

*DIVISION 4*  
*SURFACE COURSES AND PAVEMENTS*

**4.00 PLANT-MIXED BITUMINOUS BASE, LEVELING and TOP COURSES**

**4.00.01 Description**

Plant-Mixed Bituminous Pavement shall consist of a base, leveling and top courses composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared foundation in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the plans or as established by the Engineer.

**4.00.02 Materials**

In general, the Contractor will be permitted to substitute a higher numbered Marshall Stability bituminous mixture for the bituminous mixture specified, provided that the substitute mixture will provide similar serviceability characteristics, as determined by the Engineer.

The bituminous mixture used for bituminous approaches shall be the mixture specified for the top course of the main roadway.

Aggregate. Aggregates shall consist of crushed stone, crushed gravel, or crushed slag with or without sand or other inert finely divided mineral aggregate. The portion of materials retained on the No. 8 sieve shall be known as coarse aggregate, the portion passing the No. 8 sieve and retained on the No. 200 sieve shall be known as the fine aggregate, and the portion passing the No. 200 sieve shall be known as the mineral filler.

- (a) Aggregates for the Bituminous Mixture. Aggregates for the bituminous mixture shall consist of sound, tough, durable particles, free from adherent films of matter that would prevent thorough coating with the bituminous materials and shall conform to the requirements of Table 2. \*\*\*See Table 2 on page 4.00-3.\*\*\*

Slag shall be air-cooled blast furnace slag and shall have a compacted weight of not less than 75 pounds per cubic foot when tested in accordance with ASTM C29.

- (b) Natural Sand. Natural sand may be used to obtain the gradation of the aggregate blend or to improve the workability of the mix. The amount of sand to be added will be adjusted to produce mixtures conforming to the requirements of this specification.
- (c) Sampling and Testing. ASTM D75 shall be used in sampling coarse and fine aggregate, and ASTM C183 shall be used in sampling mineral filler. The Contractor shall furnish documentation to the Engineer confirming that the aggregates meet specification requirements.
- (d) Sources of Aggregates. Sources of aggregates shall be selected well in advance of the time the materials are required in the work. When the aggregates are obtained from a previously approved source or an existing source producing aggregates are obtained from a previously approved source or an existing source producing aggregates that have a satisfactory service record in bituminous pavement construction, samples may be submitted 10 days prior to the start of production. An inspection of the producer's operation will be made by the Engineer. Approval of the source of the aggregate does not relieve the Contractor in any way of the responsibility for delivery at the job site of aggregates that meet the requirements specified herein.

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**4.00.02    Materials (Cont'd.)**

- (e) Samples of Aggregates. Samples of aggregates shall be furnished by the Contractor at the start of production and at intervals during production of the bituminous mixtures. The sampling points and intervals will be designated by the Engineer.

Filler. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D242.

Bitumen. Bitumen shall conform to the requirements of Table 3 for the asphalt cement specified.  
\*\*\*See Table 3 on page 4.00-4.\*\*\*

The Contractor shall furnish vender's certified test reports for each tank load of bitumen shipped to the project. The report shall be delivered to the Engineer before permission is granted for use of the material.

**4.00.03    Composition**

Composition Of Mixture. The bituminous plant mix shall be composed of a mixture of aggregate, filler if required, and bituminous material. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements of the job mix formula.

Job Mix Formula. No bituminous mixture for pavement shall be produced until a job mix formula has been approved by the Engineer. The formula shall be submitted in writing by the Contractor to the Engineer at least 5 days prior to the start of paving operations and shall indicate the definite percentage of each sieve fraction of aggregate, the percentage of bitumen, and the temperature of the completed mixture when discharged from the mixture. All test data used to develop the job mix formula shall also be submitted. The job mix formula for each mixture shall be in effect until modified in writing by the Engineer.

The job mix formula shall be determined by a testing laboratory selected by the City. The furnishing of samples for all the necessary job mix formula tests and payment to the laboratory shall be the responsibility of the Contractor. The City may, at its option, allow the use of a job mix formula and materials which the Contractor, during the current year, has used with the approval of the Michigan Department of Transportation on MDOT projects.

Should a change in source of materials be made, a new job mix formula must be established before the new material is used.

The bituminous mixture shall be designed using procedures contained in Chapter III, MARSHALL METHOD OF MIX DESIGN, of the Asphalt Institute's Manual Series No. 2 (MS-2), current edition, and shall meet the requirements of Table 4. The temperature of the mix immediately prior to compaction shall be in accordance with Table B, "Minimum Laydown Temperatures".

The mineral aggregates shall be of such size that the percentage composition by weight, as determined by laboratory screens, will conform to the gradation or gradations specified in Table 4, "Master Gradation Range" when tested in accordance with ASTM Standard C136. The percentage by weight of the bituminous material shall be within the limits specified.

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**TABLE NO. 1  
MASTER MIX SPECIFICATION**

MIX #	MARSHALL STABILITY	BLOWS	FLOW	% VOID	AGGREGATE	ASPHALT CEMENT		% BITUMEN
						PEN.	VIS.	
1	1300	50	8-16	3-5	35AA (2)	85-100	AC-10	5-7
2	1300	50	8-16	3-5	20AAA (2)	85-100	AC-10	5-7
3	1300	50	8-20	3-8	20AAA	85-100	AC-10	(3)
4	1100	50	8-18	3-5	35AA (2)	120-150	AC-5	5-7
5	1100	50	8-18	3-5	20AA (2)	120-150	AC-5	5-7
6	1100	50	8-20	3-8	20AA	120-150	AC-5	(3)
7	900	25(1)	8-20	3-5	20A (2)	200-250	AC-25	5-8
8	900	25(1)	8-20	3-8	20A	200-250	AC-25	(3)
9	500	25	8-20	3-8	20C	85-100	AC-10	4-5

- (1) If 50 blows mixture is accepted, add 3.0% to asphalt content.
- (2) Aggregates produced from limestone quarries shall not be permitted for top course unless said aggregate is certified as having an Aggregate Wear Index (AWI) of 290 or greater.
- (3) For Mixtures No. 3, 6, and 8 the bitumen content will be designed to have up to 0.5 percent less bitumen than the optimum specified for the corresponding top course Mixtures Nos. 2, 5 and 7.

**TABLE NO. 2**

**GRADING AND PHYSICAL REQUIREMENTS FOR AGGREGATES**

MICH. SERIES	CLASS	GRAVEL and STONE (1)		SIEVE ANALYSIS (a) (ASTM C-136) TOTAL PERCENT PASSING								PERCENT LOSS BY WASHING (a) (ASTM C-117)
		CRUSHED MAT'L. min (2) (3)	LOSS max, LOS ANGELES ABRASION (AASHTO T96)	1½" 37.5 mm	1" 25 mm	¾" 19 mm	½" 12.5 mm	3/8" 9.5 mm	No. 4 4.75 mm	No.8 2.36 mm	No. 30 0.60 mm	
20	AAA	60	40	-	-	100	95-100	65-90	55-75	45-65	20-40	0-7
20	AA	40	40	-	-	100	85-100	65-90	-	45-65	20-40	0-7
20	A	25	40	-	-	100	-	65-85	-	40-60	20-35	0-7
20	C	-	50	100	80-100	-	-	55-85	-	30-60	15-40	0-10
35	AA	60	40	-	-	-	100	92-100	65-90	55-65	20-40	0-7

- (a) Based on dry weights. The limits of Loss by Washing of dense-graded aggregates are significant to the nearest whole percent.
  - (1) All values in percent.
  - (2) Determined by dividing the weight of the particles picked by the weight of that portion of the sample from which they were selected.
  - (3) The percentage of crushed material will be determined on that portion of the sample retained on all sieves down to and including the No. 4 sieve for Aggregate Series 20 and 35.

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**TABLE 3**

**PENETRATION-GRADED and VISCOSITY-GRADED ASPHALT CEMENTS**

<b>TESTS</b>	<b>Asphalt Designations (Viscosity Graded in Parentheses)</b>		
	<b>85-100 (AC-10)</b>	<b>120-150 (AC-5)</b>	<b>200-250 (AC-2.5)</b>
Specific Gravity, 25/25c, min. ASTM D 70	1.00	0.996	0.993
*Viscosity, 60 C, P, ASTM D 2171	800-1200	400-600	200-300
Viscosity, 135 C, cST, min, ASTM D 2170	220	165	120
Flash Point, Cleveland Open Cup, C, min ASTM D 92	232.2	218.3	204.4
Ductility, 25 C, cm, min, ASTM D 113	100	100	100**
Solubility in Trichlorethylene, %, min, ASTM D 2042	99.5	99.5	99.5
Spot test using 35% Xylene/65% Heptane Solvent, Anline No: 30 C ? 2 degrees. AASHTO T 102	Neg.	Neg.	Neg.
Loss on Heating, % max, ASTM D 6	1.0	1.3	1.5
Penetration of Residue, % of original, min, ASTM D5	50	46	40
Ductility of Residue, 25 C, 5 cm/min, cm, min, ASTM D 113	75	100	100**
*Viscosity, 60 C, P, Max, ASTM D 2171	4000	2000	1000
Penetration-Graded Asphalt Cement	85-100	120-150	200-250
Viscosity-Graded Asphalt Cement	75-100	120-175	175-275

\* Viscosity-Graded Asphalts only.

\*\* If less than 100 at 25 C but more than 100 at 15.6, the material will be acceptable for ductility.

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**4.00.03 Composition (Cont'd.)**

The gradations in Table 4 represent the limits which shall determine the suitability of aggregates for use from the sources of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 4 and shall not vary from the low limit of one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

**TABLE 4**  
**MASTER GRADATION RANGE**

MIX NO.	Total Percent Passing Designated Sieve for Applicable Bituminous Mixture (1)					
	1	2 & 3	4	5 & 6	7 & 8	9
<b>SIEVE SIZES</b>	1300 (35 AA)	1300 (20 AAA)	1100 (35 AA)	1100 (20 AA)	900 (20 A)	500 (20 C)
1 ½"	-	-	-	-	-	100
1"	-	-	-	-	-	80-100
¾"	-	100	-	100	100	-
½"	100	90-100	-	90-100	-	-
3/8"	92-100	65-95	100	65-95	60-90	55-90
No. 4	65-90	55-75	65-90	-	-	-
No. 8	55-71*	45-70	45-70	45-70	40-65	30-65
No. 30	25-45	20-45	20-45	20-45	20-40	15-45
No. 200	4-9	3-10	4-9	3-10	3-10	3-12
% Bitumen in Mixture (2)	5-9	5-7**	5-9	5-7**	5-8**	3-6**

(1) Composition limits are shown in percent by weight, based on the total aggregate, including mineral filler, in the mixture.

(2) The percent of bitumen in the mixture shown in Table 4, is a range and the actual bitumen content in the production mixture shall be as determined by the Job-Mix-Formula.

\* 63% is Optimum Desired.

\*\* For Mixtures Nos. 3, 6, and 8 the bitumen content will be designed to have up to 0.5 percent less bitumen than the optimum specified for the top course. Mixture No. 9 will be designed to have 4.5 percent bitumen content unless indicated on the plans or in the proposal. Exceptions will be made when highly absorbent aggregates are used or when a base course or leveling course mixture is to be left open to carry traffic over the winter.

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Uniformity Tolerances.

**TABLE A**

**UNIFORMITY TOLERANCES**

Passing US Sieve No.	Percentage Deviation from Job Mix Formula	
	Surface Course	Leveling Course
1 ½ in. and larger	? 8%	? 10%
3/8 in.	? 7%	? 8%
No. 8	? 6%	? 7%
No. 30	? 5%	? 6%
No. 200	? 3%	? 5%
Asphalt Cement #1,2	? .4%	? .5%

- 1) Minimum Asphalt Content for Surfaces Courses – 5.5%
- 2) Asphalt Content for Leveling Course may be 0.5% (Maximum less than Surface Course)

The job mixture tolerances shown in Table A shall be applied to the job mix formula to establish a job control grading band. The full tolerance still will apply if application of the job mix tolerances results in a job control grading band outside the master grading band.

The aggregate gradation may be adjusted within the limits of Table A as directed, without adjustments in contract unit prices.

Deviation from the final approved design for bitumen content and gradation of aggregates shall not be greater than the tolerances permitted and shall be based on daily plant extraction.

The Contractor shall perform, or cause to be performed, two extraction tests early in each production day to determine bitumen content in accordance with ASTM D2162 and aggregate gradation in accordance with ASTM C-136.

In the taking of samples for the extraction test, the Contractor shall save “splits” and make them available to the Engineer for Independent Assurance Testing.

The Contractor or his testing agent, shall make the results of any extraction test available to the Engineer as soon as they are produced and shall, in the case of any test falling outside the tolerance levels of Table A or Table 4, notify the Engineering Department immediately of the failure of said test while at the same time making corrections to the plant operation to bring the product back into specification. Following correction of the process the Contractor shall cause another extraction test to be taken.

The engineer may halt production if the criteria of Table A are not met and not allow it to resume until the problem is corrected. Payment for placed material deviating from the requirements of Table A but within the Master Gradation Range will be decreased 25 percent. Material outside the tolerances of Table A and outside the Master Gradation Range will be decreased 75 percent.

Testing Laboratory. The testing laboratory used to develop the job mix formula and to perform the tests required by this specification shall meet the requirements of ASTM D3555. A certification that the laboratory meets the requirements shall be submitted to the Engineer upon request.

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**4.00     PLANT-MIXED BITUMINOUS BASE, LEVELING and TOP COURSES (Cont'd.)**

**4.00.04   Equipment**

Equipment Requirements. The following equipment will be required unless otherwise specified:

- (a) Flasher Lights For Bituminous Construction Equipment. On bituminous construction where traffic is being maintained, distributors and rollers shall be equipped with at least one approved flashing, rotating, or oscillating amber light and pavers shall be equipped with at least one such light on each side of the paver. The lights shall be mounted so that the warning signal will be visible to traffic in both directions. The lights shall be in operation all the while the work is in progress and as otherwise directed by the Engineer.
  
- (b) Cold-Milling Machines. Cold-milling machines shall have continuously variable depth control adjustments. The machine shall be of a type designed specifically for reduction in size of pavement material, in place, and be capable of reducing the pavement material to a maximum size of two inches. The cutting drums shall be enclosed and shall have a sprinkling system around the reduction chamber for pollution control.

The equipment for removing the bituminous surface shall be capable of accurately removing the bituminous surface in one or more passes, to the grade and cross section shown on the plans or directed by the Engineer.

- (c) Hauling Equipment. Trucks used in hauling bituminous mixtures shall have tight, clean, smooth beds which have been thinly coated with lime solution, or other approved release agent, to prevent the mixture from adhering to the beds. Each truck shall have an adequately secured cover of such size and material as to completely protect the mixture from weather and to retard the escape of heat from the mixture.

Hauling units used to haul bituminous mixtures when the air temperature is below 50°F shall be insulated. The insulation shall be continuous along the bottom and four sidewalls.

Hauling units creating a hazard on the project, or adversely affecting the quality of the work, as determined by the Engineer, shall be removed from the project.

- (d) Pressure Distributor. The distributor shall be mounted upon a vehicle which is capable of maintaining uniform speeds required for proper application of the bituminous material. The vehicle shall be equipped with an accurate tachometer which is calibrated to indicate speed in feet per minute.

The pressure distributor shall have a capacity of at least 800 gallons. It shall be equipped with heating facilities capable of maintaining the bituminous material at the specified temperature. A positive displacement type pump, installed so as to permit circulation of the material in the tank and the spray bar, shall be provided. The pump power shall be independent of the vehicle power or the pump shall be operated by a power take-off from the vehicle motor in such a manner that uniform distribution of the bituminous material, at the rate specified, will be obtained. The distributor shall be equipped with a tachometer calibrated in revolutions per minute. Full circulating spray bars shall be available for application widths of 3 to 24 feet in one-foot increments.

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**4.00.04 Equipment (Cont'd.)**

(d) Pressure Distributor. (Cont'd.)

The nozzles shall produce a uniform fan spray, and the shutoff shall be instantaneous, with no dripping. Nozzles in various sizes between 1/8 and 1/4 inch, inclusive, shall be available, and the size used shall meet the approval of the Engineer.

The spray bar shall be set at the proper height to provide a uniform application at the specified coverage rate.

- (e) Pavers. The paver shall be an approved self-powered machine capable of spreading and finishing the bituminous mixture in a uniform layer at the desired thickness and cross section and ready for compaction. The use of any machine in poor mechanical or worn condition will not be permitted. The paver shall be of such design that the supporting wheels, treads and other devices ride on the prepared base. The full width of the bituminous mixture being applied shall be screeded by an oscillating or vibrating screed. The paver shall at all times produce a uniformly finished surface, free from tearing or other blemishes that would require hand work. The screed shall be adjustable to provide for tilting to secure the proper drag or compressive action necessary to produce the desired surface texture.

The paver shall be equipped with a hopper and an automatic material-depth control device so that each distributing auger and corresponding feeder shall respond automatically to provide for a constant level of mix ahead of the screed unit to the full width being paved. In order to ensure that adequate material shall be fed to the center of the paver, reverse pitch augers or paddles shall be installed at the inside of one or both ends of the auger shafts to force the mix to the center of the paver. If necessary to prevent segregation of the mix as it drops off the feed conveyer, baffle plates shall be installed at the required location.

When extensions are added to the paver, they shall be provided with the same vibrating screed or tamper action as the main unit of the paver, except for paving variable width areas. The extensions shall also be equipped with a continuation of the automatically controlled spreading augers. The screed and any extensions shall be provided with an approved method of heat distribution.

Bituminous pavers shall be equipped with an automatically controlled and activated screed and strikeoff assembly capable of grade reference and transverse slope control. A manufacturer-approved grade referencing attachment, not less than 30 feet in length, shall be used for all lower courses and the first pass of the top course. After the first pass of the top course has been placed, a 10-foot, or longer, grade referencing attachment may be substituted for constructing subsequent adjacent passes of the top course.

When paving ramps or shoulders, or when the grade of a concrete gutter or other existing installation must be met, the manner of use of the automatic grade reference and slope control devices shall be determined by the Engineer. Whenever a breakdown or malfunction of the automatic control occurs, the equipment may be operated manually for the remainder of the normal working day, provided this method operation will produce results meeting the specification requirements.



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**4.00.04 Equipment (Cont'd.)**

(f) Rollers. The size, type and number of rollers required will depend on the method of paving, the rate of production of mixture and the bituminous course being placed.

- (1) Steel-Wheel Rollers. Steel-wheel rollers shall weigh at least 8 tons, unless otherwise directed by the Engineer and shall be self-propelled, vibratory or static, tandem roller. Steel-wheel rollers shall be free from back lash, faulty steering mechanisms, or worn king bolts. The steering device shall respond readily and permit the roller to be directed on the alignment desired. Rollers shall be equipped with wheel sprinklers and scrapers. Roller wheels shall be smooth and free from openings or projections which will mar the surface of the pavement.

Vibratory rollers shall have a shutoff to deactivate the vibrators when the roller speed is less than 0.5 mph and shall have provisions to lock in the Manufacturer's recommended speed, the vibrations per minute, and the amplitude of vibration (dynamic force) for the type of bituminous mixture being compacted.

- (2) Pneumatic-Tired Rollers. The pneumatic-tires rollers shall be of the self-propelled type with a total weight, including ballast, not greater than 30 tons. It shall be equipped with a minimum of 7 wheels situated on the axles in such a way that the rear group of tires will not follow in the tracks of the forward group, but will be so spaced that a minimum tire overlap of 1/2 inch is obtained. The tires shall be smooth and shall be capable of being inflated to a pressure necessary to provide ground-contact pressures of at least 80 pounds per square inch. The tire pressures shall not vary by more than 5 pounds per square inch between individual tires. The Contractor shall furnish a tire gauge which shall be available at all times to enable the Engineer to check tire pressures. The Contractor shall furnish the Engineer charts or tabulations showing the contact areas and the contact pressures for the full range of tire inflation pressures and tire loadings for the type and size of roller used. The roller shall be equipped with a mechanism capable of reversing the motion of the roller smoothly. The roller shall be equipped with wheel sprinklers and scrapers or mats.

- (g) Miscellaneous Equipment -- Straightedges (12 foot minimum) for testing the pavement and all other small tools to completely and satisfactorily finish the work shall be provided by the Contractor.

**4.00.05 Construction Methods**

Preparation Of Subgrade course mixtures required to be placed directly on the subgrade, the density, grade and cross section shall conform to the requirements shown on the plans and meet the approval of the Engineer at the time of placement of any mixture.

Preparation Of Subbase. The subbase shall be constructed to the density, grade and cross section as shown on the plans and shall meet the approval of the Engineer prior to the placement of the bituminous mixture.

Preparation Of Aggregate Base.

- (a) For Bituminous Pavements. The aggregate base shall be prepared as described in the specifications and shall meet the approval of the Engineer prior to the placement of the bituminous mixture. Surfaces that have become too wet or too dry shall be reworked to provide the required density.

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**4.00.05 Construction Methods (Cont'd.)**

- (b) For Bituminous Shoulders. The aggregate base shall be shaped and compacted in accordance with the specifications and to the elevation and cross section shown on the plans or in the proposal.

Preparation Of Existing Pavement. Catch basin and manhole covers, monument boxes and water shutoffs shall be adjusted as shown on the plans or as directed by the Engineer.

- (a) Cleaning Existing Pavement. Before placing the bituminous mixture, the surface of the existing pavement and paved shoulders, if applicable, and the joints and cracks shall be thoroughly cleaned of all dirt and debris. No separate payment will be made for Cleaning Existing Pavement.
- (b) Chipping Concrete Pavement for Joints. When a butt joint is specified, the existing concrete surface shall be tapered back for at least 10 feet to a depth of at least 1 1/2 inches, for the full width of the joint.
- (c) Edge Trimming. Where the removal of bituminous shoulder material is required, the bituminous material shall first be cut with a coultter wheel, or saw, along the pavement edge to prevent the tearing of the pavement surface. Pavement for Edge Trimming when specified shall be by the lineal foot.
- (d) Cold-Milling Bituminous Surfaces. The bituminous surface shall be removed to the depth, width, grade and cross section as shown on the plans or as directed by the Engineer.

Where material is removed below the grade specified due to poor cold-milling practices, the resultant holes or depressions shall be backfilled and compacting by hand patching in accordance with these specifications. Such work shall be at the expense of the Contractor.

The material which is picked up by sweeping after cold-milling shall not be incorporated in the bituminous mixture.

The material removed from the pavement and its disposal is the responsibility of the Contractor.

- (e) Removing Bituminous Surface. Removing Bituminous Surface applies to:
- (1) removing a bituminous surface, regardless of thickness or width, overlying a base course that has to remain in place and
  - (2) constructing butt joints.

When removing a bituminous surface overlying a base course that is to remain in place, the edges of the area of bituminous surfacing to be removed shall be cut along straight lines for the full depth of the bituminous surface.

When constructing butt joints, the pavement shall be cut to a minimum depth of two inches and tapered back as directed by the Engineer. If the bituminous pavement to be removed in an existing overlay over a concrete pavement it may be necessary to remove the total depth of the bituminous surface and expose the underlying concrete pavement. Payment for Removing Bituminous Surface shall be in square yards and includes furnishing and using equipment for cutting straight lines.

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**4.00.05 Construction Methods (Cont'd.)**

- (f) Removing Bituminous Patches. Existing bituminous patches with a high bitumen content which may cause bleeding or instability, as determined by the Engineer, shall be removed.
- (g) Repairing Pavement Joints and Cracks. This work shall consist of repairing joints and cracks in accordance with the applicable details shown on the plans.

Repairing Pavement Joints and Cracks, of the detail specified, will be measured by length in linear feet of joints and cracks repaired. The bituminous material used to fill the joints, after removal of the objectionable material, will be measured.

- (h) Pavement Cut. Pavement cut shall consist of removing selected areas of existing bituminous surface and the underlying base, as directed by the Engineer, to a depth of 6 inches, and disposing of the material removed. The excavated area shall then be filled with bituminous base material in accordance with the requirements of hand patching.
- (i) Hand Patching. This work consists of placing Hand Patching at locations shown on the plans and as directed by the Engineer. The Hand Patching shall be placed in layers not to exceed 4 inches in depth. The Hand Patching material shall be Bituminous Mixture No. 8 or 9, or as otherwise approved by the Engineer. The patches shall be compacted to the required grade by use of a machine vibrator, air operated tamper or an approved roller.

Bond Coat. The bond coat shall be applied to each layer of bituminous mixture and to the vertical edge of the adjacent pavement or curb and gutter before the succeeding layer is placed. The rate of application shall be as specified by the Engineer; this rate will be between 0 and 0.10 gallons per square yard on the bituminous or concrete foundation and between 0 and 0.05 gallons per square yard between subsequent courses. The bond coat material shall be applied ahead of the paving operation for a distance of at least 500 feet, depending on traffic conditions, as determined by the Engineer. The surfacing shall not be placed until the bond coat has cured. No separate payment will be made for applying bond coat.

Transportation of Mixtures. Release agents shall be applied to the hauling units with atomizing spray equipment. Excessive use of release agents will be cause for rejection of the load. All loads shall be sent out in time to allow placing and compacting the mixtures in daylight, unless approval has been granted to perform night work under adequate artificial light.

All loads shall be covered.

The surface of the bituminous mixture, as delivered to the paver, shall not be crusted.

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**4.00.05 Construction Methods (Cont'd.)**

The temperature of the mixture as discharged from the hauling unit should be at the target temperature specified by the Engineer. A tolerance of  $\pm 20^{\circ}\text{F}$  from the specified target temperature is allowed for acceptable mixtures. Occasional loads slightly outside the  $\pm 20^{\circ}\text{F}$  limits may be permitted, provided that adjustments are being made to bring the temperature of the mixture back to the specified target temperature for placement. Any load having a temperature below  $250^{\circ}\text{F}$  or above  $350^{\circ}\text{F}$  at time of discharge from the hauling unit will be rejected.

Seasonal Limits. Seasonal limits for placing bituminous mixtures shall be from May 10 to November 10, unless otherwise authorized by the Engineer.

Laydown Temperatures. Laydown temperatures shall be in accordance with Table B:

<b>TABLE B</b>						
<b>MINIMUM LAYDOWN TEMPERATURES and AVAILABLE ROLLING TIMES for VARIOUS MAT THICKNESSES AND BASE TEMPERATURES</b>						
Base Temp. (?F)	½"	¾"	1"	1 ½"	2"	3" and Greater
20-32						285
32-40				305	295	280
40-50			310	300	285	275
50-60		310	300	295	280	270
60-70	310	300	295	285	275	265
70-80	300	290	285	280	270	265
80-90	290	280	275	270	265	260
90+	280	275	270	265	260	255
Rolling Time, min.	4	6	8	12	15	15

Increase by  $15^{\circ}\text{F}$  when placement is on base or subbase containing frozen moisture.

Placing Bituminous Mixtures. Pavers will be required to have an automatically controlled and activated screed and strikeoff assembly except when placing mixtures for: (1) variable width sections, (2) the first course of a base course mixture on a subgrade or on a sand subbase, (3) base course mixtures for shoulders and widening less than 10.5 feet in width, or (4) top and leveling course mixtures for shoulders and widening less than 8 feet in width.

When necessary to take out irregularities in the existing road surface, wedging with bituminous mixture shall be done by placing several layers with the paver, or as directed by the Engineer. Any corrections made to the foundation by wedging with bituminous material shall be placed, compacted and allowed to cool prior to placing base, leveling, or top course mixtures.

- (a) Placing Bituminous Base Course Mixtures. Bituminous base course mixtures shall not be placed in lifts exceeding 4 inches, unless otherwise approved by the Engineer. Approval to place lifts in excess of 4 inches will be based on the ability of the Contractor to place and compact the base course to the required density, cross section, and within the specified tolerances.

*DIVISION 4*  
*SURFACE COURSES AND PAVEMENTS*

**4.00 PLANT-MIXED BITUMINOUS BASE, LEVELING and TOP COURSES (Cont'd.)**

**4.00.05 Construction Methods (Cont'd.)**

- (b) Placing Bituminous Leveling and Top Course Mixtures. When the application rate for a bituminous pavement exceeds 220 pounds per square yard, the pavement shall be constructed in two or more courses unless otherwise specified on the plans or in the proposal.

The bituminous mixture shall be placed by an approved self-propelled mechanical paver to such a depth that when compacted, it will have the thickness specified or directed by the Engineer.

When placing the bituminous top course, or the top 2 courses of a multi-level pavement, on the traveled portion of the roadway, the paving operation shall be conducted in a combination of widths which will cause longitudinal joint lines to coincide with the proposed painted lane lines. Connections with existing surfaces at the beginning and ending of resurfacing sections and at intersections shall be made by the use of butt joints.

The work shall be planned such that at the completion of each day's paving operations, all lanes will have been resurfaced within one load of the same point-of-ending.

When placing the bituminous mixture in a lane adjoining a previously placed lane, the mixture shall be placed such that it uniformly overlaps the first lane by 2 to 4 inches and is placed at a height above the cold mat equal to the breakdown roller depression on the hot mat. The overlapping material shall be bumped, using a lute or other device accomplishing similar results, back onto the hot lane so that the roller will compress the small amount of excess material into the hot side of the joint. If the overlap is excessive, the excess material shall be trimmed so as to leave an edge having a uniform thickness; the excess material shall be discarded, it shall not be spread across the surface course.

If the lanes are being constructed with 2 or more pavers in echelon, the loose depths of bituminous material from each paver shall match at the longitudinal joints.

- (c) Placing Bituminous Shoulders. The bituminous material shall be placed by the self-propelled mechanical paver or spreader to a depth that when compacted, the mixture will have the thickness, width, and slope specified or as directed by the Engineer.

The shoulders may be placed in the same pass with the adjacent pavement lane or may be paved separately. When paved in the same pass with the adjacent pavement lane, a vibratory screed is required. Shoulders placed separately from the pavement and in thicknesses of 250 pounds per square yard, or less, may be placed in one course.

The bituminous base shall be placed to the slope specified and such that the top of the completed base course is within a tolerance of  $\pm 1$  inch of the specified width, without segregation.

When placing the top course on shoulders 8 feet in width or greater, the material shall be placed using a paver having an automatically controlled and activated screed and strike-off assembly and corresponding grade referencing equipment. The use of the grade referencing equipment shall be as directed by the Engineer.

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*SURFACE COURSES AND PAVEMENTS*

**4.00 PLANT-MIXED BITUMINOUS BASE, LEVELING and TOP COURSES (Cont'd.)**

**4.00.05 Construction Methods (Cont'd.)**

Rolling. Each layer of bituminous mixture shall be compacted to the required density.

The final rolling operation on each layer of bituminous mixture placed shall be accomplished by use of tandem steel-wheel rollers; vibratory rollers shall be operated in the static mode when used for finish rolling or pinching the joint.

Pneumatic-tire rollers shall be used only if approved by the Engineer and will not be permitted on top courses.

Steel roller wheels shall be kept properly moistened with water but usage of an excess is prohibited. Pneumatic-tire rollers shall be wiped down, off the paved surface, with fuel oil prior to rolling.

Rolling of the mixture shall begin as soon after placing as it will bear the roller without undue displacement, picking up the mat, or cracking. Rolling shall start longitudinally at the extreme sides of the lanes and proceed toward the center of the pavement, overlapping on successive trips by at least half the width of the drive wheel of the roller. Alternate passes of the roller shall be of slightly different length. The maximum roller speed shall not exceed the manufacturer's recommended speed for the type of mixture or thickness of layer being placed.

When compacting an adjoining lane, the longitudinal joint shall be rolled first with the roller supported mainly on the cold lane with only 3 to 6 inches of the roller extending onto the freshly placed bituminous material.

Finish rolling shall continue until all roller marks are eliminated.

Pneumatic-tire rolling of longitudinal joints shall overlap the hot joint. Pneumatic-tired rollers shall be operated in a competent manner and shall not mark or rut the surface or displace the pavement edges. The pneumatic-tired roller shall be ballasted to obtain the required ground-contact pressures as directed by the Engineer. In order to obtain a uniformly textured mat and the desired pavement density, the Engineer may direct the Contractor to raise or lower tire pressures at any time during the rolling operations. The roller operations shall be conducted in such a manner as to prevent scuffing or chatter marks in the pavement surface. The number of passes made by the pneumatic-tired roller shall not be less than two road trip passes over each area.

Where there is a break in the transverse slope, the Contractor shall use a roller of a weight and width such that the required density in the feathered portion of the paving may be achieved. In all places not accessible to the roller, the hot mixture shall be compacted by hand-tampers. Skin patching on an area that has been rolled will not be permitted. Any mixture that becomes mixed with foreign material or is in any way defective shall be removed, replaced with fresh mixture and compacted to the density of the surrounding area.

When the placement rate exceeds 800 square yards per hour, a separate finish roller shall be used in addition to the roller(s) used in establishing the rolling procedure. Roller speeds shall not exceed those established by the rolling pattern.

**DIVISION 4  
SURFACE COURSES AND PAVEMENTS**

**4.00 PLANT-MIXED BITUMINOUS BASE, LEVELING and TOP COURSES (Cont'd.)**

**4.00.05 Construction Methods (Cont'd.)**

Rolling shall proceed continuously until the required compaction is attained. The amount of rolling required will be based on using a specified minimum number of rollers in accordance with Table C.

<b>TABLE C</b>		
Average Laydown Rate, Square yards per hour	Number of Rollers Required	
	Compaction Rollers	Finish Rollers
Less than 800	1	1*
800-1800	1	1
1800-4000	2	1
4000-7200	3	1

\*The compaction roller may be used as the finish roller also.

**COMPACTION OF BITUMINOUS MIXTURES.** The Engineer may determine, by use of a modified Marshall Test, the control density for the bituminous mixture to be placed.

During the Contractor's start-up operations, a rolling procedure will be established. The rolling procedure will be based on the number and type of rollers used and the rolling pattern. The goal of the rolling procedure will be to attain 100 percent of the control density. In no case shall the densities attained on any course be less than 95 percent of the control density.

Once the rolling procedure has been established on the start-up section, the procedure shall be used for the remainder of the mixture to be placed, unless subsequent tests indicate a need to change the number of rollers or the rolling pattern.

If difficulties are encountered or if there is a significant change in aggregate or bitumen content, the Engineer will determine the control density for the new mixture and require the Contractor to again establish the number and type of rollers and the rolling pattern required on the new mixture to attain the control density. The compactive procedures thus determined shall be used when placing the remainder of the mixture.

Density checks will be made at the discretion of the Engineer to determine if the compactive procedure being used is achieving the required density, or if a change in procedure is necessary. Density values less than 97 percent of the control density will be caused for the Engineer to require an adjustment in the rolling procedure.

**Smoothness Requirements.** After final rolling, the surface will be tested longitudinally by the Engineer using a 12 foot straightedge at selected locations. The variation of the surface from the testing edge of the straightedge between any two contacts with the surface shall at no point exceed the following limits:

*For Bituminous Base Course Mixtures:*

Lower Courses: 3/4 inch

Top Course: 3/8 inch

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**4.00 PLANT-MIXED BITUMINOUS BASE, LEVELING and TOP COURSES (Cont'd.)**

**4.00.05 Construction Methods (Cont'd.)**

*For Leveling and Top Course Mixtures:*

Multiple Course Construction:

1/8 inch for Top Course

1/4 inch for Lower Course

Single Course Construction: 1/4 inch

Variations in excess of the specified tolerance shall be corrected as directed by the Engineer.

Aggregate Shoulders. On resurfacing projects, the existing aggregate shoulder surfaces shall be scarified prior to placing new aggregate material. The placement of shoulder aggregates shall precede placing the top course of bituminous mixture. Final shaping and compaction of the shoulders shall follow the placement of the top course of bituminous mixture. On multiple course resurfacing projects, the shoulder aggregate shall be maintained flush with the bituminous courses as placed.

The shoulder shall be maintained as a satisfactory surface for vehicles to travel on while passing the construction equipment. If the area between pavement edges and right-of-way lines is disturbed by the Contractor's operations or by traffic, it shall be restored to a condition satisfactory to the Engineer at the Contractor's expense.

Weighing Loads. Each load of bituminous mixture accepted by the City shall be weighed, under the jurisdiction of the Engineer, to the nearest 20 pounds on an approved scale having an automatic print-out system.

**4.00.06 Method of Measurement**

Bituminous Base Course, Bituminous Leveling Course, and Bituminous Top Course will be measured by weight in tons. The tonnage shall be the weight of the material of the specified gradation used in the accepted pavement.

**4.00.07 Basis of Payment**

Payment shall be made at the respective contract unit prices per ton for base course, leveling course and top course. These prices shall be full compensation for furnishing all materials; for all preparation, mixing and placing of these materials; and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under:

1. Bituminous Base Course.....	Ton
2. Bituminous Leveling Course.....	Ton
3. Bituminous Top Course.....	Ton
4. Chipping Concrete Pavement for Joints.....	Square Yard
5. Edge Trimming.....	Lineal Foot
6. Cold-Milling Bituminous Surfaces.....	Square Yard
7. Removing Bituminous Surface.....	Square Yard
8. Removing Bituminous Patches.....	Square Yard
9. Repairing Pavement Joints and Cracks.....	Lineal Foot
10. Pavement Cut.....	Square Yard
11. Hand Patching.....	Ton



*DIVISION 4*  
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**4.06     BITUMINOUS SEAL COATS**

**4.06.01   Description**

This work shall consist of one or more applications of bituminous material applied to the prepared surface of an existing paved street or aggregate surfaced roadway and one or more coverings of coarse or fine aggregate applied to the bituminous material, as provided.

**4.06.02   Materials**

The materials shall meet the requirements specified in Division 8 of the current edition of the MDOT Standard Specifications for Highway Construction, as follows:

Aggregate:

Blast Furnace Slag Aggregate  
for Cover Material (31A).....E. C. Levy Spec.

Bituminous Material:

Asphalt Emulsion CRS-2M or HFRS-2M.....Section 8.04

**4.06.03   Equipment**

Equipment used on this work shall be of such capacity and shall be coordinated in such a matter as to provide continuous operation and the production of work of satisfactory quality.

Equipment shall meet the requirements of Section 4.06.03 of the current edition of the MDOT Standard Specifications for Highway Construction and the MDOT special provision for slag chip seal.

Construction methods shall meet the requirements of Section 4.06.04 of the current edition of the MDOT Standard Specifications.

Prior to placing the emulsion on an existing paved surface, the surface shall be thoroughly cleaned of all dirt, debris, vegetation and other residue.

Cost of the surface cleaning shall be incidental to the unit price bid per gallon for the work item "Specified Asphalt Emulsion".

**4.06.10   Weather and Seasonal Limitations**

Surface Treatment shall be applied during the period from June 1 to September 15, unless otherwise approved by the Engineer. No bituminous material shall be applied during rainy or threatening weather, or when the air temperature is less than 55° F, or when the existing pavement temperature may be too low for satisfactory placement of the material, as determined by the Engineer.

**4.06.13   Testing**

The blast furnace slag aggregate shall be tested by the Owner. Samples shall be taken from approved stockpiles.

The bituminous material shall be tested by an approved testing laboratory with reports furnished to the Owner prior to incorporation in the project. The independent testing laboratory shall make a definite statement on each test report furnished that the material does or does not meet the applicable specification.

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*SURFACE COURSES AND PAVEMENTS*

**4.06 BITUMINOUS SEAL COATS (Cont'd.)**

**4.06.14 Rates of Application**

The blast furnace slag aggregate shall be applied at a rate of 15-20 lbs. per square yard.

The bituminous material shall be applied at a rate of between 0.35 and 0.38 gallon per square yard.

**4.06.15 Method of Measurement**

The blast furnace slag aggregate shall be measured in area of square yards of aggregate placed.

The bituminous material and latex additive shall be measured in gallons incorporated in the work.

Prior to the start of the work, the Contractor and the Engineer shall agree on the precise manner of measurement as to meet the intent of these specifications.

**4.06.16 Basis of Payment**

The blast furnace slag aggregate shall be paid for at the contract unit price per square yard, which price shall be payment in full for furnishing and placing the slag aggregate.

The bituminous material and latex additive shall be paid for at the contract unit price per gallon, which price shall be payment in full for furnishing and placing the bituminous material and latex additive.

If the contract includes an item for Mobilization and General Conditions, then this item shall include preparatory, continuing, and close-out operations which are necessary direct costs to the Contractor but are of a general nature and not directly attributable to, or specified as incidental to, other contract pay items. This shall include, but is not limited to, movement of personnel, equipment, supplies and incidentals to the project site, establishment of the Contractor's offices, building, and facilities necessary to undertake the work, operations which must be performed and costs incurred prior to beginning work on other pay items, pre-construction costs exclusive of bidding costs, continuing general conditions and general maintenance of the contract, restoration and general clean up of the contract areas, and other similar costs.

This item shall also include furnishing, installing, maintaining, moving and removing of all necessary temporary signs, flags, barricades, lights and devices, to protect traffic, pedestrians and surface transportation in contract areas.

The total sum of all payments for this item shall not exceed the original contract amount bid for mobilization, regardless of the fact that the Contractor may have, for any reason, shut down his work on the project, moved equipment away from the project and then back again, or for additional quantities or items of work added to the contract.

*DIVISION 4*  
*SURFACE COURSES AND PAVEMENTS*

**4.14      CONCRETE PAVEMENT**

**4.14.01    Description**

This work shall consist of a single course of concrete, with or without integral curb as detailed on the plans, with or without reinforcement as provided, constructed on the prepared subgrade.

**4.14.02    Materials**

The materials shall meet the requirements specified in Division 7 of the current MDOT Standard Specifications.

**4.14.03    Equipment Requirements**

All equipment necessary for the proper preparation of the subgrade, batching, mixing, placing, finishing, and curing of the concrete pavement shall be on the project in first class working condition and shall have been inspected by the Engineer before the Contractor will be permitted to begin paving operations. Throughout the construction of the project the Contractor shall maintain sufficient adequate equipment in first class working condition to insure the proper prosecution of the work.

a.    Forms

Forms shall be of metal, of an approved section, which shall insure their rigidity under the impact, thrust and weight of the heaviest machine carried on them. Forms shall have a minimum length of 10 feet and shall have a depth of not less than the edge thickness of the work prescribed. The width of the base and direct bearing on the soil shall be equal to or greater than the depth of the form. Each 10 foot section of form shall have at least three stake pockets. the form shall be straight, free from distortion, and shall show no vertical variation greater than 1/8 inch in 10 foot lengths from the true place surface on the top of the form when tested with a 10 foot straight-edge and shall show no lateral variation greater than 1/4 inch from the true plane surface on the vertical face of the form when tested with a 10 foot straight-edge. Where the radius for the edge of the pavement is less than 200 feet, the curved alignment shall be provided for by either standard steel forms with a flexible liner or by flexible forms.

Under normal conditions, sufficient forms shall be provided so that it will not be necessary to remove them in less than 12 hours. This period of time may be increased or decreased, depending on temperature, when ordered by the Engineer.

b.    Weighing Equipment

Weighing equipment will conform to the specifications contained in subparagraph a-2 of Section 7.01 of the Standard Specifications.

c.    Mixer

The mixer shall be of the batch type, or essential mixer of approved design having the capacity to produce a concrete of a uniform mixture in quantities necessary to all effective and efficient paving operations.

d.    Finishing Machine

The finishing machine shall be power driven and of an approved type which will strike off and compact the concrete with a screening and troweling action. A spreader with a screen attachment will be classified as a finishing machine. The machine shall be capable of finishing the concrete in the manner specified herein.

*DIVISION 4*  
*SURFACE COURSES AND PAVEMENTS*

**4.14**     **CONCRETE PAVEMENT (Cont'd.)**

**4.14.03**   **Equipment Requirements (Cont'd.)**

e.   Other Equipment

The Contractor shall also furnish all other equipment, small tools and supplies which are necessary to the proper prosecution of the work.

**4.14.04**   **Preparation of Subgrade and Foundation**

The subgrade shall be smooth, trimmed and compacted substantially to the required line, grade and cross-section to receive the pavement. The roadbed shall be compacted to at least 95 percent of the maximum unit weight. The subgrade shall be finished in an acceptable condition for at least one day's progress in advance of the pavement construction at all times.

The subgrade shall be in a moist condition at the time the concrete is placed. It shall be thoroughly wetted a sufficient time in advance of the placing of the concrete to insure that there will be no puddles or pockets of mud when the concrete is placed. The subgrade shall not be allowed to dry out before the concrete is placed.

Immediately prior to placing the concrete, the subgrade shall be tested for conformity with the cross-sections shown on the plans by means of an approved template riding on the side forms. If necessary, material shall be removed or added, as required to bring all portions of the subgrade to the correct elevation. It shall then thoroughly compacted and again tested with the template.

Concrete shall not be placed on any portion of the subgrade that has not been tested for correct elevation. The subgrade should also be cleared of any loose material that may have fallen upon it.

The finished subgrade shall be maintained in a smooth and compacted condition until the concrete has been placed. At any time the trucks cause rutting or displacement of the subgrade material, suitable runways shall be provided.

When the slip form method is used, the subgrade, including the areas which will support the paving equipment, shall be completed, compacted and trimmed to the required elevation and cross-section by means of approved equipment designed for that purpose.

**4.14.05**   **Placing Forms**

The subgrade on which the forms are to be placed shall be checked for line and grade and all the irregularities shall be corrected before placing the forms.

Forms shall be checked for line and grade in advance of placing concrete. They shall be adequately staked and braced to resist the pressure of the concrete and the thrust of the finishing machine, and shall have uniform bearing on the subgrade throughout their entire length and width. Forms shall be set directly in contact with the finished subgrade, which shall be thoroughly compacted for a sufficient distance outside the areas required for the pavement to adequately support the forms.

After the forms are set in place, their top surfaces shall be checked for grade. Any form showing a variance from the stake line by more than 1/2 inch or the stake grade by greater than 1/8 inch in 10 feet shall be reset or removed as directed.

*DIVISION 4*  
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**4.14      CONCRETE PAVEMENT (Cont'd.)**

**4.14.06    Furnishing and Handling Aggregates**

Aggregates shall be furnished and handled in accordance with Section 7.01.05 of the MDOT Standard Specifications.

**4.14.07    Concrete**

Concrete shall meet all requirements for Grade 35P concrete as specified in Section 7.01, "Portland Cement Concrete".

**4.14.16    Placing Concrete**

The concrete shall be mixed in quantities required for immediate use and shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. While being placed, the concrete shall be spaded and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented. The concrete shall be especially well spaded and tamped against the forms and along all joints. Internal vibrators may be used if approved by the Engineer.

**Workability:**

The concrete shall at all times be of such workability that it can be puddled readily into corners and angles of the forms and around joints, dowels, tie-bars and reinforcement (if used) without excessive spading, segregation or undue accumulation of water of laitance on the surface.

**4.14.18    Joints**

Longitudinal and transverse joints shall be constructed as shown on the plans.

Longitudinal joints are those joints parallel to the lane of construction. They may be either intermediate center joints or the construction joints between construction lanes.

Transverse joints shall be contraction joints or construction joints. Construction joints are put in transversely wherever construction operations require them.

Expansion joints may be either longitudinal or transverse. They are used only where specifically shown on the plans.

The edges of the pavement and those joints where such edging is shown on the plans shall be rounded with an edger having a radius of not larger than 1/8 inch. Transverse joints shall be continuous across the entire paved area.

a.    **Longitudinal Joints**

Longitudinal joints shall be placed as shown on the plans. They shall be of the sawed, dummy groove, pre-molded strip, or keyed construction type.

Sawed Center Joints - Sawed longitudinal joints shall be sawed grooves made with a concrete saw after the concrete has hardened. The grooves shall be of the width and depth shown on the plans. The joint shall be sawed within 72 hours and sealed prior to the time the pavement is opened to traffic.

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*SURFACE COURSES AND PAVEMENTS*

**4.14**     **CONCRETE PAVEMENT (Cont'd.)**

**4.14.18**   **Joints (Cont'd.)**

Pre-molded Strip Joints - Longitudinal pre-molded strip joints shall be of the proper dimensions as shown on the plans. The pre-molded filler shall be placed in a vertical groove formed to receive it. The top of the filler should be flush with the pavement surface.

Construction Joints - Longitudinal construction joints (i.e., joints between construction lanes) shall be of the dimensions shown on the plans. The key when specified shall be constructed by a deformed plate affixed to the form when the first lane adjacent to the joint is placed.

When placing the second slab, care must be taken that no concrete is left to overhang the lip formed on the first slab by the edging tool. Before opening the pavement to traffic, the groove formed by the edges shall be filled with the specified joint sealing material.

b.    Tiebars

Tiebars, when shown on the plans, shall be of deformed steel or hook bolts of the dimensions and at the spacing specified. Tiebars shall be firmly supported by subgrade chairs or so installed as not to be displaced during construction operations. Hook bolts shall be installed in an approved manner at construction joints.

c.    Transverse Joints

Transverse joints shall be contraction, expansion, or construction joints. Contraction joints shall be placed as indicated on the plans construction joints wherever construction may require them. They shall make a right angle with the centerline of the pavement and surface of the subgrade.

Contraction Joints - Transverse contraction joints may be of either the sawed or pre-molded strip type.

When transverse contraction joints are to be formed by sawing, care must be taken to saw the grooves early enough to control cracking, but late enough to prevent damage to the slab surface or concrete adjacent to the joint.

Construction Joints - Transverse construction joints of the type shown on the plans shall be placed wherever the placing of concrete is suspended for more than 30 minutes. A butt type joint with dowels shall be used if the joint occurs at the location of a contraction joint. Keyed joints with tiebars are used if the joint occurs in the middle of the normal joint interval.

d.    Integral Curb Joints

In the construction of transverse joints on concrete integral curb pavement, special care must be taken to see that all transverse joints extend continuously through the pavement and curb.

e.    Load Transfer Devices

When specified, transverse joints shall be equipped with dowels or some other approved type of load transfer device of the dimensions and at the spacing and location shown on the plans. Dowels shall be firmly supported in place, accurately aligned parallel to the subgrade and the centerline of the pavement by means of a dowel support which will remain in the pavement and will insure that the dowels are not displaced during construction. One-half of each dowel shall be painted and oiled to permit free horizontal movement. When a load transfer device other than a dowel is used it shall be installed in a manner meeting the approval of the Engineer.

*DIVISION 4*  
*SURFACE COURSES AND PAVEMENTS*

**4.14**    **CONCRETE PAVEMENT** (Cont'd.)

**4.14.18**    **Joints** (Cont'd.)

f.    Joint Sealer

After the curing period, all sawed, dummy grooved and expansion joints in the pavement shall be cleaned and sealed with the material specified. All foreign material, joint sawing residue, dirt and curing membrane shall be removed. Joints shall be filled by the pressure method to the full depth of the groove. Any excess material should be removed from the pavement surface as soon after sealing as possible.

**4.14.19**    **Consolidating and Finishing**

a.    General

The pavement shall be struck-off and consolidated with a mechanical finishing machine. The concrete shall be struck-off at such height that after consolidation and final finishing, it shall be at the exact elevation and have the exact crown as shown on the plans. A depth of at least two inches of concrete shall be carried in front of the strike-off screed for the full width of the slab.

When hand finishing is permitted, the concrete shall be struck-off and consolidated, by means of a metal shod screed, to the crown and cross-section shown on the plans and to such an elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. The screed shall be moved forward with a combined longitudinal and transverse motion, moving always in the direction in which work is progressing and so manipulating that neither end is raised from the side forms during the strike-off process.

If vibrated finishing is required by special provision, the finishing machine shall be equipped with surface or internal vibrators approved by the Engineer and operated in a manner suitable to him.

b.    Straight Edging

Following the finishing of the pavement surface it shall be tested for irregularities with a 10-foot straightedge. The straightedge shall be placed on the surface parallel to the centerline of the pavement and at not more than five foot intervals transversely. After each test the straightedge shall be moved forward one-half its length and the operation repeated. Irregularities shall be corrected by adding or removing concrete. All distributed places shall be floated with a wooden float not less than three feet long and not less than six inches wide.

c.    Burlap Drag

Burlap drag when specified as the final finishing method, shall be at least three feet wide and four feet longer than the width of the slab under construction and shall be kept clean and saturated while in use. It shall be laid on the surface of the pavement and dragged forward in the direction in which the pavement is being laid.

d.    Edging

After final finishing is completed, but before the concrete has taken its initial set, the edges of the slab shall be carefully finished with an edger of the radius shown on the plans.

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*SURFACE COURSES AND PAVEMENTS*

**4.14      CONCRETE PAVEMENT (Cont'd.)**

**4.14.19    Consolidating and Finishing (Cont'd.)**

e.    Final Surface Texture

The final surface of the concrete pavement shall have a uniform gritty texture free from excessive harshness and true to the grades and cross-sections shown on the plans. The Engineer may require changes in the final finishing procedure of belting, brooming, or burlap drag as required to produce the desired final surface texture.

**4.14.22    Curing**

- a.    The curing of the finished pavement shall be carefully systematically carried out in accordance with the prescribed requirements.

Failure to provide sufficient curing material to maintain the protection required or lack of sufficient equipment to take care of both curing and other construction requirements shall be cause for the immediate suspension of construction operations.

After the final finishing operations, and as soon as it is possible to do so without marring the surface, curing shall be started by any of the following methods, approved by the Engineer: 1) wet burlap or mat, 2) paper or polyethylene sheets, or 3) white membrane. Regardless of method used, it shall be so applied as to maintain a relatively uniform temperature in the slab for a period of at least 72 hours. Any method used which does not require added water shall be applied within 20 minutes of final finishing.

b.    Shouldering

After the forms have been removed, the slab edges shall be cured in the same manner as the slab surface, after which ground shall be shaped, uniformly graded and compacted in accordance with the requirements shown on the plans. Care shall be exercised in placing and compacting the earth at the edges of the pavement in order that the new concrete will be spalled or fractured.

**4.14.23    Protection Against Rain**

In order that the edges of pavement placed by the slip-form method may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor shall have available at all times materials for the protection of the edges of the unhardened concrete. Such protective material shall consist of standard metal forms or wood plank having a nominal thickness of not less than one inch and a nominal width of not less than the thickness of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin placing forms against the sides of the pavement.

**4.14.24    Protection from Cold Weather**

Except by specific written authorization, concreting shall cease when the descending air temperature in the shade and away from artificial heat falls below 40°F. It shall not be resumed until the ascending air temperature in that shade and away from artificial heat rises to 35°F.

When concreting is permitted during cold weather, the temperature of the mixed concrete shall be not less than 60°F, nor more than 90°F at the time of placing in the forms. The aggregate or water, or both, may be heated. The aggregates may be heated by steam or dry heat prior to being placed in the mixer. The water shall not be hotter than 170°F. Aggregates shall not be used which are hotter than 150°F. In no case shall concrete be deposited on a frozen subgrade nor shall frozen materials be used in concrete.



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*SURFACE COURSES AND PAVEMENTS*

**4.14     CONCRETE PAVEMENT CON'T.)**

**4.14.24    Protection from Cold Weather (Cont'd.)**

When concrete is being placed in cold weather and temperature may be expected to drop below 35°F, a supply of straw, hay, grass or other suitable blanketing material shall be provided along the line of the work. At any time when the air temperature may be expected to reach the freezing point during the day or night within seven (7) days of the time of placing the concrete, the material so provided shall be spread over the concrete to a sufficient depth to prevent freezing of the concrete. Such protection shall be maintained for at least seven (7) days. Concrete injured by frost action shall be removed and replaced at the Contractor's expense.

**4.14.25    Opening of Pavement**

The pavement shall be closed to traffic, including the vehicles of the Contractor, for a period of ten (10) days after the concrete is placed or longer, if in the opinion of the Engineer, the conditions make it desirable to extend or decrease this time.

**4.14.26    Toleration in Pavement Thickness**

The thickness of uniform thickness slab may be determined by average measurement of the length of cores taken from it and by measurement of the edge thickness. At such points as the Engineer may select in each five hundred (500) linear feet of pavement two (2) or more cores shall be taken and measured and a measurement will be made of each edge of the slab opposite the point from which the core was taken. The average thickness of each five hundred (500) linear feet will be determined from these measurements and an adjusted unit price shall be used as the basis of payment therefore. In calculating the average thickness of the slab, measurements which are in excess of thickness specified on the plans by more than one-fourth (1/4) inch shall be considered as the specified thickness plus one-fourth (1/4) inch, and measurements which are less than the specified thickness by three-fourths (3/4) inch or more shall not be included in the average.

The thickness of the thickened edge slab shall be determined in the same manner as for uniform thickness slab except that the cores alone shall determine the thickness of the central or uniform thickness portion and edge measurements only shall determine the thickness of the thickened edge portion. Two measurements at each edge shall be made within fifty (50) feet of the point at which the core is taken and the average of these two (2) edge measurements shall be taken as the thickness of the edge at the section where the core is taken. The penalties for too thin pavement shall be the same as for uniform thickness slab except that the penalties shall be assessed separately on the central or uniform thickness portion and the thickened edge portion.

**4.14.27    Penalty for Deficient Thickness**

For pavement slab, the average thickness of which determined as herebefore provided is equal to within one-eighth (1/8) inch to the thickness required by the typical cross-section shown on the plans, the contract unit price bid shall be used for payment.

For pavement slab, the average thickness of which, determined as herebefore provided, is less than the thickness shown on the plans by more than one-eighth inch, but less than three-fourths (3/4) inch, an adjustment unit price shall be used in payment, which price shall bear the same ratio to the contract unit price as the square of the average thickness specified on the plans.

No additional payment over the unit contract price bid will be made for any slab where the average thickness of pavement, determined as herebefore provided, exceeds the thickness shown on the plans.

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**4.14**     **CONCRETE PAVEMENT** (Cont'd.)

**4.14.27**   **Penalty for Deficient Thickness (Cont'd.)**

No payment shall be made for slab that is found deficient in thickness by three-fourth (3/4) inch or more. When the measurement of any core or edge thickness indicates that the slab is deficient in thickness by three-fourth (3/4) inch or more, determination shall be made of the actual thickness of transverse sections of the slab at twenty-five (25) foot intervals set off along the centerline of the pavement in each direction until a transverse section of the slab is found which is not deficient in thickness by as much as three-fourth (3/4) inch on either edge or at the core taken on the same transverse section. The area of slab for which no payment will be made shall be the product of the full width of the slab or strip of pavement multiplied by the sum of the distances in each direction from the affected location along the centerline of the strip of pavement to the transverse sections found within the limit of tolerance as above set out.

**4.14.27**   **Penalty for Deficient Thickness (Cont'd.)**

If, in the opinion of the Engineer, a deficiency in thickness of three-fourths (3/4) inch or more is sufficient to seriously impair the traffic service expected from the pavement, the Contractor will be required to remove such deficient areas and replace them with concrete of a satisfactory quality and thickness. The Contractor shall receive no compensation for materials or labor used in the removal or replacement of defective slab.

**4.14.27**   **Penalty for Deficient Thickness (Cont'd.)**

If removal is required because of deficiency in thickness, the slab shall be removed for a width from one longitudinal construction joint to another longitudinal construction joint.

If the Contractor believes that the cores and measurements taken are not sufficient to indicate fairly the actual thickness of pavement he may request additional cores and measurements. Such measurements shall be made at intervals of not less than one-hundred (100) feet. The cost of additional cores and measurements shall be deducted from any sums due the Contractor.

**4.14.29**   **Method of Measurement**

The quantity of pavement laid shall be the number of square yards of full depth pavement with or without integral curbs as specified. The number of square yards shall be determined by the Engineer after construction of the pavement has been completed.

**4.14.30**   **Basis of Payment**

The quantity of accepted pavement shall be measured as above provided and shall be paid for at the contract unit price per square yard as called for in the proposal. This price shall constitute full compensation for furnishing and preparation of all materials, including all joints, joint filler, integral curb, dowels, and reinforcing if required in the construction drawings or special provisions; placing, finishing, curing, and all labor, equipment, tools, incidentals and testing necessary to complete these items. However, the unit price shall be reduced for deficiencies and thickness in accordance with Section 4.14.27 of these specifications.

*DIVISION 4*  
*SURFACE COURSES AND PAVEMENTS*

**SUPPLEMENTAL SPECIFICATIONS FOR BITUMINOUS**  
**MIXTURES CLASSIFIED BY STABILITY**

**Description**

This work shall consist of preparing the foundation and furnishing and placing surface course mixtures in accordance with Sections 4.00 and 7.10 of the current M.D.O.T Standard Specifications, as applicable, with the modifications to the aggregates and bituminous mixture compositions specified herein.

Bituminous pavement mixture number 900 (leveling course) shall be mixed and placed in accordance with applicable requirements specified for No. 9 Bituminous Mixtures in Sections 4.00 and 7.10.

Bituminous pavement mixture number 1100 (top course) shall be mixed and placed in accordance with applicable requirements specified for No. 11 Bituminous Mixtures in Sections 4.00 and 7.10.

**Aggregate**

The aggregate used in the Bituminous Mixture shall be in accordance with Table A. The aggregates shall meet the gradation and physical requirements specified in Section 8.02 of the current Standard Specifications with the exceptions additions specified herein.

Aggregates For Top Course Bituminous Mixtures. The aggregate Wear Index (AWI) for the roadway on this project is 300. The AWI number does not apply to aggregate produced from natural gravel or blast-furnace slag sources. Aggregate produced from carbonate quarries (limestone and/or dolomite) may only be used in the production of bituminous mixtures used in top courses when the coarse aggregate portion (the portion coarser than the No. 4 sieve) has an AWI meeting or exceeding the AWI specified for the project. If the Contractor desires to use a carbonate aggregate having an AWI below the AWI specified for the project, he may request permission to blend the aggregate having the low AWI with an aggregate having a high AWI. If permission is granted, the aggregates, the proportions to be used, and the procedures to be used for blending the aggregates shall be as approved by the Engineer.

The AWI established for an aggregate source is based on wear track testing and/or petrographic analysis of representative samples of the aggregate.

The Contractor shall submit, for Department approval, a mix design which has been prepared by an approved testing laboratory. The bituminous mixture shall meet the requirements specified herein under Composition of Bituminous Mixture.

The Contractor shall provide uniformity in the gradations of the aggregates placed in the cold feed bins so that the combination of aggregates produced for the mixture by blending the aggregates from two or more cold feed bins will be uniformly fed by means of adjusting feeders onto a belt supplying the asphalt plant. The feeders shall be equipped with cutoffs which will automatically stop the operations of the asphalt plant at any time the flow of any aggregate fraction is changed so as to affect the uniformity of the finished product.

The Contractor has the option of using hot bins for proportioning the aggregates to meet the specified tolerances.

Aggregate gradation tests will be made on aggregate extraction from samples of bituminous mixture taken from the trucks. At initial start of production at other times when tests indicate that the aggregate gradation is fluctuating, truck samples will be taken at a frequency of one sample per 250 tons of mixture, but not more than 4 samples per day. During other periods where tests indicate the aggregate gradation is stable, truck samples will be taken at frequency of one sample per 500 tons of mixture, but not more than 2 samples per day.

**DIVISION 4  
SURFACE COURSES AND PAVEMENTS**

**SUPPLEMENTAL SPECIFICATIONS FOR BITUMINOUS  
MIXTURES CLASSIFIED BY STABILITY (Cont'd.)**

Aggregates For Top Course Bituminous Mixtures (Cont'd.)

The Department reserves the right to require the Contractor to discontinue the use of blended aggregate as provided herein and furnish graded aggregate from approval stockpiles, if in the opinion of the Engineer, the blended aggregate as incorporated in the bituminous mixture does not meet the requirements specified herein.

**Bituminous Material**

Asphalt cement shall be used in the mixture and shall meet the requirements as specified in Section 8.04 of the current Standard Specifications for the penetration (viscosity) grade specified on the plans or in the proposal.

**Composition of Bituminous Mixture**

The specified aggregates, mineral filler (if required), and asphalt cement shall be combined as necessary to produce a mixture proportioned within the master gradation range limits shown in Table A and meeting the uniformity tolerance limits shown in Table C; bituminous mixtures shall also meet the mix design criteria specified in Table B.

Composition limits in Table A are shown in percent by weight, based on the total aggregate, including mineral filler, in the mixture.

**TABLE A: MASTER GRADATION RANGE FOR BITUMINOUS MIXTURES**

Sieve Sizes	Total Percent Passing Designated Sieve For Application Bituminous Mixture	
	Top Course No. 1100 (20AA)	Leveling Course No. 900 (20A)
1 1/2"	-	-
1"	-	-
3/4"	100	100
1/2"	-	-
3/8"	60-90	60-90
No. 4	-	-
No. 8	40-65	40-65
No. 30	20-40	20-40
No. 200	3-10	2-10
% Bitumen in Mixture	5-7	5-8*

\*For Mixtures No. 900 and 1100, placed in two courses, the bitumen content of the leveling course will be designed to have up to 0.5 percent less bitumen than the optimum specified for the top course. Exceptions will be made when highly absorbent aggregates are used or when a base or leveling mixture is to be left open to carry traffic over the winter.

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**SUPPLEMENTAL SPECIFICATIONS FOR BITUMINOUS  
MIXTURES CLASSIFIED BY STABILITY (Cont'd.)**

**Composition of Bituminous Mixture (Cont'd.)**

**TABLE B: MIX DESIGN CRITERIA FOR DENSE-GRADED AGGREGATES**

Mixture Number	Aggregate Required	Stability Pounds, Minimum	Flow Hundredths Of an inch	VMA Percent, Minimum
900	20B/20A	900	8-18	14.5
1100	20A/20AA	1100	8-18	15.0

Mixtures failing to meet the requirements specified in Table B will be rejected and the Contractor will be required to submit additional samples of aggregates until a material is found which will produce a mixture meeting the Table B requirements.

If there is a change in the source of any of the aggregates, a new job-mix formula will be required.

An appropriate No. 12 bituminous mixture may be substituted for any mixture in Table A, provided that the No. 12 mixture meets all the requirements of the specified mixture.

After the job-mix formula is established, the aggregate gradation and the bitumen content of the bituminous mixture furnished for the work shall be maintained within the uniformity tolerance limits permitted for the job-mix formula as specified herein under Table C and within the master gradation range as specified in Table A. If two consecutive aggregate gradations on one sieve, or bitumen contents as determined by the field extractions are not within the uniformity tolerance limits, the Contractor shall suspend all operations. (Work days will be charged during the down time.) Before resuming any production, the Contractor shall make all necessary alterations to the materials or plant so that the job-mix formula can be maintained within the deviations permitted under Table C and within the master gradation range shown in Table A (page S4-2).

**TABLE C: UNIFORMITY TOLERANCE LIMITS FOR BITUMINOUS MIXTURE**

Mixtures Numbered	Range	Percentage 3/8-in.	Passing No. 8	Designated No. 30	Sieves No. 200	Bitumen Content
900, 1100	1*	5.0	5.0	4.0	1.0	0.4
	2**	5.0-8.0	5.1-8.0	4.1-7.0	1.1-3.0	.41-6.0

\*Range 1: Maximum Allowable Deviations Permitted form Job-Mix Formula  
Within the Master Gradation Range

\*\*Range 2: Suspend Mix Production and Make Necessary Changes.

**Rejected Mixtures.** Any mixture exceeding the maximum tolerances listed in Range 2 under Table C, or exceeding the maximum limits specified for the master gradation range will be rejected. If such mixtures are placed in a pavement, the pavement will be cored to determine the extent of the deficient material and such pavement shall be removed and replaced at the Contractor's expense.

**Equipment**

Equipment used on this work shall be of such capacity and shall be coordinated in such a manner as to provide continuous operation and the production of work of satisfactory quality.

Equipment shall meet the requirements of Sections 4.12.03 through 4.12.10 of the current MDOT Specifications.

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**SUPPLEMENTAL SPECIFICATIONS FOR BITUMINOUS**  
**MIXTURES CLASSIFIED BY STABILITY (Cont'd.)**

**Composition of Bituminous Mixture (Cont'd.)**

**Weather and Seasonal Limitations**

Bituminous mixtures shall not be placed, nor the prime coat or bond coat applied when rain is threatening or when the moisture on the existing surface would prevent satisfactory bonding. Bituminous courses having a nominal application rate of 10 pounds per square yard or greater, shall not be placed when air temperature is lower than 40° F, unless approved by the Engineer.

**Grading or Regarding Manholes**

All manholes shall be set to the final grade after the bituminous leveling course has been placed.

**Method of Measurement**

Bituminous Wearing Course and Bituminous Leveling Course will be measured by weight in tons.

**Basis of Payment**

"Bituminous Wearing Course" will be paid for at the contract unit price per ton, which price shall be payment in full for furnishing the materials and constructing the wearing course complete.

"Bituminous Leveling Course" will be paid for at the contract unit price per ton, which price shall be payment in full for furnishing the materials and constructing the leveling course complete.

If the contract does not include a separate item for "Bituminous Bond Coat", "Bituminous Prime Coat", "Preparing New Concrete Base", "Preparing Existing Pavement", "Conditioning Aggregate Surface", "Reshaping Bituminous Surface Treatment", "Maintaining Traffic", or "Removing Bituminous Surface", these items shall be incidental to the work of bituminous surfacing.