ITEM 18303.0182 M - SUPERPAVE OPTIONAL FLEXIBLE SHOULDERS

The requirements of Section 303 - Optional Flexible Shoulder and Section 403 - Hot Mix Asphalt Concrete Pavement shall apply except as modified and/or revised below.

DESCRIPTION

This work shall consist of furnishing an placing flexible shoulders in reasonable close conformity with the required lines, grades, thicknesses, and typical sections shown on the plans or where directed by the Engineer. The Contractor shall have the option of selecting from five alternative flexible shoulder systems. This is a performance based specification in which the Contractor is responsible for compacting the shoulder within a specified density range. Written instructions for determining shoulder density are available from the Regional Materials Engineer or the Director, Materials Bureau.

MATERIALS

The materials which shall be used and individual component course thickness are specified in the table below for the five options:

MATERIAL	THICKNESS OF COURSES (millimeters)				
	OPTION 1	**OPTION 2**	**OPTION 3**	**OPTION 4**	**OPTION 5**
12.5 mm (9.5 mm if Indicated on Plans) SUPERPAVE Hot Mix Asphalt	25	25	25	75	-
Bituminous Stabilized Course §302-2 (opt A or C)	75	-	-	-	-
19.0 mm (25.0 mm if Indicated on Plans) SUPERPAVE Hot Mix Asphalt	-	-	50	-	75
37.5 mm SUPERPAVE Hot Mix Asphalt	-	75	-	-	-
Subbase Course §304-2	-	-	25	25	25

Table 1 - SUPERPAVE Flexible Shoulder Options

Where the adjacent pavement is asphalt concrete and the new overlay surface course is 40 mm thick, then the thickness of the surface course of the shoulder may be increased to 40 mm. When the surface course thickness is increased the course of Bituminous Stabilized Course (option 1), 37.5 mm SUPERPAVE Hot Mix Asphalt course (option 2), or the 19.0 mm SUPERPAVE Hot Mix Asphalt course (option 3) may be decreased by 15 mm.

Materials requirements and quality control methods pertaining to this work shall be as required under Sections 302, 304, and 401 in conformance with the procedures contained in appropriate Department publications in effect on the date of advertisement for bids.

The materials and composition for the SUPERPAVE Hot Mix Asphalt mixtures referenced shall meet the requirements specified in Subsection 403-2 Materials, except as noted herein. The specific Performance Graded Binder and the Design Estimated Traffic in 80 kN ESALs will be specified by a special note in the Contract Proposal.

Subsection 401-2.02 Composition of Mixtures shall be deleted and replaced with the following:

"Formulate and submit to the Regional Director, a *SUPERPAVE* Mix Design that satisfies the design control points and does not pass through the restricted zone listed in Table 2 based on the specified nominal maximum aggregate size.

If for any reason, a change in gradation or materials occurs or is contemplated, prepare a separate job mix formula and *SUPERPAVE* mixture design to fit each change in material or gradation. Changes in Performance Graded Binder content can be made by the Regional Director or his representative providing the resultant mixture has properties within the specified mechanical and volumetric properties.

The mixtures shall be produced, delivered to the work site, and incorporated into the work within 10_C of the temperature specified by the Engineer but within the mixing and compaction range of 120_C and 175_C. Additionally, the Performance Graded Binder shall be introduced into the pugmill at a temperature compatible with that of the aggregate as determined by the Regional Director or his representative, between the limits of 110_C and 175_C.

The aggregates shall be those approved for use by the approved job mix formula and will be accepted at the plant site. The Performance Graded Binder will be conditionally accepted at the supplier's source and at the plant on the basis of certification. Samples taken at the plant will be tested by the Department to determine specification compliance. The gradation of the plant mixed material will be tested to determine compliance with the job mix formula during the production of the material. The plant mixed material will be accepted after blending and mixing at the plant. The shoulder courses will be accepted after all paving operations are completed.

Standard Sieves, mm	**Percent Passing Criteria (*Control Points*)**									
	Nominal Maximum Aggregate Size									
	37.5 mm		**25.0 mm**		**19.0 mm**		**12.5 mm**		**9.5 mm**	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
50.0		100.0								
37.5	100.0	90.0		100.0						
25.0	90.0		100.0	90.0		100.0				
19.0			90.0		100.0	90.0		100.0		
12.5					90.0		100.0	90.0		100.0
9.5							90.0		100.0	90.0
4.75									90.0	
2.36	41.0	15.0	45.0	19.0	49.0	23.0	58.0	28.0	67.0	32.0
0.075	6.0	0.0	7.0	1.0	8.0	2.0	10.0	2.0	10.0	2.0

Table 2 - Design Control Points

Standard Sieves, mm	**Percent Passing Criteria (*Control Points*)**									
	Nominal Maximum Aggregate Size									
	37.5 mm		**25.0 mm**		**19.0 mm**		**12.5 mm**		**9.5 mm**	
	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4.75	34.7	34.7	39.5	39.5						
2.36	27.3	23.3	30.8	26.8	34.6	34.6	39.1	39.1	47.2	47.2
1.18	21.5	15.5	24.1	18.1	28.3	22.3	31.6	25.6	37.6	31.6
0.600	15.7	11.7	17.6	13.6	20.7	16.7	23.1	19.1	27.5	23.5
0.300	10.0	10.0	11.4	11.4	13.7	13.7	15.5	15.5	18.7	18.7

Table 3 - Restricted Zone

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The SUPERPAVE Hot Mix Asphalt mixtures shall meet the volumetric and mechanical properties detailed in Tables 4 and 4.1.

Design Property	Criteria
% Compaction at N_{init}	<89.0% of G_{mm}
% Compaction at N_{design}	=96.0% of G_{mm}
% Compaction at N_{max}	<98.0% of G_{mm}
Voids in the Mineral Aggregate	See Table 4.1
Voids Filled with Asphalt	See Table 4.1
Fines to Effective Asphalt Ratio	See Table 4.1

Table 4 - *SUPERPAVE* Design Criteria

Estimated Traffic, Million 80 kN ESALs	Voids in the Mineral Aggregate					Voids Filled with Binder		Fines to Effective Asphalt Ratio	
	9.5mm	12.5mm	19.0mm	25.0mm	37.5mm	Min	Max	Min	Max
	Minimum								
<0.3	15.0 %	14.0 %	13.0%	12.0%	11.0 %	70	80	0.6	1.2
<1.0						65	78		
<3.0						65	78		
<10.0						65	75		
<30.0						65	75		
<100.0						65	75		
>100.0						65	75		

Table 4.1 *SUPERPAVE* Volumetric Design Criteria

Voids in the Mineral Aggregate. The voids in the mineral aggregate are defined as the intergranular void space between the aggregate particles in a compacted paving mixture that includes the air voids and the effective binder content, expressed as a percent of total volume.

Voids Filled with Binder. The voids filled with binder are defined as the voids in the mineral aggregate that are filled with binder (excluding absorbed binder), expressed as a percent of the volume of the voids in the mineral aggregate.

Fines to Effective Asphalt Ratio. The Fines to Effective Asphalt Ratio is defined as the ratio of the percent by weight of aggregate passing the 75 _m sieve to the effective binder content expressed as percent by weight of the total mix.

The *SUPERPAVE* specimens shall be prepared, mix properties determined, and completed mix design submitted in accordance with the procedures outlined by Department written instructions. The Design Number of Gyrations shall be determined from Table 5 based on an estimation of the cumulative ESALs in the design lane over the design life.

Estimated Traffic, Million 80 kN ESALs	<0.3	<1.0	<3.0	<10.0	<30.0
$N_{initial}$	7	7	7	8	8
N_{design}	68	76	86	96	109
$N_{maximum}$	104	117	134	152	174

Table 5 - Design Number of Gyrations

Once the target gradation is selected the following production tolerances listed in Table 6 shall be applied for control of the mixture through the plant. The production tolerance range will be permitted to exceed the control points and enter the restricted zone.

Standard Sieves, mm	37.5	25.0	19.0	12.5	9.5	4.75	2.36	1.18	0.600	0.300	0.150	0.075
Tolerance	±5	±5	±5	±5	±5	±4	±4	±4	±3	±3	±3	±2

Table 6- Production Tolerances

The details of §401-2.03 Aggregates shall apply except as modified below:

In addition to the requirements detailed in §401-2.03 Aggregates, the aggregates utilized must conform to the following additional requirements based on the design traffic level and depth from the surface:

Estimated Traffic, Million 80 kN ESALs	Coarse Aggregate Angularity (Minimum)		Uncompacted Void Content of Fine Aggregate (Minimum)		Flat and Elongated Particles (Maximum)	Sand Equivalent (Minimum)
	Depth from Surface					
	<100mm	>100mm	<100mm	>100mm		
<0.3	55/-	-/-	-	-	-	40
<1.0	65/-	-/-	40	-	-	40
<3.0	75/-	50/-	40	40	10	40
<10.0	85/80	60/-	45	40	10	45
<30.0	95/90	80/75	45	40	10	45
<100.0	100/100	95/90	45	45	10	50
>100.0	100/100	100/100	45	45	10	50

Table 7 - Additional Aggregate Criteria

Coarse Aggregate Angularity. Coarse aggregate angularity is defined as the percent by weight of the aggregate particles larger than 4.75 mm with one or more fractured faces measured on the coarse particles of the blended aggregate by Pennsylvania Department of Transportation Test Method No. 621, Determining the Percentage of Crushed Fragments in Gravel. Note that "95/90" denotes that 95% of the coarse aggregate has one fractured face and 90% has two fractured faces. Note that the criteria is presented as the minimum percent of coarse aggregate with the required number of fractured faces.

Fine Aggregate Angularity. Fine aggregate angularity is defined as the percent of air voids present in loosely compacted aggregate that passes the 2.36 mm sieve measured on the fine aggregate portion of the blended aggregate by AASHTO Standard Method of Test TP33, Uncompacted Void Content of Fine Aggregate. Note that the criteria is presented as the minimum percent air voids required in loosely compacted fine aggregate.

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Flat and Elongated Particles. Flat and elongated particles are defined as the coarse aggregate particles which have a ratio of maximum to minimum dimensions greater than five (5). The percentage of flat and elongated particles is measured on the portion of the blended aggregate retained on the 9.5 mm sieve by ASTM Standard Method of Test D 4791-95, *Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate*. Note that the criteria is presented as the maximum percent allowed by weight of flat and elongated particles.

Sand Equivalent. Sand equivalent is defined as the percent of the sand reading to the clay reading measured on the portion of aggregate that passes the 4.75 mm sieve by AASHTO Standard Method of Test T 176, Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test. Note that the criteria is presented as the minimum percent sand equivalent required in the fine aggregate.

Subsection 401-2.05 Bituminous Materials shall be deleted and replaced with the following:

"The Performance Graded Binder (PGB) used in the production of these mixes shall be defined by AASHTO Provisional Standard MP1 - Standard Specification for Performance Graded Asphalt Binder.

Acceptance of the PGB is based on the primary source appearing on the Department's Approved List for Bituminous Material Primary Sources, A. Asphalt Cements for Paving. Acceptance of the PGB is contingent upon satisfactory test results from samples taken, as required by the Department's procedural directives, at the location where the material is incorporated into the work. A primary source is defined as a firm that samples, tests, and certifies by Production Lot that the PGB is in conformance with the specifications. The procedural directives for sampling, testing, and certifying the PGB, and for achieving and maintaining approved list status, are available from the Materials Bureau.

The PGB shall not be delivered to the HMA Production Facility at a temperature in excess of 175ºC."

Subsection 401-2.06 Reclaimed Asphalt Pavement shall be deleted.

CONSTRUCTION DETAILS

The details of §303-3 Construction Details shall be deleted and replaced with the following:

"The construction details shall be the same as those in Sections 302-3, 304-3, and 401-3 (except as modified below). Under options 3, 4, & 5, the Subbase Course materials shall be placed at the same time as the underlying Subbase Course. For option 5, vibratory compaction equipment appearing on the current "Approved List - Bituminous Concrete Vibratory Compaction Equipment" shall be required if the entire 75 mm lift of 19.0 mm SUPERPAVE Hot Mix Asphalt is to be placed as a single lift. For option 4, the 12.5 mm SUPERPAVE Hot Mix Asphalt shall be placed in two lifts."

The details of §401-3 Construction Details shall apply except as modified below:

Prior to paving operations for this item, construct a test section, as detailed in "Test Section" in this specification, on the project site at a location approved by the Engineer, using the same equipment and procedures to be used in the construction of the remainder of the course being laid. Routine paving operations may begin immediately following the construction of the test section once a Project Target Density (PTD) has been determined by the Engineer.

Add the following to the end of Subsection 401-3.02 Bituminous Mixing Plant A. Requirements for All Plants No. 11:

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"Y. Gyratory Compactor - A power driven gyratory compactor capable of maintaining an angle of gyration of 1.25º ± 0.02º, a speed of gyration of 30.0 rpm ±0.5 rpm, and a consolidation pressure of 600 k Pa ± 10% for gyrations zero to five and ± 3% for gyrations six and greater. The make and model of the gyratory compactor supplied must be approved by the Director, Materials Bureau.

Z. Gyratory Specimen Mold Assembly - The specimen mold assembly consisting of the mold 150.00 mm + 0.00 mm and - 0.01 mm, base plate and top plate (if required). The minimum height of the mold is 250.00 mm. A minimum of 4 mold assemblies and an adequate supply of 150.00 mm paper discs shall be provided.

AA. Gyratory Specimen Extractor - A simple means of specimen extraction from the gyratory molds shall be supplied.

BB. Oven - A thermostatically controlled convection type oven having a minimum capacity of 0.15 cubic meters shall be supplied to preheat the *SUPERPAVE* Gyratory Compactor mold assemblies and asphalt mix samples. The oven shall have a controlled temperature range up to 190ºC with a ± 3ºC accuracy throughout the range."

Add the following to the end of Subsection 401-3.06 Rollers.

"The compaction equipment shall conform to the requirements of this Subsection. Control the operation of the rollers during the placement of these items including the speed, the amplitude settings, the vibration frequency, and the weight of the rollers."

Subsection 401-3.12 Compaction shall be deleted and replaced with the following:

"Immediately after the hot mix asphalt (HMA) has been spread, struck off and surface irregularities adjusted, compact the mix by rolling thoroughly and uniformly. Roll the surface when the mixture is in the proper condition and when the rolling does not cause undue displacement, cracking or shoving. Initially roll the shoulder with the roller traveling parallel to the centerline of the pavement beginning at the low edge and working toward the super-elevated edge. The types of rollers used, the number of rollers used, and the number of roller passes made will be at your discretion.

Use a nuclear density gauge to monitor and record the shoulder density in accordance with this section and Materials Procedure 96-XX, "Pavement Density Monitoring with a Nuclear Gauge." The nuclear density gauge should consist of a radioactive source, scaler and other basic components housed in a single backscatter unit. The gauge must be operated by personnel trained in the principles of nuclear testing and safety practices. Only gauge(s) calibrated during the construction of the test section will be used during normal paving operation. If another nuclear gauge is to be used, a new test section must be constructed to calibrate that gauge and to establish a new PTD.

Compact the shoulder sufficiently to achieve a minimum density of 96% of the PTD in a single test location and 98% of the PTD calculated as a moving average of the last 10 test locations as determined by a nuclear density gauge. Take nuclear gauge readings at each site, randomly selected by the Engineer, approximately every 60 meters along the length of the shoulder for each pass of the paver and record them on a BR340M.

If the average of 4 nuclear density gauge measurements taken at 90º angles over two consecutive locations falls below 96% of the PTD or if the moving average of the last 10 nuclear gauge test sites falls below 98% of the PTD, stop routine paving operations and construct a new test section. Normal production will only resume after establishing a new PTD.

When the rolling operation is complete there should be no visible shallow ruts, ridges, other roller marks, or irregularities in the shoulder. If these imperfections are present, correct the imperfections or relay the shoulder to the satisfaction of the Engineer. Perform all corrective work at no additional cost to the Department.

Correct at once any displacement occurring as a result of reversing the direction of the roller, or from other causes, by the use of rakes and addition of fresh mixture as required. Exercise care in rolling not to displace the line and grade of the edges of the bituminous mixture. To prevent adhesion of the mixture to the drum(s) of the roller, properly moisten the drum(s) with water, or water mixed with small quantities of detergent or other Department approved asphalt release compounds. If a pneumatic tire roller is used, the pneumatic drive wheels may be coated with a fine mist spray of fuel oil or other similar materials to prevent pneumatic tire pickup. In all instances, protect the surface of the shoulder from drippings of fuel oil or any other solvents used in paving, compaction or cleaning operations.

Unless otherwise directed by the Engineer, compact the longitudinal joint by using one of the pneumatic drive wheels to overlap the joint in two (2) passes with the drum operating static where vibratory rollers having pneumatic drive wheels are used. If dual vibrating drum rollers are used compact the joint by overlapping the joints in two (2) passes with both drums operating static.

Along forms, curbs, headers, walls and other areas not accessible to the rollers, compact the mix thoroughly with mechanical tampers as directed by the Engineer. On depressed areas, a trench roller or small vibratory roller approved by the Engineer may be used. Cleated compression strips also may be used under the roller to transmit compression to the depressed area.

Remove any mixture that becomes loose and broken, mixed with dirt, or is in any way defective and replace with fresh hot mixture and compact to conform with the surrounding area. Correct any area showing an excess or deficiency of bituminous materials to the satisfaction of the Engineer.

If vibratory compaction equipment is used, the Contractor assumes full responsibility for the cost repairing all damage which may occur to highway components and adjacent property including buried utility and service facilities.

When multiple paving operations are utilized with material production from a single plant each paving operation will be evaluated separately.

Routine paving operations will not begin unless both a project calibrated nuclear density gauge and an operator are present."

Add the following to the end of §401-3:

"**Test Section**. Prior to paving operations for this item, construct a test section on the project site at a location approved by the Engineer, using the same equipment and procedures to be used in the construction of the remainder of the course being laid. The amount of mixture prepared according to the job mix formula should be sufficient to construct a test section 500 linear-meters long, the full width of shoulder, and shall be of the same depth specified for the construction of the course which it represents. Routine paving operations may begin immediately following the construction of the test section once a PTD has been determined by the Engineer based the evaluation of nuclear density readings. The test section is for determining the PTD for this item and for calibration of the nuclear density gauge.

Use the first 300 linear meters of the test section to stabilize the paving operation. The next 200 linear meters will be used to determine the PTD. Once a sufficient amount of material has been placed in the last 200 linear meters of the test section compact the shoulder with 2 machine passes of the breakdown

roller. Perform density readings at two sites, randomly selected by the Engineer in accordance with Materials Procedure 96-XX, "Pavement Density Monitoring with a Nuclear Gauge." A nuclear density reading at each location will be the average of the four measurements taken at 90°. Mark these sites so that subsequent density tests can be performed at the same locations. Make two additional machine passes using either the intermediate or finish roller. Perform additional density readings at the two previously selected sites. Continue rolling and density testing until the increase in density is less than 32.0 kg/m^3, or until the Engineer stops further compaction because the shoulder shows signs of distress.

The Engineer will immediately determine the average of the final density measurements at the two test locations. This average density will be the PTD. Once a PTD has been established routine paving operations may begin.

Only gauge(s) calibrated during the construction of the test section will be allowed to be used during normal paving operations."

METHOD OF MEASUREMENT

Subsection 303-4 Method of Measurement shall apply.

BASIS OF PAYMENT

Subsection 303-5 Basis of Payment shall apply.

Payment will be made under:

ITEM NO.	ITEM	PAY UNIT
18303.0182M	*SUPERPAVE* Optional Flexible Shoulder	Square Meters