

CONTRACTOR MIX DESIGN GUIDELINES

For

ASPHALT CONCRETE

OREGON DEPARTMENT OF TRANSPORTATION

January 2006

CONTRACTOR MIX DESIGN GUIDELINES for ASPHALT CONCRETE

These guidelines outline the procedures to be used in developing, testing and submitting asphalt concrete mix designs for ODOT contracts and for projects with other agencies that use the Oregon Standard Specifications for Construction 2002. According to these specifications the contractor is responsible for developing the mix designs for all Hot Mixed Asphalt Concrete (HMAC) and Emulsified Asphalt Concrete (EAC). Stone Matrix Asphalt mix designs will be developed by ODOT.

The actual test procedures used to develop a mix design are available in a separate document described in Section 1 & 2 of these guidelines.

If you have any questions about the information contained in these guidelines or any corrections to suggest, contact Dick Dominick, Senior Mix Design Technician at (503)-986-3071 or Bruce Patterson, Pavement Materials Engineer at (503)-986-3052.

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For ASPHALT CONCRETE

1.0 SCOPE

- 1.1 The Oregon Standard Specifications for Asphalt Concrete 00744.13, 00745.13(a) and 00735.13 require the Contractor to develop the mix designs for HMAC and Emulsified Asphalt Concrete (EAC). For projects under an ODOT contract, the proposed mix design is submitted to the ODOT Project Manager. The ODOT Project Manager forwards the mix design to the Pavement Materials Engineer to conduct a review of the design. The only exception is that SMA (Stone Matrix Asphalt) mix designs will be developed by ODOT.
- 1.2 This document establishes the procedures for developing and submitting a new HMAC or EAC mixture design. It also describes procedures for submitting existing mix designs for use on a new contract. The guidelines cover Dense-Graded virgin and RAP mixtures and Open-Graded virgin mixtures. The design procedure for Dense-Graded Superpave mixes; Open-Graded HMAC and EAC, along with a few other procedures are in the ODOT "Supplemental Test Procedures for HMAC and EAC". See Section 2.0 "Applicable Documents" for a list of required procedures and their location.
- 1.3 Mix designs are reviewed by ODOT as described in Section 9 and if the design meets all requirements a Mix Design Review Report signed by the Pavement Materials Engineer is issued with a unique ODOT number. No report will be issued for designs that are incomplete or those not meeting specification requirements. However, the CMDT will be notified of the problem. ODOT may delay issuing a mix design review report until it has confirmed that the produced aggregate for the project meets the specifications. In most cases, aggregate product compliance testing must have been performed within the last twelve months on produced HMAC aggregate to meet these requirements. If the aggregate used to develop the mix design is determined to be unrepresentative of the aggregate produced for construction, all or part of the mix design may be rejected.
- 1.4 Existing mix designs developed or reviewed by ODOT for a project will be considered for transfer to other contracts with the written concurrence of the Pavement Materials Engineer. See Section 10 for the transfer policy.

2.0 APPLICABLE DOCUMENTS

Refer to the ODOT Manual of Field Test Procedures for the following test procedures. There may be modifications or special instructions relative to the AASHTO procedure.

AASHTO T84: Specific Gravity and Absorption of Fine Aggregate

AASHTO T85: Specific Gravity and Absorption of Coarse Aggregate

AASHTO T166: Bulk Specific Gravity of Compacted Bituminous Mixtures using SSD Specimens

AASHTO T209: Theoretical Maximum Specific Gravity and Density of Bituminous Mixtures

AASHTO T283: Resistance of Compacted Bituminous Mixture to Moisture-Induced Damage

ODOT TM 323: Determination of Calibration Factors for Determining the Asphalt Binder Content of Hot Mix Asphalt by the Ignition Method

Refer to AASHTO books for the following:

AASHTO T312: Preparing and Determining the Density of Hot-Mix Asphalt Specimens by Means of the Superpave Gyratory Compactor

AASHTO R30: Mixture Conditioning of Hot-Mix Asphalt

AASHTO TP63-03: Determining Rutting Susceptibility of Asphalt Paving Mixtures Using the Asphalt Pavement Analyzer (APA)

The following mix design procedures are in a separate document called "Supplemental Procedures for HMAC and EAC". This document is available from the ODOT Construction Section and is also found on the ODOT website at <http://www.odot.state.or.us/tsconstruction/>.

ODOT TM 303: Resistance to Deformation of Bituminous Mixtures by Means of Hveem Stabilometer

ODOT TM 313: Compressive Strength of Emulsified Asphalt Mixtures

ODOT TM 316: Adding Anti-Strip Additives or Lime to Mix Design Samples

ODOT TM 318: Selection of Asphalt Content in Open-Graded Bituminous Mixtures by the Draindown Procedure

ODOT TM 330: Superpave Volumetric Design for Dense Graded HMAC

3.0 DENSE GRADED MIX DESIGNS

ODOT Special Provisions (SP00745) require that all Level 2, 3 and 4 mix designs be developed by the Superpave mix design procedure described in ODOT TM 330. For other agencies the Standard 00745 specifications allow Marshall mix designs for some mix levels.

- 3.1 Level 3 wearing course and all Level 4 mix designs require performance tests as described in Section 4 of these guidelines. Results of the APA rut test must be submitted with the mix design.
- 3.2 If the Ignition Oven is selected for measuring the asphalt content on the project, fabricate and deliver a set of calibration samples for each mix design to the ODOT Region Quality Assurance Coordinator, a set to the ODOT Central Lab, and a set to the lab that will do the quality control testing. Follow the procedures and documentation in the current ODOT TM 323 when preparing calibration samples. This test procedure is in the ODOT Manual of Field Test Procedures.
- 3.3 Refer to Section 5 for information about submitting dense-graded mix designs to ODOT. Section 6 provides information about submitting mix design material to ODOT when requested.

4.0 PERFORMANCE TESTING OF DENSE GRADED MIXES

Test each Level 3 dense graded wearing course mix and all Level 4 dense graded mixes submitted for review per specification 00745.13 for rut resistance in an Asphalt Pavement Analyzer. Existing mix designs which are submitted for transfer to a new project must also be tested even if they have been tested prior to 2006.

The APA device must meet the requirements of AASHTO TP63-03 and must be equipped with an automatic rut measurement system. The APA device must be calibrated at least once per year according to the procedures in the test method. In addition, the load cell used for checking wheel loads shall be calibrated at least once per year.

Provide laboratory batched aggregate samples blended according to each JMF to be tested and samples of the appropriate grade and source of asphalt to an ODOT approved APA testing laboratory. Contact the APA testing laboratory to determine the required quantity of material.

The APA test lab shall fabricate samples according to the JMF being tested and shall perform the test according to AASHTO TP 63-03 at a test temperature of 64C for all mixes.

Submit APA test results in the format required by AASHTO TP 63-03 to the Engineer with the mix design. Identify each mix with a unique identification number, such as ODOT Lab Number or Suppliers Mix Number.

The maximum acceptable APA rut depths are as follows:

Level 3 with PG 64-22 or PG 64-28	7.0 mm rut depth
Level 3 with PG 70-22 or PG 70-28	6.0 mm rut depth
Level 4 with PG 64-22 or PG 64-28	6.0 mm rut depth
Level 4 with PG 70-22 or PG 70-28	5.0 mm rut depth

5.0 REPORTING DENSE GRADED MIX DESIGNS

- 5.1 Submit the mixture design report, in the required format (example on page 11) to the ODOT Construction Section and the Project Manager. Include copies of the laboratory testing worksheets for mixture Gmb, Gmm, TSR, and individual aggregate bulk specific gravity.
- 5.2 Aggregate – include in the report the following aggregate information.
- 5.2.1 Provide the source number, Gsb, and Gsa for each aggregate component.
- 5.2.2 Show the gradation data for each aggregate or RAP and the blend as a percent passing to the nearest 1% for the ¾", ½", 3/8", No. 4, No. 8, No. 30 sieves and the nearest 0.1% for the No. 200 sieve.
- 5.2.3 Provide the percent of each aggregate, lime and/or RAP in each trial blend.
- 5.2.4 Verify that each aggregate product has current passing Product Compliance test results.
- 5.3 Asphalt – Provide the source, grade, and specific gravity at 77°/77° F (25°/25° C) and 60°/60° F (15.6°/15.6° C).
- 5.3.1 Provide the design asphalt content expressed to the nearest 0.1%.
- 5.3.2 Provide the percentage of asphalt cement (average of 4 samples) in RAP to the nearest 0.1%.
- 5.3.3 Provide the mixing and placement temperature ranges in degrees Celsius (or Fahrenheit).
- 5.4 Mixture – Provide all data used to determine the design aggregate structure and the design asphalt content, including the sample heights at N-initial and N-design gyrations.
- 5.4.1 Provide Gmb, Gmm, and volumetric data for samples fabricated for each trial aggregate blend. (stage 1) Briefly describe why the selected trial blend was chosen as the JMF blend. Note on the worksheet if the dryback procedure was used to determine Gmm.
- 5.4.2 Provide volumetric data normalized to 4.0% Va for samples fabricated for each trial aggregate blend (stage 1).
- 5.4.3 Provide Gmb, actual and calculated Gmm's, and volumetric data for all samples fabricated at the selected aggregate blend used to determine the design asphalt content. (stage 2) Note on the worksheet or summary sheet if the dryback procedure was used.
- 5.4.4 Provide APA rut test results to the nearest 0.1 mm.
- 5.4.5 Provide a summary of the results of the mix design testing in the following format:

ODOT CONTRACTOR MIX DESIGN SUMMARY

PROJECT	
CONTRACT NO.	
MIX PRODUCER	
CMDT (print)	

MIX CLASS	
LEVEL (2,3,4)	
PROJECT MANAGER	
CMDT JMF MIX ID NO.	

AGGREGATE & OTHER CONSTITUENTS (RAP, BL. SAND, LIME, ETC.)

STOCKPILE SIZES							
SOURCE NUMBER							
STOCKPILE PERCENTAGE (Psp)							
Bulk Specific Gravity (Gsb)							
Apparent Specific Gravity (Gsa)							

MIXTURE AT DESIGN ASPHALT CONTENT

Maximum Specific Gravity (Gmm)	
Gyratory Bulk Gravity (Gmb)	
Air Voids, % (Va)	
VMA, %	
VFA, %	
Effective Asphalt Content, % (Pbe)	
P200 / Pbe Ratio	
Combined Aggregate (Gsb)	
Effective Specific Gravity (Gse)	
Combined Apparent Gravity (Gsa)	
Tensile Strength Ratio (TSR)	
TSR Compaction Blows	
Film Thickness (T _f) - optional	
Absorbed Asphalt, % (Pba)	
APA Rut depth - mm	
Gmb Sample Weight @ JMF	
Number of Gyration	
Draindown % (open graded)	
Date	
CMDT Signature	

JOB MIX FORMULA

Aggregate Gradation	
Sieve	
3/4" (19 mm)	
1/2" (12.5 mm)	
3/8" (9.5 mm)	
1/4" (6.3 mm)	
No. 4 (4.75 mm)	
No. 8 (2.36 mm)	
No. 30 (0.60 mm)	
No. 200 (0.075 mm)	
Asphalt content, %	
Asphalt percent in RAP	
Antistrip, %	
Asphalt Brand	
Asphalt Grade	
Mixing temp. range	
Placement temp. range	
Asphalt SpGr (Gb) 77/77 F	
Asphalt SpGr (Gb) 60/60 F	

COMMENTS: BLEND CHOSEN? REASON?:

6.0 DENSE GRADED MIX DESIGN MATERIALS SUBMITTAL

6.1 Mix designs **may** be verified according to Section 9. **If requested**, for each JMF submitted, furnish representative samples (split from the materials used for the mixture design) and a completed Form 4000 for design verification to the Department's Materials Laboratory in Salem as follows:

<u>Material</u>	<u>Amount</u>
Aggregate	2 – 50 pound aggregate samples from each aggregate stockpile (untreated)
Asphalt Cement	6 – quarts in 1 quart metal containers
Lime (If required)	1 - 2 lb. sample
Antistripping Additive (If used)	1 – 1 pint sample in a non-metal container
RAP (Recycled a/c pavement)	2 – 50 pound RAP samples

6.2 If the contract requires that a mix design be developed by ODOT, furnish representative samples to the Department's Material's Laboratory in Salem as follows:

<u>Material</u>	<u>Amount</u>
New Coarse Aggregate	16 – 50 lb. (1 bag)*
New Fine Aggregate	16 – 50 lb. (1 bag)*
RAP (if used)	4 – 50 lb. (1 bag) One bag from each of four locations (200 lbs. total)
Hydrated lime (if used)	1 -- 2 lb.
Asphalt cement	18 -- quarts in 1 quart metal containers
Antistripping additive (if used)	1 -- pint in a non-metal container

- If coarse or fine aggregate is in multiple stockpiles, divide the submittal evenly between stockpiles.

6.3 For Stone Matrix Asphalt (SMA) furnish all materials noted in 6.2 and 20 lbs. of mineral filler and 2 lbs. of fiber.

7.0 OPEN GRADED MIX DESIGN

- 7.1 The Open-Graded Mix Design procedures are found in the document “SUPPLEMENTAL TEST PROCEDURES FOR HMAC AND EAC”. Protocol and procedures for ½” (12.5 mm) and ¾” (19 mm) Open-Graded hot mixes, and ¾” (19 mm) Asphalt Treated Permeable Base (ATPB) are described in ODOT TM 318. The protocol and procedures for Emulsified Asphalt Concrete (EAC) cold mix are described in ODOT TM 313.

This document is available from the ODOT Construction Section and is also found on the ODOT website at <http://www.odot.state.or.us/tsconstruction/>.

- 7.1.1 Submit a one quart emulsion sample to the ODOT Central Lab prior to submitting an EAC mix design. It is helpful to submit this sample as soon as it is received from the supplier.

OPEN GRADED MIX DESIGN REPORT

- 7.2 Mix Design Report: For Open-Graded HMAC use the same report format as used for dense-graded mixes (page11) and provide the information required by ODOT TM 318. For EAC mixes provide the information required by ODOT TM 313 in a convenient format. Include the percent of oil distillate (cutter) in the emulsion used to develop the mix design. Note that for Open-Graded HMAC mix designs a Tensile Strength Ratio test result from a surrogate dense graded mix is required. See the test method for details.

8.0 OPEN GRADED MIX DESIGN MATERIALS SUBMITTAL

- 8.1 The ODOT Central Lab **may** verify mix designs according to Section 8. **If requested**, for each JMF submitted, furnish representative samples (split from the materials used for the mixture design) and a completed Form 4000 for design verification to the Department’s Materials Laboratory in Salem as follows:

<u>Material</u>	<u>Amount</u>
Aggregate	2 – 50 lb. samples from each stockpile
Asphalt Cement	4 – quarts in 1 quart containers
Lime (if required)	1 – 2 lb. sample
Antistripping Additive (if required)	1 - pint in a non-metal container

9.0 REVIEW OF CONTRACTOR MIX DESIGNS

9.1 General

By specification ODOT retains the right to review all bituminous mix designs proposed for use on the State Transportation System. ODOT recognizes that the risk associated with each paving application varies. Therefore, the extent of each mix design review will be in accordance with these potential risks.

9.2 Dense Graded Mix Design Review

All dense graded mix designs will be reviewed for accuracy, completeness, reasonableness, compliance with specifications and compliance with the mix design guidelines. ODOT retains the right to perform one or more tests on submitted material to verify the design. These tests may include one or more of the following tests.

- Aggregate gradation
- Aggregate specific gravity
- Maximum specific gravity of mix
- Bulk specific gravity of mix
- Tensile Strength Ratio
- Hveem stability

The type of tests performed, if any, will be determined by a risk assessment based on aggregate source, CMTD experience, and use of the mix. If there are significant differences between ODOT test results and contractor test results, the mix design may be returned to the CMTD for reevaluation and testing.

9.3 Open Graded Mix Design Review

The standard process for reviewing open graded mix designs will include the following:

- Review of the mix design documents and calculations

The review process may include the following split sample testing:

- Fine and coarse aggregate Gsb
- Geometric Gmb, Va, VMA, and VFA @ 4.5, 5.5, and 6.5% asphalt
- Draindown and Gmm at 4.5, 5.5, and 6.5% asphalt

9.4 Allowable Differences

The test results reported in a Contractor developed mix design will be considered acceptable when ODOT Central Laboratory test results from split samples submitted by the Contractor fall within the following allowable differences:

Test Procedure	Allowable Difference (±)
AASHTO T-84 Bulk Specific Gravity (dry)	0.066
AASHTO T-85 Bulk Specific Gravity (dry)	0.038
AASHTO T-166 Bulk Specific Gravity	0.030
AASHTO T-209 Specific Gravity	0.019
AASHTO T-283 Tensile Strength Ratio	10 units
ODOT Draindown	5%
NCAT Draindown	0.05%
ODOT Film Coating	5%
Batched Sample Weights (oven dried)	1%

- 9.4.1 If results do not fall within the allowable differences, the Pavement Materials Engineer will work with the CMDT to determine the cause of the difference.

10.0 EXISTING MIX DESIGN GUIDELINES (TRANSFERS)

10.1 General

A mix design (dense-graded or open-graded) reviewed and accepted for a previous or current ODOT project may be proposed in writing for use on a new project. Acceptance of the mix design will be based on meeting the following requirements and is subject to final approval by the ODOT Pavement Materials Engineer.

10.2 All existing mix designs must meet the following to be considered for transfer:

- The proposed mix design is of the type and level required for the new project.
- Aggregate to be used for mix on the new project is from the same source and other materials are substantially the same as used in the original project. If the original mix design is more than one year old, provide current aggregate specific gravities. Specific gravity running averages are preferred over single test results.
- Aggregate has passed product compliance testing as required by the ODOT “Manual of Field Test Procedures”
- There were no pertinent restrictions placed on transferring the mix design when it was originally reviewed.
- Adjustments made to asphalt content or gradation targets during production are reflected in the proposed design.
- Materials placed under the original mix design are not currently under investigation for mix related premature distress

10.3 Dense-graded mix designs must also meet the following:

- The mix design was developed according to the Superpave mix design procedures outlined in ODOT TM 330 at the appropriate number of gyrations for the current contract.
- Mix produced following the design met the Mix Design Verification criteria shown in specification section 745.16 within the past 12 months.

10.4 Level 3 Dense-graded wearing course mix designs and all Level 4 Dense-graded mix designs must also meet the following:

- The mix design meets APA rut depth criteria listed in Section 4.0 when tested according to AASHTO TP63-03 with the grade of asphalt required for the current contract. All mixes transferred under Section 10.4 must have new APA rut tests performed in 2006.

10.5 Existing mix designs with changes to asphalt grade or source

- Existing open-graded designs with changes to the asphalt grade or asphalt source are not acceptable. A new mix design must be developed.
- For dense-graded mix designs if the asphalt supplier has changed from the original design, a new Tensile Strength Ratio (TSR) test and a new APA rut test with the new asphalt must be performed and must meet criteria. If the aggregate comes from a commercial source with a satisfactory history of stripping resistance, the requirement for a new TSR test may be waived if requested.
- For dense-grade mix designs if the asphalt grade has changed, a new TSR test and a new APA rut test must be performed. If the aggregate comes from a commercial source with a satisfactory history of stripping resistance, the requirement for a new TSR test may be waived if requested.

10.6 Submitting the Request to Use an Existing Mix Design

- Submit a request to use an existing mix design in writing to the ODOT Project Manager with the following information:
- Identity of the mix design by ODOT Number.
- Note any adjustments made to the asphalt content or gradation of the original design during production of the mix.
- Confirm the source and grade of asphalt to be used on the new project.
- Provide summary of recent MDV test data for dense-graded mix designs.