

**SECTION 334
SUPERPAVE ASPHALT CONCRETE**

334-1 Description.

334-1.1 General: Construct a Superpave Asphalt Concrete course using the type of mixture specified in the Contract, or when offered as alternates, as selected. Superpave mixes are identified as Type SP-9.5, Type SP-12.5 or Type SP-19.0.

Meet the requirements of Section 320 for plant and equipment. Meet the general construction requirements of Section 330, with the exception that the density requirements of 334-5.4 shall be met.

The Engineer will accept the work on a LOT to LOT basis in accordance with the applicable requirements of Sections 5, 6, and 9. The size of the LOT will be as specified in 334-5 for the asphalt mixture produced at the plant and as specified in 334-5.4 and 330-13 for the material placed on the roadway.

334-1.2 Traffic Levels: The requirements for Type SP Asphalt Concrete mixtures are based on the design traffic level of the project, expressed in 22,000 pound [80 kN] Equivalent Single Axle Loads (ESAL's). The seven traffic levels are as shown in Table 334-1.

Table 334-1 Superpave Traffic Levels	
Traffic Level	Traffic Level (1x10 ⁶ ESAL's)
1	≤ 0.3
2	0.3 to ≤ 1
3	1 to ≤ 3
4	3 to ≤ 10
5	10 to ≤ 30
6	30 to ≤ 100
7	> 100

The traffic level(s) for the project are as specified in the Contract. The Contractor may substitute a Type SP mix one traffic level higher than the traffic level specified in the Contract, at no cost to the Department. Where Type S Asphalt Concrete is specified in the Contract, if approved by the Engineer, the equivalent fine Type SP Asphalt Concrete mixture (Traffic Level 4) may be selected as an alternate at no additional cost to the Department. The equivalent mixes are as follows:

Type S-I Type SP-12.5
 Type S-II Type SP-19.0
 Type S-III Type SP-9.5

334-1.3 Layer Thicknesses: The Superpave mixes are categorized as either “coarse” or “fine”, depending on the overall gradation of the mixture. Coarse mixes are defined as having a gradation that passes below the restricted zone, defined in 334-2.3, when plotted on an FHWA 0.45 Power Gradation Chart. Fine mixes are defined as having a gradation that passes above the restricted zone.

334-1.3.1 Fine Mixes: The allowable structural layer thicknesses for fine Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 3/4 inch - 1 1/4 inches [20 mm - 30 mm]
 Type SP-12.5 1 1/4 inches - 2 1/2 inches [30 mm - 60 mm]
 Type SP-19.0 2 inches - 2 3/4 inches [50 mm - 70 mm]

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on fine mixes when used as a structural course:

Type SP-9.5 - Limited to the final (top) structural layer, one layer only.

Type SP-12.5 - May not be used in the first layer of courses over 3 1/2 inches [90 mm] thick, nor in the first layer of courses over 2 3/4 inches [70 mm] thick on limited access facilities.

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.3.2 Coarse Mixes: The allowable structural layer thicknesses for coarse Type SP Asphalt Concrete mixtures are as follows:

Type SP-9.5 1 1/2 inches - 2 inches [40 mm - 50 mm]

Type SP-12.5 2 inches - 3 inches [50 mm - 80 mm]

Type SP-19.0 3 inches - 3 1/2 inches [80 mm - 90 mm]

In addition to the minimum and maximum thickness requirements, the following restrictions are placed on coarse mixes when used as a structural course:

Type SP-19.0 - May not be used in the final (top) structural layer.

334-1.3.3 Additional Requirements: The following requirements also apply to coarse and fine Type SP Asphalt Concrete mixtures:

1. A minimum 1 1/2 inch [40 mm] initial lift is required over an Asphalt Rubber Membrane Interlayer (ARMI).

2. When construction includes the paving of adjacent shoulders (≤ 5 feet [≤ 1.5 m] wide), the layer thickness for the upper pavement layer and shoulder shall be the same and paved in a single pass, unless shown differently in the plans.

3. All overbuild layers shall be fine Type SP Asphalt Concrete with the traffic level as stated in the Contract, up to a maximum of Traffic Level 4. Use a Traffic Level 4 mix for areas with higher traffic levels. Use the minimum and maximum layer thicknesses as specified in 334-1.3.1 unless shown differently in the plans.

4. On variable thickness overbuild layers, the minimum allowable thickness may be reduced by 3/8 inch [10 mm], and the maximum allowable thickness may be increased 3/8 inch [10 mm], unless shown differently in the plans.

334-2 Materials.

334-2.1 General Requirements: Meet the material requirements specified in Division III. Specific references are as follows:

Asphalt Cement Viscosity Grade AC-30, or Recycling Agent.....916-1 and 916-2

Asphalt Binder PG 64-22.....AASHTO MP-1

Mineral Filler917-1 and 917-2

Coarse Aggregate, Stone, Slag or Crushed Gravel Section 901

Fine Aggregate..... Section 902

334-2.2 Gradation Requirements: Combine the coarse and fine aggregate in proportions that will produce an asphalt mixture meeting all of the requirements defined in this Specification and conform to the gradation requirements at design as defined in Table 334-2. Aggregates from various sources may be combined.

Table 334-2 Aggregate Gradation Control Points (Gradation Design Ranges)						
Sieve Size	Superpave Mixture (Percent Passing)					
	SP-9.5		SP-12.5		SP-19.0	
	Min.	Max.	Min.	Max.	Min.	Max.
1 inch [25.0 mm]	-	-	-	-	100	-
3/4 inch [19.0 mm]	-	-	100	-	90	100
1/2 inch [12.5 mm]	100	-	90	100	-	90
3/8 inch [9.5 mm]	90	100	-	90	-	-
No. 4 [4.75 mm]	-	90	-	-	-	-
No. 8 [2.36 mm]	32	67	28	58	23	49
No. 200 [75 µm]	2	10	2	10	2	8

334-2.3 Restricted Zone: The gradation identified in 334-2.2 shall not pass through the restricted zones specified in Table 334-3. For Traffic Levels 5, 6 and 7 the design gradation shall pass below the restricted zone, when plotted on an FHWA 0.45 Power Gradation Chart. Unless otherwise noted in the plans, for Traffic Levels 1, 2, 3 and 4, the design gradation may pass either above or below the restricted zone, provided the lift thickness requirements specified in 334-1.3 are met.

334-2.4 Aggregate Consensus Properties: Meet the following consensus properties at design for the aggregate blend:

334-2.4.1 Coarse Aggregate Angularity: When tested in accordance with ASTM D 5821, meet the coarse aggregate angularity requirement defined in Table 334-4.

334-2.4.2 Fine Aggregate Angularity: When tested in accordance with AASHTO T-304, meet the fine aggregate angularity requirement defined in Table 334-5.

Table 334-3 Aggregate Gradation Restricted Zone (Design Only)						
Sieve Size within Restricted Zone	Boundaries of Restricted Zone Superpave Mixture (Percent Passing)					
	SP-9.5		SP-12.5		SP-19.0	
	Min.	Max.	Min.	Max.	Min.	Max.
No. 4 [4.75 mm]	-	-	-	-	-	-
No. 8 [2.36 mm]	47.2	47.2	39.1	39.1	34.6	34.6
No. 16 [1.18 mm]	31.6	37.6	25.6	31.6	22.3	28.3
No. 30 [600 µm]	23.5	27.5	19.1	23.1	16.7	20.7

Table 334-4 Coarse Aggregate Angularity Criteria (Minimum Percent Fractured Faces)				
Traffic Level	Depth of Top of Pavement Layer From Surface			
	≤4 inches [≤100 mm]		>4 inches [>100 mm]	
	1 or More Fractured Faces (%)	2 or More Fractured Faces (%)	1 or More Fractured Faces (%)	2 or More Fractured Faces (%)
1	55	-	-	-
2	65	-	-	-
3	75	-	50	-
4	85	80	60	-
5	95	90	80	75
6	100	100	95	90
7	100	100	100	100

Table 334-5 Fine Aggregate Angularity Criteria		
Traffic Level	Depth of Top of Pavement Layer From Surface	
	≤4 inches [≤100 mm]	>4 inches [>100 mm]
	Minimum Uncompacted Void Content (%)	Minimum Uncompacted Void Content (%)
1	-	-
2	40	-
3	40	40
4	45	40
5	45	40
6	45	45
7	45	45

334-2.4.3 Flat and Elongated Particles: When tested in accordance with ASTM D 4791, use a ratio of maximum to minimum dimensions of 5:1 and do not exceed 10% as the maximum amount of flat and elongated particles for the coarse aggregate blend for all projects with Traffic Levels 3 and higher. This criteria does not apply for projects with lower traffic levels.

334-2.4.4 Clay Content: When tested in accordance with AASHTO T 176, meet the sand equivalent value for fine aggregate blend defined in Table 334-6.

Table 334-6 Clay Content	
Traffic Level	Sand Equivalent Minimum (%)
1	40
2	40
3	40
4	45
5	45
6	50
7	50

334-2.5 Specific Requirements:

334-2.5.1 Condition of Aggregate: Provide clean aggregate that contains no deleterious substances. Do not use coarse or fine aggregate containing more than 0.5% of phosphate.

334-2.5.2 Fine Aggregate and Mineral Filler: In laboratory tests, and for the purpose of proportioning the paving mixture, all material passing the No. 8 [2.36 mm] sieve and retained on the No. 200 [75 µm] sieve will be considered as fine aggregate, and the material passing the No. 200 [75 µm] sieve will be considered as mineral filler.

334-2.5.3 Screenings: Do not use any screenings in the combination of aggregates which contain more than 15% of material passing the No. 200 [75 µm] sieve. When blending two screenings to produce the screening component of the aggregate, one of the screenings may contain up to 18% of material passing the No. 200 [75 µm] sieve, provided the combination of the two does not contain over 15% material passing the No. 200 [75 µm] sieve. Screenings may be washed to meet these requirements.

334-2.5.4 Use of Reclaimed Asphalt Pavement:

334-2.5.4.1 General Requirements: Reclaimed Asphalt Pavement (RAP) may be used as a component material of the asphalt mixture subject to the following:

1. The Contractor assumes responsibility for the design of asphalt mixes which incorporate RAP as a component material.

2. For design purposes, the Contractor assumes responsibility for establishing accurate specific gravity values for the RAP material. This may be accomplished by one of the following methods:

a) Calculation of the bulk specific gravity value based upon the effective specific gravity of the RAP, determined on the basis of the asphalt binder content and maximum specific gravity. The Engineer will approve the estimated asphalt binder absorption value used in the calculation.

b) Testing of the extracted aggregate obtained through a vacuum extraction or ignition oven extraction.

3. For projects with Traffic Levels 5, 6 and 7, do not permit the amount of RAP material used in the mix to exceed 30% by weight of total aggregate. For projects with Traffic Levels 1, 2, 3 and 4, do not permit the amount of RAP material used in the mix to exceed 50% by weight of total aggregate. or grid over the RAP cold bin, in-line roller crusher, screen, or other suitable means to prevent oversized RAP material from showing up in the completed recycled mixture.

If oversized RAP material appears in the completed recycled mix, take the appropriate corrective action immediately. If the appropriate corrective actions are not immediately taken, stop plant operations.

5. Provide stockpiled RAP material that is reasonably consistent in characteristics and contains no aggregate particles which are soft or conglomerates of fines.

6. Provide RAP having a minimum average asphalt content of 4.0% by weight of total mix. The Engineer may sample the stockpile to verify that this requirement is met.

334-2.5.4.2 Special Requirements For RAP Milled From Projects:

When milling is required on the project and a Composition of Existing Pavement is included in the Contract Documents, and the use of the milled material as a component of the asphalt mixture is elected, use the following procedures for obtaining representative samples for the mix design:

1. Cut a minimum of ten 6 inch [150 mm] cores in area(s) approved by the Engineer. Fill the core holes prior to opening to traffic. Assume responsibility for accounting for the degradation that will occur during the milling operation.

2. Representative samples may also be obtained by milling the existing pavement to the full depth shown on the plans for pavement removal for a length of approximately 200 feet [60 m]. If required to maintain traffic, immediately replace the pavement removed with the mix specified in the Contract. This mix will be paid for at the Contract unit price.

3. Submit a written request to the Engineer for any variance from the above outlined methods of obtaining samples for mix designs.

334-2.5.4.3 Requirements For RAP Stockpiled From a Previous FDOT

Project: When the RAP to be used as a component in a mix design is stockpiled from a previous FDOT project and the Composition of Existing Pavement is known, design the mix and submit to the Engineer for approval.

334-2.5.4.4 Requirements For RAP With Unknown Characteristics: When the composition of stockpiled RAP to be used as a component in a mix design is not known, use the following procedures for design:

1. Submit a bag of RAP, composed of samples from a minimum of three separate locations in the stockpile(s) to the Engineer at least four weeks prior to the planned start of mix design. The Engineer will run viscosities on the RAP and furnish the information to the Contractor.
2. Run a minimum of six extraction gradation analyses and six determinations of bulk specific gravity of the RAP. Take samples at random locations around the stockpile(s).
3. Request the Engineer to make a visual inspection of the stockpile(s) of RAP. Based on visual inspection, the Engineer will determine the suitability of the stockpiled materials. Once the RAP stockpile has been approved, do not add additional material without prior approval of the Engineer.
4. Submit the data required above when submitting the proposed mix design to the Department for approval.

334-2.5.5 Recycling Agents: When RAP is approved for use as a component material, use a recycling agent meeting the requirements of 916-2 in the mix.

The Engineer will select the best formulation suited for the project and reserves the right to request reasonable changes throughout the construction duration.

334-3 Permissible Variation for the Coarse Aggregate.

Size and consistently grade or combine the aggregate or aggregates shipped to the job in such proportions that the resulting mixture meets the grading requirements of the mix design.

334-4 General Composition of Mixture.

334-4.1 General: Compose the asphalt mixture using a combination of aggregate (coarse, fine or mixtures thereof), mineral filler, if required, and asphalt binder material. Size, grade and combine the aggregate fractions to meet the grading and physical properties of the approved mix design. Aggregates from various sources may be combined.

334-4.2 Mix Design:

334-4.2.1 General: Design the Superpave asphalt mixture in accordance with AASHTO PP-28 or The Asphalt Institute's Superpave Mix Design Manual, to meet the requirements of this Specification. Short-term oven age the mixture for two hours at the compaction temperature at a thickness of 1 to 2 inches [25 to 50 mm]. Prior to the production of any Superpave asphalt mixture, submit the proposed mix design with supporting test data indicating compliance with all Superpave mix design criteria. Include representative samples of all component materials, including asphalt cement. Allow the Engineer a maximum of three weeks to either conditionally verify or reject the mix as designed. The Engineer will provide final verification of the mix design when the requirements of 334-4.4.2 have been met.

At the sole option of the Engineer, Type SP asphalt mixes may be used based on evidence of final verification and satisfactory performance in previous production for that particular mix.

334-4.2.2 Grading Requirements: Meet the gradation design ranges of Table 334-2.

334-4.2.3 Gyrotory Compaction: Compact the design mixture in accordance with AASHTO TP-4. Compact the mixture to the maximum number of gyrations and back calculate to the design number of gyrations. Use the number of gyrations as defined in Table 334-7.

Table 334-7 Superpave Design Gyrotory Compactive Effort			
Traffic Level	$N_{initial}$	N_{design}	$N_{maximum}$
1	7	68	104
2	7	76	117
3	7	86	134
4	7	86	134
5	8	96	152
6	8	96	152
7	8	96	152

334-4.2.4 Volumetric Criteria: Use an air void content of the mixture at design of 4.0% at the design number of gyrations (N_{design}). Meet the requirements of Table 334-8.

Table 334-8 Mixture Densification Criteria			
Traffic Level	% G_{mm}		
	$N_{initial}$	N_{design}	$N_{maximum}$
1	≤ 91.5	96.0	≤ 98.0
2	≤ 90.5	96.0	≤ 98.0
3	≤ 90.0	96.0	≤ 98.0
4	≤ 89.5	96.0	≤ 98.0
5	≤ 89.0	96.0	≤ 98.0
6	≤ 89.0	96.0	≤ 98.0
7	≤ 89.0	96.0	≤ 98.0

334-4.2.5 VMA Criteria: Meet the requirements of Table 334-9 for voids in the mineral aggregate (VMA) of the mixture at the design number of gyrations.

Table 334-9 VMA Criteria	
Type Mix	Minimum VMA (%)
SP-9.5	15.0
SP-12.5	14.0
SP-19.0	13.0

334-4.2.6 VFA Criteria: Meet the requirements of Table 334-10 for voids filled with asphalt (VFA) of the mixture at the design number of gyrations.

Table 334-10 VFA Criteria	
Traffic Level	Design VFA (%)
1	70 - 80
2	65 - 78
3	65 - 78
4	65 - 75
5	65 - 75
6	65 - 75
7	65 - 75

Note: For Type SP-9.5 mixtures at Traffic Levels 4-7, the maximum design VFA value is 76.

334-4.2.7 Dust Proportion: Use a dust to effective asphalt binder content by weight between 0.6 to 1.2 for fine mixes and 0.6 to 1.6 for coarse mixes.

334-4.2.8 Moisture Susceptibility: Provide a mixture (4 inch [100 mm] specimens) having a retained tensile strength ratio of at least 80% when compacted to $7 \pm 0.5\%$ air voids, and a minimum tensile strength (dry and unconditioned) of 120 psi [825 kPa]. Test the specimens in accordance with AASHTO T 283 with the following exceptions: saturate the specimens to a minimum saturation level of 90% and include one freeze-thaw cycle. If necessary, add an approved liquid anti-stripping agent in order to meet this criteria.

334-4.2.9 Water Permeability: Do not exceed a maximum coefficient of permeability (coarse mixes only) of the mixture of 125×10^{-5} cm/s when compacted to 6% air voids and tested in accordance with FM 5-565.

Trim the compacted specimen at both ends to the minimum thickness in 334-1.3 prior to testing.

334-4.2.10 Additional Information: In addition to the requirements listed above, provide the following information with each proposed mix design submitted for verification:

1. The specific project on which the mixture will be used.
2. The design traffic level and the maximum number of gyrations (N_{maximum}).
3. The source and description of the materials to be used.
4. The DOT source number and the DOT product code of the aggregate components furnished from a DOT approved source.
5. The gradation and approximate proportions of the raw materials as intended to be combined in the paving mixture. The gradation of the component materials shall be representative of the material at the time of use.
6. A single percentage of the combined mineral aggregate passing each specified sieve. Degradation of the aggregate due to processing (particularly -No. 200 [-75 μm]) should be accounted for and identified for the applicable sieves.
7. A single percentage of asphalt binder by weight of total mix intended to be incorporated in the completed mixture, shown to the nearest 0.1%.
8. A single temperature at which the mixture is intended to be discharged from the plant and compacted at the roadway.
9. Evidence that the completed mixture will conform to all specified physical requirements.
10. The name of the individual responsible for the Quality Control of the mixture during production.
11. The ignition oven calibration factor.

334-4.3 Revision of Mix Design: Submit all requests for revisions to verified mix designs, along with supporting documentation, to the Engineer. In order to expedite the revision process, the request for

revision or discussions on the possibility of a revision may be made verbally, but must be followed up by a written request. The verified mix design will remain in effect until a change is authorized by the Engineer. In no case may the effective date of the revision be established earlier than the date of the first communication between the Contractor and the Engineer regarding the revision.

A new design mix will be required for any substitution of an aggregate product with a different aggregate code, unless approved by the Engineer.

334-4.4 Contractor's Quality Control:

334-4.4.1 Personnel: In accordance with the requirements of 330-2.2, Quality Control by the Contractor, provide the necessary quality control personnel. Employ a Quality Control Technician who is certified by the Department and possesses a valid certificate of qualification. When it becomes evident to the Department that the Quality Control Technician cannot perform as required by the position, the Department will revoke the certification and require replacement with another certified technician. Turn over a copy or summary of all Quality Control test data to the Department when the project is completed.

334-4.4.2 Initial Production Test Strip: For initial use of a Type SP mix design at a particular plant, limit full-scale production and placement of the mix to a test strip of 500 tons [450 metric tons] (for each mix) to demonstrate the capability of producing, placing, and compacting the mix as specified. Upon agreement between the Contractor and the Engineer, test strips of up to 1,000 tons [900 metric tons] may be used. Initial production requirements do not apply if the total quantity of mix to be placed is less than 2,200 tons [2,000 metric tons].

334-4.4.2.1 Calibration of the Superpave Gyratory Compactor: Calibrate the Superpave Gyratory Compactor in accordance with the manufacturer's recommendations prior to producing the Superpave mixture for the test strip. Check the height calibration, the speed of rotation, ram pressure and angle of gyration. (Following completion of the test strip, calibrate the height daily, the ram pressure and speed of rotation weekly, and the angle of gyration monthly.)

334-4.4.2.2 Plant Testing Requirements: During the initial production period, take a minimum of three separate sets of mixture samples which will be used for extraction gradation analysis and determination of volumetric properties. Provide a split sample of one of the samples for comparison testing with the Engineer.

334-4.4.2.3 Roadway Testing Requirements: Assume responsibility for cutting 3- 6 inch [150 mm] diameter roadway cores at locations determined by the Engineer for evaluation of permeability by the Department. The Department will have a maximum of three working days from the date the cores are obtained to complete the evaluation. (Permeability criteria applies only to coarse mixes when the average density for the test strip is less than 93.5% of G_{mm}).

For density determination, obtain 6 inch [150 mm] diameter roadway cores at random locations as directed by the Engineer within the test strip, at a frequency shown in Table 334-14.

334-4.4.2.4 Criteria for Passing Test Strip: Resume production when authorized by the Engineer based upon acceptable extraction gradation analysis as determined in accordance with 334-4.4.3, acceptable volumetric properties as determined in accordance with 334-4.4.4, acceptable density in accordance with 334-5.4.1, a coefficient of permeability of less than 125×10^{-5} cm/s as determined in accordance with FM 5-565 (permeability criteria applies only to coarse mixes when the average density for the test strip is less than 93.5% of G_{mm}), and a favorable comparison with the Engineer's test results (G_{mb} at N_{design} (within 1%) and G_{mm} (within 0.019) only). In the event that the test strip fails to meet any of the above mentioned criteria, remove and replace the material at no cost to the Department if so directed by the Engineer.

334-4.4.3 Extraction Gradation Analysis: The Engineer will sample the asphalt mixture at the plant in accordance with FM 1-T 168. The percent asphalt binder content of the mixture will be determined in accordance with FM 5-563 (ignition oven). The gradation of the extracted mixture will be determined in accordance with FM 1-T 030. Perform the extraction and gradation analysis in accordance

with FM 5-544 and 5-545, respectively, if the calibration factor for the mix exceeds 0.50%. All test results will be shown to the nearest 0.01. All calculations will be carried to the nearest 0.001 and rounded to the nearest 0.01, in accordance with the Department's rules of rounding.

Run an extraction gradation analysis on the mixture at a minimum frequency of once per production day when the daily production is less than 1,000 tons [900 metric tons]. If the daily production exceeds 1,000 tons [900 metric tons], perform the extraction gradation analysis of the mix a minimum of two times per production day.

During normal production, the Engineer will not require extraction gradation analysis on days when mix production is less than 100 tons [90 metric tons]. However, when mix production is less than 100 tons [90 metric tons] per day on successive days, run the test when the accumulative tonnage on such days exceeds 100 tons [90 metric tons].

The target gradation and asphalt content will be as shown on the mix design. Any changes in target will require a change in the mix design in accordance with 334-4.3.

If the percentage of asphalt binder deviates from the optimum asphalt binder content by more than 0.55%, or the percentage passing any sieve falls outside the limits in Table 334-11, immediately resample the mix and test to validate the previous test result, and if needed, make the necessary correction. If the results for two consecutive tests deviate from the optimum asphalt binder content by more than 0.55%, or exceed the limits in Table 334-11 for any sieve, notify the Engineer and take immediate steps to identify and correct the problem, then resample the mix. If the results from this test deviate from the optimum asphalt binder content by more than 0.55%, or exceed the limits in Table 334-11 for any sieve, stop the plant operation until the problem has been corrected.

Sieve Size	Percent Passing
1 inch [25.0 mm]	7.0
3/4 inch [19.0 mm]	7.0
1/2 inch [12.5 mm]	7.0
3/8 inch [9.5 mm]	7.0
No. 4 [4.75 mm]	7.0
No. 8 [2.36 mm]	5.5
No. 16 [1.18 mm]	5.0
No. 30 [600 μm]	4.5
No. 50 [300 μm]	4.5
No. 100 [150 μm]	3.0
No. 200 [75 μm]	2.0

Maintain control charts showing the results of the extraction gradation analysis (asphalt binder content and sieve analysis).

334-4.4.4 Volumetric Control: During production of the mix, monitor the volumetric properties of the Superpave mix with a Superpave Gyratory Compactor to determine the air voids, VMA, VFA, and dust-to-effective asphalt binder ratio (dust proportion) at N_{design} .

For coarse mixes, take appropriate corrective actions in order to maintain an air void content at N_{design} between 2.5 and 5.0% during production. When the air void content at N_{design} drops below 2.0 or exceeds 5.5% on any one test, or is less than 2.5% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved to the satisfaction of the Engineer.

For fine mixes, take appropriate corrective actions to maintain an air void content at N_{design} between 3.0 and 5.0% during production. When the air void content at N_{design} drops below 2.5 or exceeds 6.5% on any one test, or is less than 3.0% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved to the satisfaction of the Engineer.

Determine the volumetric properties of the mixture at a minimum frequency of once per production day when the daily production is less than 1,000 tons [900 metric tons]. If the daily production exceeds 1,000 tons [900 metric tons], monitor the volumetric properties two times per production day.

During normal production, volumetric properties of the mixture will not be required on days when mix production is less than 100 tons [90 metric tons]. However, when mix production is less than 100 tons [90 metric tons] per day on successive days, run the test when the accumulative tonnage on such days exceeds 100 tons [90 metric tons].

Testing required for volumetric property determination includes AASHTO TP-4, FM 1-T 209, FM 5-563 and FM 1-T 030.

In addition to the requirements of 330-2.2, maintain control charts showing the results of the volumetric testing (air voids, G_{mm} , G_{mb}).

334-4.4.5 Plant Calibration: At or before the start of mix production, perform an extraction gradation analysis of the mix to verify calibration of the plant. This extraction gradation analysis may also be used for the first test of the first day's production.

334-4.4.6 Viscosity of Asphalt Binder in Mixes Containing Reclaimed Asphalt Pavement: When RAP is a component material, the viscosity of the asphalt binder material in the asphalt mixture, determined by the Materials Office in accordance with FM 1-T 202, will be within the range of $6,000 \pm 2,000$ poises [400-1200 Pa·s]. This determination will be made on samples obtained by the Engineer on a random basis at a frequency of approximately one per 2,000 tons [1,800 metric tons] of mix.

If the viscosity is determined by the Engineer to be out of the specified tolerance, adjust the recycling agent formulation or blend of RAP used in the mixture to bring the viscosity within tolerance.

334-5 Acceptance of the Mixture.

334-5.1 General: The asphalt mixture will be accepted at the plant, with respect to gradation and asphalt binder content, on a LOT to LOT basis. The material will be tested for acceptance in accordance with the provisions of 330-2 and the following requirements. However, any load or loads of mixture which, in the opinion of the Engineer, are unacceptable for reasons of excessive segregation, aggregates improperly coated, or of excessively high or low temperature will be rejected for use in the work.

A standard size LOT at the asphalt plant will consist of 4,000 tons [3,600 metric tons] with four equal sublots of 1,000 tons [900 metric tons] each.

A partial LOT may occur due to the following:

- (1) the completion of a given mix type on a project.
- (2) an approved LOT termination by the Engineer due to a change in process, extended delay in production, or change in mix design.

If the partial LOT contains one or two sublots with their appropriate test results, then the previous full-size LOT will be redefined to include this partial LOT and the evaluation of the LOT will be based on either five or six subplot determinations. If the partial LOT contains three sublots with their appropriate test results, this partial LOT will be redefined to be a whole LOT and the evaluation of it will be based on three subplot determinations.

When the total quantity of any mix is less than 3,000 tons [2,700 metric tons], the partial LOT will be evaluated for the appropriate number of sublots from $n=1$ to $n=3$. When the total quantity of any mix type is less than 500 tons [450 metric tons], the Engineer will accept the mix on the basis of

visual inspection. The Engineer may run extraction and gradation analysis for verification purposes; however, the provisions for partial payment will not apply.

On multiple project contracts, the LOT(s) at the asphalt plant will carry over from project to project.

334-5.2 Acceptance Procedures: Control all operations in the handling, preparation, and mixing of the asphalt mix so that the percent bitumen and the percents passing the No. 8 [2.36 mm] and No. 200 [75 µm] sieves will meet the verified job mix formula within the tolerance shown in Table 334-12.

Table 334-12 Tolerances for Acceptance Tests	
Characteristic	Tolerance*
Asphalt Content (Extraction)	±0.55%
Asphalt Content (Printout)	±0.15%
Passing No. 8 [2.36 mm] Sieve	±5.50%
Passing No. 200 [75 µm] Sieve	±2.00%

*Tolerances for sample size of n=1. See Table 334-13 for other sample sizes n=2 through n=6.

Acceptance of the mixture will be on the basis of test results on consecutive random samples from each LOT. The Engineer will take one random sample from each subplot. The asphalt mixture will be sampled at the plant in accordance with FM 1-T 168. The percent asphalt binder content of the mixture will be determined in accordance with FM 5-563 (ignition oven). The percentages passing the No. 8 [2.36 mm] and No. 200 [75 µm] sieves will be determined in accordance with FM 1-T 030. The Engineer will perform the extraction and gradation analysis in accordance with FM 5-544 and 5-545, respectively, if the calibration factor for the mix exceeds 0.50%.

Calculations for the acceptance test results for bitumen content and gradation (percentages passing the No. 8 [2.36 mm] and No. 200 [75 µm] sieves) will be shown to the nearest 0.01. Calculations for arithmetic averages will be carried to the 0.001 and rounded to the nearest 0.01 in accordance with the Department's rules of rounding.

Payment will be made on the basis of Table 334-13 "Acceptance Schedule of Payment". The process will be considered out of control when the deviation of any individual test result from the mix design falls in the 80% pay factor for the "one test" column of Table 334-13. When this happens, the LOT will be automatically terminated and acceptance of the LOT determined in accordance with Table 334-13.

Table 334-13 Acceptance Schedule of Payment (Asphalt Plant Mix Characteristics)						
Average of Accumulated Deviations of the Acceptance Tests from the Mix Design						
Pay Factor	1-Test	2-Tests	3-Tests	4-Tests	5-Tests	6-Tests
Asphalt Binder Content (Extraction)						
1.00	0.00-0.55	0.00-0.43	0.00-0.38	0.00-0.35	0.00-0.33	0.00-0.31
0.95	0.56-0.65	0.44-0.50	0.39-0.44	0.36-0.40	0.34-0.37	0.32-0.36
0.90	0.66-0.75	0.51-0.57	0.45-0.50	0.41-0.45	0.38-0.42	0.36-0.39
0.80*	over 0.75	over 0.57	over 0.50	over 0.45	over 0.42	over 0.39
No. 8 [2.36 mm] Sieve **						
1.00	0.00-5.50	0.00-4.33	0.00-3.81	0.00-3.50	0.00-3.29	0.00-3.13
0.98	5.51-6.50	4.34-5.04	3.82-4.39	3.51-4.00	3.30-3.74	3.14-3.54
0.95	6.51-7.50	5.05-5.74	4.40-4.96	4.01-4.50	3.75-4.18	3.55-3.95
0.90	7.51-8.50	5.75-6.45	4.97-5.54	4.51-5.00	4.19-4.63	3.96-4.36
0.80*	over 8.50	over 6.45	over 5.54	over 5.00	over 4.63	over 4.36
No. 200 [75 µm] Sieve **						
1.00	0.00-2.00	0.00-1.71	0.00-1.58	0.00-1.50	0.00-1.45	0.00-1.41
0.95	2.01-2.40	1.72-1.99	1.59-1.81	1.51-1.70	1.46-1.63	1.42-1.57
0.90	2.41-2.80	2.00-2.27	1.82-2.04	1.71-1.90	1.64-1.80	1.58-1.73
0.80*	over 2.80	over 2.27	over 2.04	over 1.90	over 1.80	over 1.73
*If approved by the Engineer based on an engineering determination that the material is acceptable to remain in place, the indicated partial pay may be accepted. Otherwise, the Engineer will require removal and replacement at no cost. The Contractor may remove and replace at no cost to the Department at any time.						
**When there are two reduced payments for these items in one LOT of material, only the greatest reduction in payment will be applied. CAUTION: This rule applies only to these two gradation test results.						
Note: Deviations are absolute values with no plus or minus signs.						

When possible, the Engineer will complete all acceptance tests on the same day the sample was taken, and on no occasion will they be completed later than the following work day.

334-5.3 Automatic Batch Plant With Printout: Acceptance determinations for asphalt content and gradation for mixtures produced by automatic batch plants with printout will be based on extraction results as specified in 334-5.2.

334-5.4 Acceptance on the Roadway:

334-5.4.1 Density Control: The in-place density of each course of asphalt mix construction will be evaluated by the use of 6 inch [150 mm] diameter roadway cores. The required average density of a completed course will be based on the maximum specific gravity (G_{mm}) of the as-produced mix.

The Engineer will not perform density testing on patching courses, leveling courses, open-graded friction courses, or any course with a specified thickness less than 1 inch [25 mm] or a specified spread rate less than 105 lb/yd² [57 kg/m²]. In addition, density testing will not be performed on the following areas when they are less than 1,000 feet [300 m] in length: crossovers, intersections, turning lanes, acceleration lanes or deceleration lanes. Compact these courses (with the exception of open-graded friction courses) in accordance with the rolling procedure as approved by the Engineer.

334-5.4.1.1 LOTs: For the purpose of acceptance and determination of payment, each day's production will be divided into LOTs, and all LOTs are to be closed out at the end of the day. The standard size of a LOT will consist of 5,000 feet [1,500 m] of any pass made by the paving train regardless of the width of the pass. Changes in thickness, mix design, or underlying layer shall constitute

a separate LOT. Mix placed on the shoulder shall also be considered a separate LOT. Pavers traveling in echelon will be considered as two separate passes. When at the end of a day's production (production day) or the completion of a given course, layer, or mix, or at the completion of the project, a LOT size is determined to be less than 5,000 feet [1,500 m], it is considered a partial LOT. Partial LOTs are to be handled as follows:

If the length of the partial LOT is 2,000 feet [600 m] or less, then the previous full-size LOT will be redefined to include this partial LOT and the number of tests required for the combined LOT will be as shown in Table 334-14. If the partial LOT is 2,000 feet [600 m] or less, and a previous full-size LOT from the same day, mix, layer and project is not available, then the partial LOT will be evaluated separately and the number of tests required for the partial LOT will be as shown in Table 334-14. If the partial LOT is greater than 2,000 feet [600 m] long, it will be evaluated separately, with the number of tests required as shown in Table 334-14.

LOT Size (feet) [(m)]	Number of Tests
Less than 3,000 [900]	3
3,001 - 4,000 [901 - 1,200]	4
4,001 - 5,000 [1,201 - 1,500]	5
5,001 - 6,000 [1,501 - 1,800]	6
6,001 - 7,000 [1,801 - 2,100]	7
Greater than 7,000 [2,100]	2 LOTs

334-5.4.1.2 Target Maximum Specific Gravity: The target maximum specific gravity of the mix will be based on the average daily value as determined by the Contractor's Quality Control testing described in 334-4.4.4. Obtain two separate samples for maximum specific gravity determination on a daily basis. If only one maximum specific gravity test value is available, this value shall be used as the target maximum specific gravity. If a maximum specific gravity value is not determined for a day's production, the previous day's value will be used. Obtain, under the Engineer's supervision, split samples of the asphalt mixture used for the maximum specific gravity test for verification purposes. The minimum size of the split sample will be 4,000 g. The split samples will become the property of the Department. In the event of an obvious sampling or testing error, the Engineer may allow the Contractor to retest a portion of the split sample. The Engineer will run verification tests on the split samples in order to determine the acceptability of the Contractor's test results. If the verification test result differs from the Quality Control test result by more than 0.019 for two consecutive tests, the target G_{mm} value will be established by the Department's result until the cause of the discrepancy is identified and resolved to the satisfaction of the Engineer.

334-5.4.1.3 Quality Control of In-Place Compaction: Develop and implement a method to control the compaction of the pavement and ensure its compliance with the minimum specified density requirements. Include density determinations by the use of a nuclear density gauge at a frequency of one test per 1,000 feet [300 m] of compacted pavement in the quality control method. Other density measuring devices may be used in lieu of the nuclear density gauge, provided that it is demonstrated to the satisfaction of the Engineer that the device can accurately measure the relative level of density in the pavement on a consistent basis.

334-5.4.1.4 Acceptance: The completed pavement will be accepted with respect to density on a LOT basis. For each LOT, 6 inch [150 mm] diameter roadway cores will be obtained at random locations within the LOT, at the frequency shown in Table 334-14. Obtain the roadway cores at the random locations as directed by the Engineer, at the end of each day's production prior to opening the roadway to traffic. The locations of the cores will be determined in the longitudinal direction by the use of

statistically derived stratified random number tables furnished by the Department. The locations of the cores transversely will be uniformly spaced across the width of the pavement, with no cores located closer than 1 foot [0.3 m] of any unsupported edge. These will also be used for partial LOTs. Assume responsibility for maintenance of traffic, coring, patching the core holes, and trimming the cores to the proper thickness prior to density testing.

The density of the cores will be determined in accordance with FM 1-T 166, and will be averaged for each LOT. To receive full payment for density, the average density of a LOT shall be a minimum of 93.5% of G_{mm} for coarse mixes, and 92% of G_{mm} for fine mixes. Partial payment will be made for those LOTs that have an average density less than 93.5% of G_{mm} based on Table 334-15 (for coarse mixes), and less than 92% of G_{mm} based on Table 334-16 (for fine mixes).

Once the average density of a LOT has been determined, do not provide additional compaction to raise the average.

Table 334-15 Payment Schedule For Density (For Coarse Mixes)	
Percent of Maximum Specific Gravity	Percent of Payment
94.5 and above	105*
93.5 to less than 94.5	100
93.0 to less than 93.5	95
Less than 93.0	**

*The maximum payment for all LOTs with one or more individual density values less than 92.5% or greater than 96.5% shall be 100%. The maximum payment for all shoulders shall be 100%.

** In the event that the density of a LOT is less than 93.0% of G_{mm} , the Department will assess the pavement's permeability in accordance with FM 5-565. If the coefficient of permeability is less than or equal to 125×10^{-5} cm/s, the pavement will be accepted at 90% pay. If the coefficient of permeability is greater than 125×10^{-5} cm/s, the Engineer may require removal and replacement at no cost, or may accept the pavement at 90% pay. The Contractor may remove and replace at no cost to the Department at any time.

Table 334-16 Payment Schedule For Density (For Fine Mixes)	
Percent of Maximum Specific Gravity	Percent of Payment
92.0 and above	100
91.0 to less than 92.0	95
90.0 to less than 91.0	90
Less than 90.0 *	75

*If approved by the Engineer based on an engineering determination that the material is acceptable to remain in place, the Contractor may accept the indicated partial pay. Otherwise the Department will require removal and replacement at no cost. The Contractor may remove and replace at no cost to the Department at any time.

334-5.4.1.5 Additional Density Requirements:

1) If two consecutive LOTs are less than 93.5% of G_{mm} (for coarse mixes only), stop paving operations until appropriate corrective actions are made. Obtain the Engineer's approval prior to resuming production of the mix. Limit production to 1,000 tons [900 metric tons] until passing density values are obtained.

2) On shoulders with a width of 5 feet [1.5 m] or less, the Engineer will not require density. Compact the pavement in accordance with the rolling procedure (equipment and pattern) approved by the Engineer. Stop the production of the mix if the rolling procedure deviates from the approved procedure.

3) The maximum width of the mainline (non-shoulder) pavement to be placed (for coarse mixes only) during one pass of the paving train is 13 feet [4.1 m]. As an exception,

widths greater than 13 feet [4.1 m] will be permitted if the Contractor can demonstrate the ability to obtain density uniformly across the full width of the pavement.

334-5.4.2 Surface Tolerance: The asphalt mixture will be accepted on the roadway with respect to surface tolerance in accordance with the applicable requirements of 330-13.

334-5.5 Additional Tests: The Department reserves the right to run any test at any time for informational purposes and for determining the effectiveness of the Contractor's quality control.

334-5.5.1 Verification of Densification and Volumetric Properties: The Engineer will verify the densification properties of the mix during production with the Superpave Gyratory Compactor and will determine volumetric properties of the mix (air voids, VMA, VFA, and dust-to-effective asphalt binder ratio).

For coarse mixes, take appropriate corrective actions to maintain an air void content at N_{design} between 2.5 and 5.0% during production. When the air void content at N_{design} drops below 2.0 or exceeds 5.5% on any one test, or is less than 2.5% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved.

For fine mixes, take appropriate corrective actions in order to maintain an air void content at N_{design} between 3.0 and 5.0% during production. When the air void content at N_{design} drops below 2.5 or exceeds 6.5% on any one test, or is less than 3.0% on two consecutive tests, stop plant operations until the appropriate corrective actions are made and the problem is resolved.

When plant operations are stopped for coarse or fine mixes that have failing volumetric properties, obtain the Engineer's approval prior to resuming production of the mix. Limit production to 500 tons [450 metric tons] until passing volumetric properties are obtained.

334-5.5.2 Disposition of In-Place Material: Any material that is represented by the failing test results (less than 2.0% air voids at N_{design} for coarse mixes and less than 2.5% air voids at N_{design} for fine mixes) will be evaluated by the Engineer to determine if removal and replacement is necessary. Remove and replace any material, if required, at no cost to the Department.

334-6 Method of Measurement.

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons [metric tons].

The bid price for the asphalt mix will include the cost of the liquid asphalt or the asphalt recycling agent. There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. For the calculation of unit price adjustments of bituminous material specified in 9-2.1.1, the average asphalt content of Superpave mixes to be used in these calculations shall be set at 6.5%. The weight will be determined as provided in 320-2 (including the provisions for the automatic recordation system).

334-7 Basis of Payment:

Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

Payment shall be made under:

- | | |
|--------------------|--|
| Item No. 334- 1 - | Superpave Asphaltic Concrete - per ton. |
| Item No. 2334- 1 - | Superpave Asphaltic Concrete - per metric ton. |