M 323

STANDARD SPECIFICATION FOR SUPERPAVE VOLUMETRIC MIX DESIGN FOP FOR AASHTO M 323

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Significance

The Superpave volumetric mix design process uses combinations of aggregates and binders to produce hot-mix asphalt (HMA) job-mix formulas conforming to specified requirements.

02 **Scope**

This standard specifies minimum quality requirements governing binder and aggregate selection, and establishes specifications for volumetric properties of Superpave mix designs.

03 **Binder Requirements**

The binder shall meet the following:

- Performance-graded
- Meet requirements of AASHTO M 320
- Appropriate for climate
- Appropriate for traffic loading
- Or as specified by the contract documents

The grading system is illustrated by the following graphic:

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SUPERPAVE PG BINDER SPECIFICATIONS

- Grading System Based on Climate (Pavement Temperatures)

PG XX –YY

Performance Grade

Average 7-day Max Pavement Temperature

Min Pavement Design Temperature

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Binder Adjustments

Traffic Speed and Traffic Level

If traffic speed or design ESALs warrant, the high-temperature grade should be increased by the number of grade equivalents in Table 1.

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Table 1
Adjustment to the High Temperature Grade of the Binder[1]
Based on Traffic Speed and Traffic Level

Design ESALs[2] (Million)	Traffic Load Rate		
	Standing[3]	Slow[4]	Standard[5]
< 0.3	--	--	--
0.3 to < 3	2	1	--
3 to < 10	2	1	--
10 to < 30	2	1	--[6]
≥ 30	2	1	1

[1] Increase the high-temperature grade by the number of grade equivalents indicated (one grade is equivalent to 6° C).

[2] The anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years.

[3] *Standing Traffic* – where the average speed is less than 20 km/h (12 mph).

[4] *Slow Traffic* – where the average speed ranges from 20 to 70 km/h (12 to 43 mph).

[5] *Standard Traffic* – where the average traffic speed is greater than 70 km/h (43 mph).

[6] Consideration should be given to increasing the high-temperature grade by one grade equivalent.

RAP Usage

If RAP (Reclaimed Asphalt Pavement) is to be used, adjust the binder grade according to Table 2 to account for RAP binder stiffness and amount. For procedures for developing a blending chart refer to AASHTO M 323, Appendix X1.

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Table 2
Binder Adjustment for RAP Usage

Recommended Virgin Asphalt Binder Grade	RAP Percentage
No change in binder selection	<15
Select virgin binder one grade softer than normal (e.g., select a PG 58 –28 if a PG 64 –22 would normally be used)	15-25
Follow recommendations from blending charts (see Appendix X1 of AASHTO M 323)	>25

Combined Aggregate Requirements

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Size requirements:

- HMA surface course:
  Nominal maximum size: #4 to 3/4 inch
- HMA subsurface courses:
  Nominal maximum size: 1½ inch maximum.

Gradation control points:

- When tested according to AASHTO T 11 and AASHTO T 27, the combined aggregate gradation shall conform to the gradation control points in Table 3.

Table 3
Gradation Control Points

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Sieve Size	Nominal Maximum Aggregate Size (% Passing)											
	1½”		1”		3/4”		1/2”		3/8”		#4	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
2”	100	-	-	-	-	-	-	-	-	-	-	-
1½”	90	100	100	-	-	-	-	-	-	-	-	-
1”	-	90	90	100	100	-	-	-	-	-	-	-
3/4"	-	-	-	90	90	100	100	-	-	-	-	-
1/2"	-	-	-	-	-	90	90	100	100	-	100	-
3/8”	-	-	-	-	-	-	-	90	90	100	95	100
#4	-	-	-	-	-	-	-	-	-	90	90	100
#8	15	41	19	45	23	49	28	58	32	67	-	-
#16	-	-	-	-	-	-	-	-	-	-	30	60
#200	0	6	1	7	2	8	2	10	2	10	6	12

Gradation Classification:

- The combined aggregate gradation is classified as coarse graded when it passes below the Primary Control Sieve (PCS) control point. All other gradations are classified as fine. See Table 4.

Table 4
Gradation Classification

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PCS Control Point for Mixture Nominal Maximum Aggregate Size (% Passing)					
Nominal Maximum Aggregate Size	**1½”**	**1”**	**3/4"**	**1/2"**	**3/8”**
Primary Control Sieve	3/8”	#4	4	#8	#8
PCS Control Point (% Passing)	47	40	47	39	47

Aggregate Consensus Property Requirements:

- Coarse Aggregate Angularity shall be measured according to ASTM D 5821 (Determining the Percentage of Fractured Particles in Coarse Aggregate).
- Fine Aggregate Angularity (Uncompacted Void Content) shall be measured according to AASHTO T 304 Method A.

- Sand Equivalent shall be measured according to AASHTO T 176.
- Flat-and-Elongated shall be measured according to ASTM D 4791 except the material passing the 3/8 inch and retained on the #4 will be included. The ratio of 5:1, length to thickness, will be used. (Some states may require a different ratio.)

Aggregate Consensus Properties of aggregate blends used for Super Pave Mixture Designs shall meet the requirements listed in Table 5.

Table 5
Superpave Aggregate Consensus Property Requirements 11

Design[1] ESALs (million)	Fractured Face Coarse Aggregate (Percent) Minimum		Uncompacted Void Content, Fine Aggregate (Percent) Minimum		Sand Equivalent (Percent) Minimum	Flat and Elongated[3] (Percent) Maximum
	Depth from Surface[4]		Depth from Surface[4]			
	≤ 4”	> 4”	≤ 4”	> 4”		
< 0.3	55/-	-/-	-	-	40	-
0.3 to < 3	75/-	50/-	40	40	40	10
3 to < 10	85/80[2]	60/-	45	40	45	
10 to < 30	95/90	80/75	45	40	45	
≥ 30	100/100	100/100	45	45	50	

(1) The anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years.
(2) 85/80 denotes that 85 percent of the coarse aggregate has one fractured face and 80 percent have two or more fractured faces.
(3) This criteria does not apply to the #4 nominal maximum size mixtures.
(4) If less than 25% of a lift is within 4 inch of the surface, the lift may be considered to be below 4 inch.

When RAP is used the aggregate shall be extracted (using solvent or ignition oven) from the RAP according to Agency specifications. This aggregate shall be used in determining the combined aggregate gradation and conformance to the aggregate consensus properties, with the exception of sand equivalent. The sand equivalent shall apply to the aggregate blend prior to RAP aggregate inclusion.

HMA Design Requirements

When compacted in accordance with the FOP for AASHTO T 312, the mix design shall meet the design requirements in Table 6. (See the FOP for

AASHTO R 35 for N_{ini}, N_{des}, & N_{max} number of gyrations.)

12 When tested in accordance with the FOP for AASHTO T 283, the HMA design shall have a minimum tensile strength ratio of 0.80 when compacted in accordance with the FOP for AASHTO T 312 at 7.0 ±0.5 percent air voids.

Table 6
Superpave HMA Design Requirements 13

Design Esals[1] (million)	Required Relative Density (% of Theoretical Maximum Specific Gravity)			Voids in Mineral Aggregate[7] Percent Minimum						% Voids Filled with Asphalt (VFA) Range[2]	Dust-to-Binder Ratio Range[3]
				Nominal Maximum Aggregate Size							
	$N_{initial}$	N_{design}	N_{max}	1½"	1"	¾"	½"	⅜"	#4		
<0.3	≤91.5	96.0[6]	≤98.0	11.0	12.0	13.0	14.0	15.0	16.0	70-80[4]	0.6-1.2
0.3 to <3	≤90.5									65-78	
3 to <10	≤89.0									65-75[5]	
10 to <30											
≥30											

(1) The anticipated project traffic level expected on the design lane over a 20-year period. Regardless of the actual design life of the roadway, determine the design ESALs for 20 years.
(2) For 1½ inch nominal maximum size mixtures, the specified lower limit of the VFA range is 64% for all traffic levels.
(3) For #4 nominal maximum size mixtures, the dust-to-binder ratio shall be 0.9 to 2.0.
(4) For 1 inch nominal maximum size mixtures, the specified lower limit of the VFA shall be 67 percent for design traffic levels < 0.3 million ESALs.
(5) For design traffic levels >3 million ESALs, 3/8" nominal maximum size mixtures, the specified VFA range shall be 73 to 76 percent and for #4 nominal maximum size mixtures shall be 75 to 78 percent.
(6) Corresponds to an Air Void Content (V_a) of 4.0%.
(7) VMA greater than 2% above the minimum should be avoided.

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Note: If the aggregate gradation passes beneath the PCS Control Point specified in Table 4, the dust-to-binder ratio may be increased to 0.8–1.6 at the agencies discretion.

REVIEW QUESTIONS

1. With what specification must the binder comply? What does PG 64 –34 mean?

2. When using RAP in a mix design, how might the selection of the virgin binder be different than if no RAP is used?

3. Describe the aggregate size requirements for surface courses, for subsurface courses.

4. What are the specified gradation controls?

5. Name the aggregate consensus properties.

6. Is RAP aggregate used for determining all of the consensus properties? If not, for which test(s) would the RAP aggregate be excluded?

7. For design ESAL's of 6 million, what $\%G_{mm}$ at N_{ini} is the maximum allowed?

8. For design ESAL's of 7 million, what is the lower limit of VFA range for a 3/8 inch nominal maximum size aggregate?