compacted Asphalt Mixtures Using Saturated Surface-Dry Specimens
- T 176, Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- T 209, Theoretical Maximum Specific Gravity and Density of Asphalt Mixtures
- T 283, Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage (specimens prepared using T 312)
- T 304, Test for Uncompacted Void Content of Fine Aggregate
- T 308, Determining the Asphalt Binder Content of Asphalt Mixtures by the Ignition Method (Test Method A)
- T 312, Preparing and Determining the Density of Asphalt Mixture (HMA) Specimens by Means of the Superpave Gyratory Compactor

4.1.2 T 324, Hamburg Wheel-Track Testing (HWTT) of Compacted Asphalt Mixture (only applicable to laboratories utilizing this method for Section 5.6)An asphalt mixture design laboratory shall be staffed with at least one technician who has been certified through a WVDOH approved Asphalt Mixture Design course, henceforth known as the designer. The designer shall also be certified as a WVDOH Asphalt Plant Technician and shall retain such certification at all times. Failure to maintain the Asphalt Plant Technician will result in revocation of mix design certification. MCS&T will maintain an official list of approved design technicians.

4.1.3 An Asphalt Mixture Design Course shall include but not be limited to material on the following topics: procedures and calculations for determining aggregate properties, gradations, and blending of properties and gradation; proper selection of design aggregate structure; proper sample mixing, aging and splitting procedures; volumetric testing and analysis; and hands on mixture creation.

4.1.4 A course developed in conjunction and offered through the Asphalt Pavement Association of West Virginia was specifically developed to meet the requirement in section 4.2. Alternative courses such as those offered by the Asphalt Institute, National Center for Asphalt Technology (NCAT), or other state DOTs may be approved at the discretion of the Division. To seek approval for such cases, proof of successful completion of all course requirements (including a written examination and hands-on experience) must be provided. Additionally, course materials including agenda, course outline, and other course materials may be requested for approval. Submit such requests electronically to the MCS&T Asphalt Section (DOHAsphalt@wv.gov).

5. TESTING REQUIREMENTS

5.1 The mix design shall be developed using the volumetric design guidelines provided in

AASHTO M 323 and R 35 with the exception of any modifications or additions noted in this Materials Procedure. In addition, all laboratory prepared design specimens shall be conditioned in accordance with the *Mixture Conditioning for Volumetric Mixture Design* guidelines within AASHTO R 30.

5.2 Gyrations Level

5.2.1 For laboratory compaction of samples, the standard gyratory counts shall be equal to sixty-five (65) for all mixtures, regardless of ESAL counts.

5.2.2 A 4.75mm mixture is the only exception to section 5.3.1, with 4.75mm mixtures being compacted to fifty (50) gyrations.

5.3 Performance Graded (PG) Binder Selection

5.3.1 The PG Binder for the JMF shall be selected in accordance with Section 401.2 of the Standard Specifications based on ESAL levels of the project.

5.3.2 If Reclaimed Asphalt Pavement (RAP) is to be utilized in the JMF, refer to MP 401.02.24 regarding any modifications required to PG Binder Selection and/or RAP material processing.

5.3.3 The PG Binder for J

TABLE 1—SUPERPAVE METHOD VOLUMETRIC MIX DESIGN CRITERIA

Design air void content, percent (T269)						4.0
		Nominal Maximum Size, mm (in.)				
ASHTO R35 Tests		25 (1)	19 (¾)	12.5 (½)	9.5 (⅜)	4.75 (No.4)
Fines-to-effective asphalt (FA) ratio	Fine	0.6-1.2	0.6-1.2	0.6-1.2	0.6-1.2	0.9 – 2.0
	Coarse	0.8-1.6	0.8-1.6	0.8-1.6	0.8-1.6	
Percent Voids in Mineral Aggregate (VMA)[Note 1]		12.5	13.5	14.5	15.5	16.5
Percent Voids Filled with Asphalt (VFA)		68 – 76	70 – 78	72 – 79	74 – 80	75 – 81

Note 1: Mixtures designed with the VMA exceeding the minimum value by more than two percent may be susceptible to flushing and rutting, especially when used on pavements subjected to slow moving traffic conditions. They may also be difficult to compact as they often have a tendency to shove under the roller.

5.4 Volumetric Design

5.4.1 Utilizing best practices and historic knowledge the designer shall determine an estimated asphalt content for the mixture. Designers in need of guidance of selecting an estimated asphalt content should review Asphalt Institute's MS-2 publication, in particular the section on *Selecting a design aggregate Structure*. To establish a JMF, mixture samples shall be created at a minimum of four asphalt contents (P_b) as described below.

5.4.1.1 The designer shall create a minimum of two bulk specific gravity (G_{sb}) samples the estimated asphalt content as well as asphalt contents which are -0.5%, +0.5%, +1.0%

from the estimated asphalt content.

5.4.1.2 The designer shall create two maximum theoretical specific gravity (G_{mm}/Rice) samples at 0.5% above the designers' estimated asphalt content. The average value of these two Rice samples shall be utilized to calculate the effective specific gravity of stone (G_{se}). Utilizing G_{se} calculate the Rice values at the remaining asphalt contents for use in volumetric analysis.

5.4.2 Samples prepared in Section 5.4.1 shall be analyzed for the volumetric properties including: Percent Air Voids (VTM), Percent Voids in the Mineral Aggregate (VMA), Percent Voids Filled with Asphalt (VFA) and Dust to Effective Asphalt (FA).

5.4.3 The optimal design binder content shall be selected from the interpolation of the P_b vs VTM graph at 4% Air Voids. The remaining volumetric properties shall be determined via interpolation with the optimal design binder content and shall meet the design criteria listed in Table 1.

5.4.4 When a JMF is under development using the same aggregate proportions, and sources as a prior Division approved JMF, but with a different neat binder grade, full volumetric testing is not required. Utilizing the existing approved JMF's aggregate structure and the new PG binder grade, the designer may instead elect to create two bulk specific gravity (G_{sb}) samples and two maximum theoretical specific gravity (G_{mm}/Rice) samples at the approved JMF's optimal design binder content. Samples shall be made in accordance with this section. Mixing and compaction temperature will be adjusted based on the requirements of the new binder grade. The designer shall calculate the volumetric properties of the one-point check, which shall meet the criteria of Table 2 or Table 1 as noted. If the one-point check meets these requirements, then the designer shall submit the one-point data along with a new T-400 which denotes the reference T-400 number in the remarks. If the mix design fails to meet all of the requirements, then a new mix design shall be developed.

TABLE 2 – ONE-POINT VOLUMETRIC MIX DESIGN CRITERIA

Design air void content, percent (T269)	4.0 ± 0.3%
Percent Voids in Mineral Aggregate (VMA)	Reference JMF VMA ± 0.5%
Fines-to-effective asphalt (FA) ratio	Design Criteria (Table 1)
Percent Voids Filled with Asphalt (VFA)	Design Criteria (Table 1)

5.5 Moisture Susceptibility Analysis

5.5.1 Designers may utilize either the Tensile Strength Ratio or Hamburg Wheel Tracking Test to analyze JMFs for moisture susceptibility.

5.5.2 Tensile Strength Ratio

5.5.2.1 Test specimens shall be prepared and compacted using a gyratory compactor in accordance with AASHTO T312 and AASHTO T283 at the JMF's optimal design asphalt content. An 80 percent minimum tensile strength ratio is required.

5.5.2.2 If a new JMF is under development using identical aggregate sizes, percentages, and sources of a previously approved JMF, and the previously approved JMF has a minimum tensile strength ratio of 85 percent, TSR testing shall be waived. Follow section 5.5.5.

5.5.2.3 Hamburg Wheel Tracking Test (HWTT) Stripping Inflection Point

5.5.2.4 Test specimens shall be prepared and compacted using a gyratory compactor in accordance with AASHTO T312 and AASHTO T324 at the JMF's optimal design asphalt content. A Stripping Inflection Point (SIP) shall not be found within XXXX number of passes, nor shall the rut depth exceed YY mm.

5.5.3 If a new JMF is under development using identical aggregate sizes, percentages, and sources of a previously approved JMF, and the previously approved JMF has met the requirements of Section 5.6.3.1, HWTT testing shall be waived. Follow section 5.6.5.

5.5.4 If the requirements within Section 5.5.2 or 5.5.2.3 are not met, the designer may consider a new aggregate structure, or the use of a Division approved antistripping additive. Such additives as hydrated lime, conforming to the requirements of AASHTO M303 or a liquid antistripping additive, may be added to the mixture. To validate an additives effectiveness, the JMF shall be retested for moisture susceptibility. The additive name, type and dosage rate shall be recorded on the JMF's T-400 Form.

5.5.5 If a previously approved JMF is to be reference for a moisture susceptibility waive, the designer shall: include the reference T400 number in the remarks of the JMF submittal; include all moisture susceptibility analysis from the reference JMF; if the reference JMF contained an antistripping additive, the new JMF must contain the same additive at the same dosage rate, the designer shall not such additives in the remarks of the JMF submittal.

5.5.6 MCS&T may request moisture susceptibility of a JMF be verified at any time on any design.

6. JMF AGGREGATE REQUIREMENTS

6.1 Aggregate Source Property Requirements

6.1.1 Individual aggregates used in a JMF shall meet the requirements of Standard Specification Sections 702.3, 702.4, 703.1, 703.2, and 703.3.

6.1.2 Aggregate gradations for the individual aggregates utilized in a JMF shall be determined using an average of a minimum of three (3) gradation samples. Each sample shall be recorded in the JMF packet.

6.1.3 The JMF's combined aggregates gradation shall meet the requirements of Table 3 for the specified mix type. Table 4 shall be used to distinguish between the gradation criteria for each mix type. The percent passing each sieve listed in Table 3, from one sieve larger than the nominal maximum size down to the 75 μm (No. 200), shall be included in all gradation calculations.

TABLE 3 – DESIGN AGGREGATE GRADATION REQUIREMENTS FOR ASPHALT MIXTURES (NOTE 3)

Type of Mix	25	19 (Patch/Level)	12.5	9.5 (Scratch)	4.75 (Scratch)
Standard Sieve Size	Nominal Maximum Size				
	25 mm (1 inch)	19 mm (3/4 inch)	12.5 mm (1/2 inch)	9.5 mm (3/8 inch)	4.75 mm (No. 4)
37.5 mm (1½")	100				
25 mm (1")	90 – 100	100			
19 mm (3/4")	90 max	90 – 100	100		
12.5 mm (1/2")		90 max	90 – 100	100	100
9.5 mm (3/8")			90 max	90 – 100	95 – 100
4.75 mm (No.4)		(Note 2)		90 max	90 – 100
2.36 mm (No.8)	19 – 45	23 – 49	28 - 58	32 – 67	----
1.18 mm (No.16)					30 – 60
600 µm (No.30)					
300 µm (No. 50)					
75 µm (No.200)	1.0 - 7.0	2.0 – 8.0	2.0 - 10.0	2.0 - 10.0	6.0 – 12.0

Note-2: When a 19 mm mix is specified for use as a surface mix, it shall be designed as a fine-graded mix with the additional requirement of a minimum of 47% passing the 4.75 mm (No.4) sieve. For quality control of the mixture, the allowable tolerance limit shall be the JMF ± 5% on the 4.75 mm (No.4) sieve, but not below the minimum requirement.

Note 3: For quality control of the mixture, the allowable tolerances for each JMF shall be the specified design control points shown in Table-3 with the exception that a 4.75 mm mix shall have a tolerance limit of the JMF ± 5% on the 1.18 mm (No. 16) sieve and all other mix types shall have a tolerance limit of the JMF ± 6% on the 2.36 mm (No.8) sieve. These tolerances shall also be applied to the mix design and shall be documented on the T-400 Form. The tolerances shall not fall outside of the specified control points of Table-3.

TABLE 4 – COARSE AND FINE GRADED MIXTURE CRITERIA

Mixture Nominal	Coarse Graded	Fine Graded
Maximum Size	% Passing / Sieve Size	% Passing / Sieve Size
25 (1)	< 40% / 4.75 mm	≥ 40% / 4.75 mm
19 (¾)	< 47% / 4.75 mm	≥ 47% / 4.75 mm
12.5 (½)	< 39% / 2.36 mm	≥ 39% / 2.36 mm
9.5 (3/8)	< 47% / 2.36 mm	≥ 47% / 2.36 mm
4.75 (No. 4)	No distinction between coarse and fine grading	

6.2 Aggregate Consensus Property Requirements

6.2.1 Given a JMF which meets the requirements set forth within Table 1, and 3, aggregate consensus properties including coarse and fine aggregate angularity, fine aggregate sand equivalency and coarse aggregate flat and elongated particles shall be determined on the final aggregate blend of a JMF. Table 5 outlines the consensus property requirements for a JMF based on the 20-year Design ESAL level of the pavement. Consensus properties shall be determined and test results submitted with a JMF on their appropriate T400 attachments. Consensus testing may be performed by a WVDOH certified Asphalt Plant Technician or Aggregate Inspector. The name and location of the testing laboratory and the technician's name conducting the test shall be indicated on the worksheets. All consensus testing results shall be reported to the whole number.

6.2.2 Fine aggregate angularity testing shall be conducted in accordance with AASHTO T304 (Method A). Material for the fine aggregate angularity as well as the fine aggregate bulk specific gravity utilized in the determination of fine aggregate angularity shall be based on a sample blended in accordance with the methods described in Section 6.2.4.1 and 6.2.4.2.

6.2.3 If a JMF contains RAP, the asphalt binder shall be removed from the RAP for consensus analysis via ignition oven (AASHTO T308) or solvent extraction (AASHTO T164). The RAP aggregate shall be proportionally blended into the samples submitted to MCS&T as described in Section 6.2.5. The RAP used for designing a mix must come from the plant stockpile from which it will be produced.

6.2.4 Consensus Property Division Approval

6.2.4.1 Other than exception noted in Section 0 or otherwise indicated in a special provision, to obtain final approval of a JMF, the designer shall submit samples in accordance with 6.2.4.2 to the division. Samples shall be submitted by the design laboratory to MCS&T through the District Materials Section. Samples shall be in appropriate containers to prevent sample loss and/or contamination. Samples shall include adequate documentation to demonstrate what JMF the consensus properties are associated with. These samples will be tested by MCS&T and used as part of the overall approval process for the mix design. These samples should be submitted well in advance of the earliest anticipated use of the mix. For JMF approval, the submitted samples shall meet the consensus property requirements of Table 5.

6.2.4.2 If a JMF is under development and uses the same aggregate sources at the same proportions as a previously approved JMF, the consensus evaluation used to accept the previous JMF will apply to the new JMF. The designer shall note the T400 number from the previously approved JMF in the remarks section of the T400 worksheet being submitted along with the documentation of the new JMF.

6.2.4.3 Consensus Property Sample Preparation

6.2.4.3.1 For each JMF, a minimum 30,000-gram sample of the combined aggregates shall be blended to the mix design proportions. The blended sample shall then be separated into plus 4.75 mm (No. 4) and minus 4.75 mm (No. 4) portions as per 6.2.4.2.

6.2.4.3.2 Fine Aggregate Sampling Procedure: The minus 4.75 mm (No. 4) portion of the blended aggregate sample shall be split into two separate samples. One samples shall be bagged

and labeled as *unwashed blended fine aggregate* to be tested for Sand Equivalency. The other sample shall be washed, oven dried, and graded to remove all plus 2.36 mm (No. 8) and minus 150 µm (No. 100) material. This washed sample shall then be split and the two potions labeled *washed fine aggregate specific gravity sample* and *washed fine aggregate angularity sample*.

6.2.5 Consensus Property Contractor Annual Review

6.2.5.1 Annually, following Division approval, aggregate consensus properties for approved JMFs shall be tested against the requirements of Table 5. Tests shall be performed on the blended aggregate sample as prepared in accordance with Section 6.2.4.3. These tests may be conducted by a WVDOH certified Asphalt Plant Technician or Aggregate Inspector. These test results shall be submitted to the District Materials Section for the purpose of maintaining approval of the mix design. The name of the testing laboratory, date tested, associated T400 number(s) and signature of the technician conducting the tests shall be indicated on the worksheets. The annual review packet shall be signed and reviewed by the designer. These test results must be submitted before the mix is used on any Division project each year.

6.2.5.1.1 Strictly for the purposes of the annual consensus review, in-lieu of blended aggregate samples, the Contractor may instead test each material stockpile individually and utilize mathematical proportional blending equation for calculating a composite result for each consensus property. If the contractor chooses to do this, the designer must submit the individual tests along with the forms showing the calculations.

6.2.5.2 If the aggregate consensus property test results submitted to the District meets specification requirements, the District shall sign off on the report and forward to MCS&T for the purpose of maintaining approval of the JMF. If any of the required aggregate tests fail to meet specification requirements, retesting by the contractor will be permitted, and the District shall submit a sample of the blended aggregate to MCS&T to verify the consensus property test that failed.

6.2.5.3 During the time that the annual aggregate consensus testing is being performed, the Division may periodically request that a duplicate set of blended aggregate samples be prepared for submittal to MCS&T for testing. The Division will identify the JMF in advance so that sufficient material is obtained for the preparation of duplicate samples. Nonconforming test results on these samples will require further investigation by the Division. No corrective action will be required by the Contractor unless the investigation concludes that it is necessary. If corrective action is required, the contractor will be notified, and at a minimum further use of the subject JMF (and associated JMFs, ie. JMFs conforming to section 6.2.4.2) shall be discontinued until the Division has determined that the problem has been properly addressed.

6.2.6 If the mix is comprised of 100 percent crushed blended aggregates that contain no more than 20 percent RAP, and it met requirements for coarse and fine aggregate angularity, the flat-and-elongated, and sand equivalent during the initial design approval, and any annual follow-up testing, then retesting each year by MCS&T will not be required. However, fine aggregate samples of mixes containing rounded natural sand and/or greater than 20 percent RAP must be prepared by a certified Asphalt Plant Technician in accordance with sections 6.2.4, and a sample of sufficient size required for testing the fine aggregate angularity shall be submitted to MCS&T on an annual basis.

TABLE 5 – AGGREGATE CONSENSUS PROPERTY REQUIREMENTS

20 Year Projected	Coarse Agg. Angularity (% Minimum) ASTM D5821 (Note 4)		Fine Agg. Angularity (% Minimum) AASHTO T304, Method A (Note 6)		Fine Agg. Sand Equivalent AASHTO T176	Coarse Agg. Flat and Elongated ASTM D4791
Design ESALs (millions)	Top Two Pavement Lifts (Note 5)	Below Top Two Pavement Lifts	Top Two Pavement Lifts	Below Top Two Pavement Lifts	% Minimum	% Maximum(Note 9)
< 3(Note 7)	75 / -	50 / -	-	-	40	10
3 to < 20	85 / 80	75 / -	45	40	45	10
20 to < 30	95 / 85	85 / 80	45	40	45	10
≥ 30	100/100	100/100	45	40	45	10

Note 4: "xx/yy denotes that a minimum of xx percent of the coarse aggregate has one fractured face and a minimum of yy percent has two or more fractured faces. This criterion does not apply to 4.75mm mixtures

Note 5: The referenced "top two pavement lifts" does not include a scratch course or patching-and- leveling course that may be placed between these lifts. When a scratch or patching-and-leveling course is placed between the top two lifts, the aggregate requirements for the mix shall fall under the "top two pavement lifts" criteria.

Note 6: For design traffic levels of 3 million ESALs or greater, any mix composed of a 100 percent crushed aggregate blend that will be used in the top two lifts of the pavement structure will be acceptable with an FAA value of 43 percent or greater. The 43 percent FAA criteria shall also apply to the 30 million or greater traffic level for mixtures below the top two lifts. It shall also apply to 100 percent crushed aggregate blends that contain no more than 20 percent RAP.

Note 7: The minimum requirement for coarse aggregate angularity for any DOH Specification Section 402 skid resistant mix design with a projected ESAL value of less than 3 million shall be 85/80.

Note 8 – PG64E-22 grade may still be used on roadways less than 30 million ESAL upon approval from the District Engineer, if a roadway is to utilize a PG64E-22 it shall meet the aggregate requirements of >30mil ESALs

Note 9: Flat and elongated particles in coarse aggregates shall be tested in accordance with D4791 with the exception that the material passing the 9.5 mm (⅜ in.) sieve and retained on the 4.75 mm (No. 4) sieve shall be included. The aggregate shall be measured using the ratio of 5:1, comparing the length (longest dimension) to the thickness (smallest dimension) of the aggregate particles.

7. REPORTING

7.1.1 The T-400 JMF form shall include the design property information required in Section 401.4 of the Standard Specification. JMF submittals shall include all Superpave mix design software printouts from the specimen compaction and analysis covering the required mix properties. In addition, if not automatically generated through the mix design software, the following information shall be included.

7.2 A summary sheet (Superpave Package Attachment #1) showing the optimum asphalt content determination plus the design properties compared to the design criteria of Table

1. This attachment shall be signed and dated by the mix design technician.

7.3 Worksheet for calculating the effective gravity of the blended aggregates (Attachment #4 or #4A).

7.4 Worksheets showing calculations for maximum specific gravities of the mix at the different asphalt contents (Attachment #5). For any mix that contains any single coarse aggregate component with the water absorption of 1.5 percent or greater, follow the supplemental procedure of T 209 to determine if a dry-back is necessary. Because the dry-back procedure is addressing an aggregate coating issue, this same supplemental procedure shall be used on quality control and verification samples of mixes containing these high absorptive aggregates to determine if the dry-back procedure is necessary.

7.5 Worksheet for calculating the bulk and apparent specific gravities of the total aggregate, and the percent VMA in the compacted mixture (Attachment #6 or #6A).

7.6 Worksheet for determining the maximum specific gravity of the mixture, including the dry-back procedure when required (Attachment #7). Note that AASHTO R 35 specifies that the maximum specific gravity shall be based on the average of at least two tests.

7.7 Worksheets showing calculation for bulk and apparent specific gravities and absorption of the coarse and fine aggregates used in the mix design (Attachments #8 or #8A).

7.8 The 0.45 power gradation chart (Attachment #9) developed for each mix design. This chart shall include the maximum density line, aggregate control points, and a gradation plot showing each screen used in the design.

7.9 A worksheet showing the calculations for the combined aggregate of the mix design (Attachment #10).

7.10 Worksheets showing the washed sieve analysis results for each aggregate used in the mix design (Attachment #11).

7.11 A worksheet showing the calculations for the fine aggregate angularity test (Attachment #13).

7.12 A worksheet showing the calculations for absorbed asphalt and effective asphalt content (Attachment #14).

7.13 The temperature-viscosity chart for the asphalt used in the mix design. A supplier issued chart or document containing the mix and compaction temperature recommended for the specific grade of asphalt will be acceptable.

7.14 The entire T-400 JMF package shall be submitted, in Excel format, to the local District Materials Section in which the mixtures plant is located. After reviewing, the District shall attach a memo to the JMF package requesting approval of the design and submit it electronically to the MCS&T Asphalt Section (DOHAsphalt@wv.gov).

7.14.1 The MCS&T Asphalt Section will conduct a final review of the design package and assign a laboratory number to each approved mix design. MCS&T will contact the mix designer if there are any problems or concerns with the JMF package that will delay final approval. An electronic copy of the approved T-400 form shall be e- mailed to the District and Producer for distribution.

7.15 All applicable mix design worksheets can be found on the MCS&T's Webpage Toolbox[2]

Michael Mance
Digitally signed by Michael Mance
Date: 2026.05.20 15:55:52 -04'00'

Michael A Mance, PE
Director
Materials Control, Soils & Testing Division

MP 401.02.28 Steward – Asphalt Section
MAM:J
ATTACHMENT

[2] http://www.transportation.wv.gov/highways/mcst

Design Package
Attachment #1SP
03-11

West Virginia Division of Highways
Optimum Asphalt Content (OAC) Determination
Superpave Mixtures
As Per MP 401.02.28, Section 4.3

Optimum Asphalt Content (OAC) Selected at 4.0 Percent Air Voids	

Mix properties from the OAC compared to the Design Criteria in MP 401.02.28, Table-1

Test Property	Proposed Test Value	Accepted Test Value	Superpave Design Criteria
Air Voids (%)	4.0	4.0	4.0
Voids in the Mineral Aggregate"VMA" (%)			
Fines to Effective Asphalt (FA) Ratio			
Voids Filled With Asphalt "VFA" (%)			
Maximum Density (Gmm) at OAC			NA

I confirm that this Superpave mix design Job Mix Formula package was developed in accordance with the current West Virginia Division of Highways specifications. All worksheet calculations contained within this mix design package have been checked for accuracy and completeness.

Signature of Division Approved
Superpave Mix Design Technician

Date

Design Package
Attachment #4-A
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING EFFECTIVE SPECIFIC GRAVITY OF AGGREGATE (G_{se})

$$G_{se} = \frac{P_{mm} - P_b}{\frac{P_{mm}}{G_{mm}} - \frac{P_b}{G_b}}$$

(P_{mm}) Total Loose Mixture, Percent by Total Weight of Mixture = 100 Percent

(P_b) Asphalt, Percent by Total Weight of Mixture = _____

(G_{mm}) Maximum Specific Gravity of Paving Mixture (No Air Voids) AASHTO T-209 = _____

(G_b) Specific Gravity of Asphalt = _____

(G_{se}) Effective Specific Gravity of Aggregate Using P_{mm} = 100 Becomes:

$$G_{se} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}} = \_\_\_\_\_$$

Note: Report the following values to the nearest thousandth (0.001): G_{mm}, G_b and G_{se}

Design Package
Attachment #4-A
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING EFFECTIVE SPECIFIC GRAVITY OF RECYCLED AGGREGATE (G_{serap}) WHEN USING RECLAIMED MATERIAL (RAP)

NOTE 1: This worksheet applicable only for mixtures containing reclaimed material (RAP)

$$G_{se} = \frac{P_{mm} - P_b}{\frac{P_{mm}}{G_{mm}} - \frac{P_b}{G_b}}$$

(P_{mm}) Total Loose Mixture, Percent by Total Weight of Mixture = 100 Percent

(P_b) Asphalt Content of RAP, Percent by Total Weight of Mixture = _____

(G_{mm}) Maximum Specific Gravity of RAP (No Air Voids) AASHTO T-209 = _____

(G_b) Specific Gravity of Asphalt = _____

(G_{serap}) Effective Specific Gravity of Recycled Aggregate Using P_{mm} = 100 Becomes:

$$G_{se} = \frac{100 - P_b}{\frac{100}{G_{mm}} - \frac{P_b}{G_b}} = \text{*} \_\_\_\_\_$$

* Report this value when calculating G_{sb} (Attachment 6-A)

Note 2: Report the following values to the nearest thousandth (0.001): G_{mm}, G_b and G_{serap}

Design Package
Attachment #5
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING MAXIMUM SPECIFIC GRAVITIES OF MIXTURES WITH DIFFERENT ASPHALT CONTENTS (G_{mm})

$$G_{mm} = \frac{P_{mm}}{\frac{P_s}{G_{se}} + \frac{P_b}{G_b}}$$

(P_{mm}) Total loose mixture, percent by total weight of mixture = 100 percent

% Aggregate By Total Weight Of Mixture	Effective Specific Gravity of Aggregate	% Asphalt By Total Weight of Mixture	Specific Gravity of Asphalt	Maximum Specific Gravity of Paving Mixture $100 / [(P_s / G_{se}) + (P_b / G_b)]$
P_s	G_{se}	P_b	G_b	G_{mm}

Note: Report the following values to the nearest thousandth (0.001): G_{se}, G_b, and G_{mm}

Design Package
Attachment #6
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING
BULK SPECIFIC GRAVITIES OF AGGREGATE (G_{sb}),
APPARENT SPECIFIC GRAVITIES OF AGGREGATE (G_{sa})
AND PERCENT VMA IN COMPACTED PAVING MIXTURE

The bulk (G_{sb}) and apparent (G_{sa}) specific gravities of the total aggregate are calculated as follows:

$$G_{sb} = \frac{A_p}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + .. + \frac{P_n}{G_n}}$$

G_{sb} = bulk specific gravity for the total aggregate
A_p = total aggregate = 100 percent
P_1, P_2, P_n = percentage of total aggregate
G_1, G_2, G_n = bulk specific gravities of aggregates
Note: When using mineral filler use the apparent specific gravity

Component Aggregate Type	Percent of Total Aggregate	Bulk Specific Gravity	Apparent Specific Gravity	G_{sb}	G_{sa}
				$100 / [P_1/G_1 + P_2/G_2 + ... + P_n/G_n]$	

$$VMA = 100 - [(G_{mb} \times P_s) / G_{sb}]$$

(VMA) voids in mineral aggregate (percent of bulk volume)
(G_{sb}) bulk specific gravity of aggregate
(G_{mb}) bulk specific gravity of compacted mixture (AASHTO T-245)
(P_s) aggregate, percent by total weight of mixture

G_{mb}	P_s	G_{sb}	VMA $100 - [(G_{mb} \times P_s) / G_{sb}]$

Note: Report the following values to the nearest thousandth (0.001):
G_{sb}, G_{sa}, G_{mb}, bulk and apparent gravities of the aggregates
Report VMA to the nearest tenth (0.1)

Design Package
Attachment #6-A
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING BULK SPECIFIC GRAVITIES OF AGGREGATE (G_{sb}), WHEN USING RECYCLED MATERIALS (RAP)

Note: This worksheet is applicable only for mixtures containing reclaimed material (RAP)

$$G_{sb} = \frac{A_p}{\frac{P_1}{G_1} + \frac{P_2}{G_2} + .. + \frac{P_n}{G_n} + \frac{P_{rap}}{G_{serap}}}$$

G_{sb} = bulk specific gravity for the total aggregate
A_p = total aggregate = 100 percent
P_1, P_2, P_n, P_{rap} = percentage of total aggregate
G_1, G_2, G_n = bulk specific gravities of aggregates
G_{serap} = effective specific gravity of the recycled aggregate

Note: When using mineral filler use the apparent specific gravity

Component Aggregate Type	Percent of Total Aggregate	Bulk Specific Gravity	Percent RAP	G_{serap}	$G_{sb} = 100 / [P_1/G_1 + P_2/G_2 + ...+ P_n/G_n + P_{rap}/G_{serap}]$
					*

** Report this value when calculating VMA (Attachment #6)*

Note: Report the following values to the nearest thousandth (0.001): G_{sb}, G_{serap} and bulk specific gravity

Design Package
Attachment #7
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

MAXIMUM SPECIFIC GRAVITY WORKSHEET

MAXIMUM SPECIFIC GRAVITY - BOWL METHOD (AASHTO T-209)		
A	Sample Weight	
B	Bowl + Sample in Water Weight	
C	Bowl in Water (Calibration Weight)	
D	Surface Dry Sample Weight (For Dry-Back Procedure Only)	
E	Max. Sp. Gr. = A / [A - (B - C)] or Dry-Back Max. Sp. Gr. = A / [D - (B - C)]	

MAXIMUM SPECIFIC GRAVITY - PYCNOMETER METHOD (AASHTO T-209)		
A	Sample Weight	
B	Pycnometer + Water Weight (Calibration Weight)	
C	Pycnometer + Sample + Water Weight	
D	Surface Dry Sample Weight (For Dry-Back Procedure Only)	
E	Max. Sp. Gr. = A / (A + B - C) or Dry-Back Max. Sp. Gr. = A / (D + B - C)	

Dry Back: In Accordance With Supplemental Procedure of AASHTO T209

Weighing Interval	Time	Weight of Pan + Sample
0 Min.		
15 Min.		
30 Min.		
45 Min.		
60 Min.		
75 Min.		
90 Min.		
105 Min.		
120 Min.		
135 Min.		
150 Min.		
165 Min.		
180 Min.		
195 Min.		
210 Min.		
225 Min.		

1) Weight of Pan + Final Surface Dry Weight _____

2) Weight of Pan _____

D) Surface Dry Sample Weight (1 - 2) _____

Percent asphalt content used for determining the maximum specific gravity = _____

Design Package
Attachment #8
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING BULK SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

Source _____
Type _____
Tested by _____
Date _____

COARSE AGGREGATE
(RECORD WEIGHTS TO THE NEAREST 0.1 GRAMS)

A = Weight of oven-dry sample in air _____
B = Weight of saturated-surface-dry sample in air _____
C = Weight of saturated sample in water _____

Bulk Specific Gravity (Oven-dry Basis) = $\frac{A}{B - C}$ = _____

Apparent Specific Gravity = $\frac{A}{A - C}$ = _____

Absorption, percent = $\frac{B - A}{A} \times 100$ = _____

Note: Report the following values to the nearest thousandth (0.001):
Bulk and Apparent Specific Gravities
Report % Absorption to the nearest hundredth (0.01)

Design Package
Attachment #8A
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING BULK SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE

Source _____
Type _____
Tested by _____
Date _____

FINE AGGREGATE
(RECORD WEIGHTS TO THE NEAREST 0.1 GRAMS)

A = Weight of oven-dry sample in air _____

B = Weight of flask filled to calibration mark with distilled water _____

C = Weight of flask, sample, and water to calibration mark _____

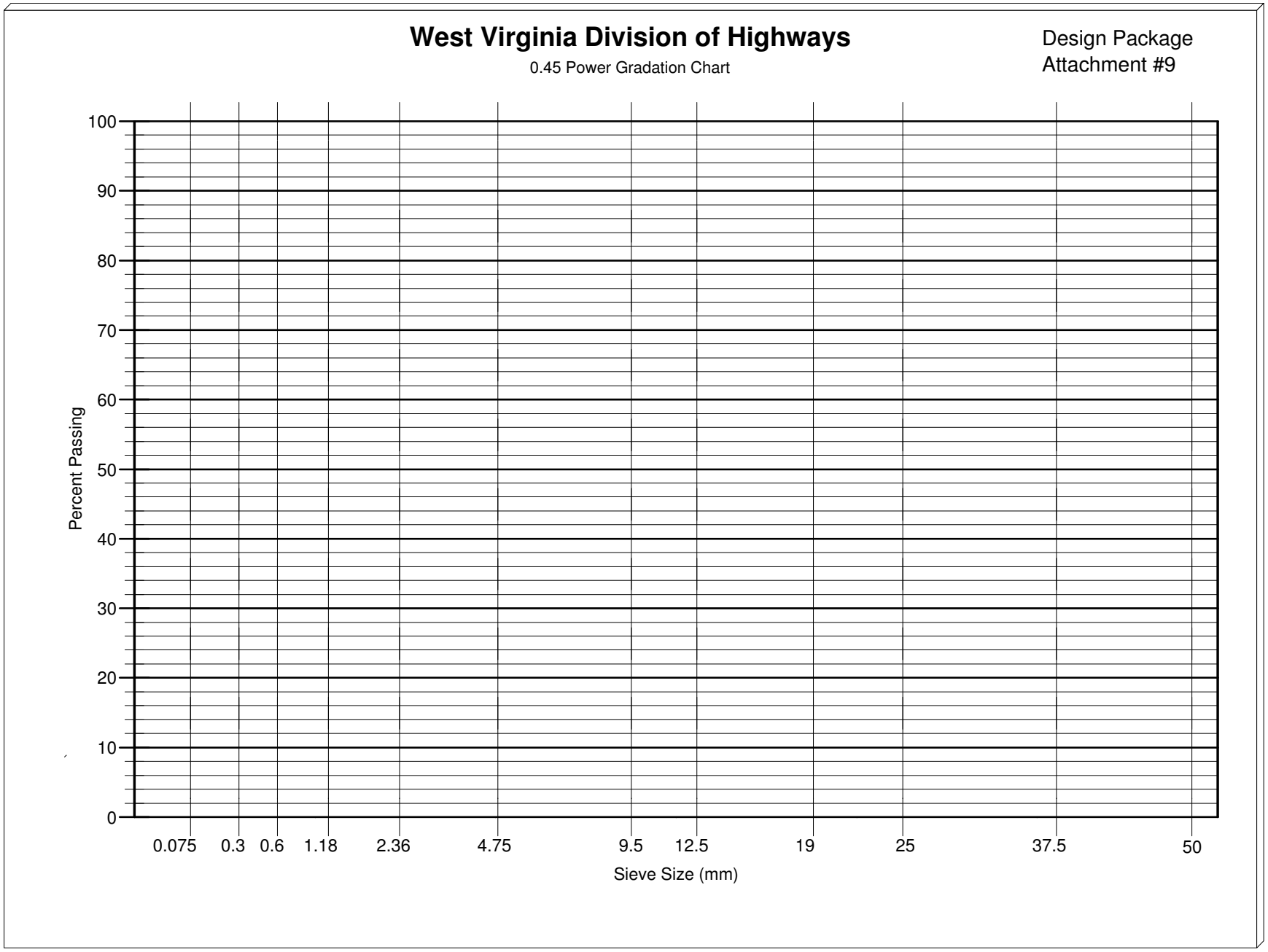
D = Weight of saturated-surface-dry sample in air _____

Bulk Specific Gravity (Oven-dry Basis) = $\frac{A}{B + D - C}$ = _____

Apparent Specific Gravity = $\frac{A}{B + A - C}$ = _____

Absorption, percent = $\frac{D - A}{A} \times 100$ = _____

Note: Report the following values to the nearest thousandth (0.001):
Bulk and Apparent Specific Gravities
Report % Absorption to the nearest hundredth (0.01)


West Virginia Division of Highways
0.45 Power Gradation Chart
Design Package
Attachment #9
Percent Passing
100
90
80
70
60
50
40
30
20
10
0
0.075
0.3
0.6
1.18
2.36
4.75
9.5
12.5
19
25
37.5
50
Sieve Size (mm)

Design Package
Attachment #10
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR COMBINING AGGREGATES

Lab Number: _____ Material Type: _____ Date Completed: _____

T-400 Number: _____ Sample Number: _____ Technician: _____

	Bin #: Size: % Used:		Bin #: Size: % Used:		Bin #: Size: % Used:		Bin #: Size: % Used:		Bin #: Size: % Used:		Percent Passing	
Column	A	B	A	B	A	B	A	B	A	B	C	D
Sieve Size	Total % Passing	% of Total	Total % Passing	% of Total	Total % Passing	% of Total	Total % Passing	% of Total	Total % Passing	% of Total	Combined Gradation	PMF or Master Range
2" (50 mm)												
1.5"(37.5 mm)												
1" (25 mm)												
3/4" (19 mm)												
1/2"(12.5 mm)												
3/8" (9.5 mm)												
#4 (4.75 mm)												
#8 (2.36 mm)												
#16 (1.18 mm)												
#30 (600 µm)												
#50 (300 µm)												
#200 (75 µm)												

Column B = (Column A x % Used) / 100 Column C = Sum of Columns B

Design Package
Attachment #11
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WASHED SIEVE ANALYSIS
(AASHTO T-11 AND T-27)

Producer _____ Aggregate Source _____

Type of Mix _____ Aggregate Type _____

Technician _____ Date _____

Sieve Size	Weight Retained	Percent Retained	Percent Passing
2" (50mm)			
1 ½" (37.5mm)			
1" (25 mm)			
3/4" (19mm)			
1/2" (12.5mm)			
3/8" (9.5mm)			
#4 (4.75mm)			
#8 (2.36mm)			
#16 (1.18mm)			
#30 (600µm)			
#50 (300µm)			
#200 (75µm)			
Total - #200 (T)			
Total			

(A) Weight of original sample _____ g

(B) Weight after washing _____ g

(C) Loss of - #200 after wash _____ g

(D) - #200 from sieving (Pan Weight) _____ g

(T) Total passing #200 (C + D) _____ g

Note: Report all values to the nearest tenth (0.1)

Design Package
Attachment #13
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

FINE AGGREGATE ANGULARITY

AASHTO T-304 (Method A)

Type of Mix: _____

Design ESAL's: _____

Testing Laboratory: _____

Technician: _____

Date: _____

CALIBRATION OF FINE AGGREGATE ANGULARITY MEASURE

A.	Mass of Measure, Glass, Grease, and Distilled Water (18 - 24°C)	(nearest 0.1 g)	_____
B.	Mass of Measure, Glass, and Grease	(nearest 0.1 g)	_____
C.	Mass of Water in Measure (A - B)	(nearest 0.1 g)	_____
D.	Temperature of Water	(nearest 0.2°C)	_____
E.	Density of Water at Temperature D (from AASHTO T19 Tables)	Kg/m^3	_____
F.	Volume of Measure 1000 x (C ÷ E)	(nearest 0.1 mL)	_____

FINE AGGREGATE ANGULARITY TEST

			1st Trial	2nd Trial
G.	Mass of Measure and Aggregate	(nearest 0.1 g)	_____	_____
H.	Mass of Measure	(nearest 0.1 g)	_____	_____
J.	Mass of Aggregate (G - H)	(nearest 0.1 g)	_____	_____
K.	Oven Dry Specific Gravity		_____	_____
L.	Volume of Measure (F)	(nearest 0.1 mL)	_____	_____
M.	Uncompacted Voids	(nearest 0.1%)	_____	_____
N.	Average Uncompacted Voids	(nearest 1%)	_____	

$M = ((L - (J \div K)) \div L) \times 100$

$N = (M_{1st} + M_{2nd}) \div 2$

Fine Aggregate Angularity Requirement: _____

Meets Specification Requirement (Y/N): _____

Design Package
Attachment #14
01-07

WEST VIRGINIA DIVISION OF HIGHWAYS

WORKSHEET FOR CALCULATING EFFECTIVE ASPHALT CONTENT OF MIX (P_{be})

Absorbed Asphalt, Percent by Mass of Aggregate (P_{ba})

$$P_{ba} = 100 \text{ x } \left(\frac{G_{se} - G_{sb}}{G_{sb} \text{ x } G_{se}}\right) \text{x } G_b$$

(G_{se})	Effective Specific Gravity of Aggregate	=	_____
(G_{sb})	Bulk Specific Gravity of Aggregate	=	_____
(G_b)	Specific Gravity of Asphalt	=	_____
	P_{ba}	=	_____

Effective Asphalt Content of Mix (P_{be})

$$P_{be} = P_b - \left(\frac{P_{ba}}{100} \text{ x } P_s\right)$$

(P_b)	Asphalt Content, Percent by Total Mass of Mix	=	_____
(P_{ba})	Absorbed Asphalt, Percent by Mass of Aggregate	=	_____
(P_s)	Aggregate Content, Percent by Total Mass of Mix	=	_____
	P_{be}	=	_____

Note: Report the following values to the nearest thousandth (0.001):
G_{se}, G_{sb}, and G_b
Report the following values to the nearest tenth (0.1):
P_b, P_{ba}, $P_{s,}$ and P_{be}