

## **DIVISION 400**

### **BITUMINOUS PAVEMENTS**

#### **SECTION 401**

#### **HOT-MIX ASPHALT BASE, WEARING, AND PATCHING AND LEVELING COURSES**

##### **401.1 - DESCRIPTION:**

This work shall consist of constructing one or more courses of hot-mix asphalt (HMA), mixed mechanically in a plant, composed of aggregate and asphalt material with or without reclaimed material, on a prepared foundation in accordance with these specifications and in reasonable close conformity with the lines, grades, weights or thicknesses, and cross sections shown on the Plans or established by the Engineer. The use of reclaimed material is the option of the Contractor.

The unit of measurement for HMA will be by the ton (megagram), square yard (square meter) or cubic yard (cubic meter).

The work will be accepted in accordance with these Specifications and the applicable requirements of 105, 106, and 109.

##### **401.2 - MATERIALS:**

The materials shall conform to the requirements of the following subsections of Division 700:

<b>MATERIAL</b>	<b>SUBSECTION</b>	<b>TYPE OR GRADE</b>
Performance Graded Binders	705.5	PG 64-22 or binder grade as specified in contract documents
Coarse Aggregate	703.1 thru 703.3	
Fine Aggregate	702.3	
Mineral Filler	702.4	

### **CONSTRUCTION METHODS**

##### **401.3 - GENERAL:**

Construction methods to be used in performing the work shall be submitted to the Engineer for review prior to the start of work. This review may require modification of the proposed methods to provide the desired end product. All equipment, tools, machinery, and plant shall be maintained in a satisfactory working condition.

##### **401.4 - COMPOSITION OF MIXTURES:**

## 401.4.2

**401.4.1 - General:** The aggregate for use in the designated mixture shall consist of a mixture of aggregate (coarse, fine, reclaimed material if desired, or mixture thereof) and mineral filler if required. It shall be the responsibility of the Contractor to determine the percentage of reclaimed material to be used in the mix. The amount and grade of virgin PG Binder to be used in the RAP designs shall be determined in accordance with Materials Procedure (MP) 401.02.24.

**401.4.2 - Plant Mix Formula:** The Contractor shall submit a proposed Plant Mix Formula (PMF) for each combination of aggregate and asphalt material for each type of HMA to be produced. The HMA shall be designed in accordance with MP 401.02.22. The PMF gradations shall be within the tolerances set forth in Table 401.4.2. The design criteria shall be within the tolerances set forth in MP 401.02.22.

Each proposed PMF must be documented on the Division Form T-400 and the entire PMF package shall be forwarded for review to the District Materials Engineer/Supervisor. The T-400/PMF package shall then be transmitted to the Contract Administration Division, Materials Section for final review. If the PMF requires revision, it will be returned to the designer through the District. The T-400 Form shall contain the following information:

- i. Identification of the source and type of materials used in the design.
- ii. The aggregate blend percentages and the percentage for each sieve fraction of blended aggregate considered the desirable target for that fraction.
- iii. The percentage of asphalt binder representing the optimum asphalt content for the PMF submitted, which is to be considered the desirable target percentage.
- iv. The temperature of the completed mixture at the plant which shall be within  $\pm 25$  °F ( $\pm 14$  °C) of the median mix temperature established by the design temperature-viscosity chart or as recommended by the asphalt supplier.
- v. The ratio (calculated to the nearest one-tenth percent) of the Fines to Asphalt (FA). The ratio is defined as the percentage of aggregate passing the No. 200 (75  $\mu$ m) sieve, divided by the percentage of asphalt content calculated at the percentage optimum asphalt content of the design.

If it becomes necessary to change aggregate sources, a new PMF shall be developed and submitted for approval. Should the PG Binder source be changed on a mix design, the plant technician shall prepare a set of Marshall test specimens and two maximum specific gravity test specimens with the new binder at the optimum asphalt content. If the percent air voids and percent voids-filled-with-asphalt remains within the tolerance limits of Table 401.02.22A (MP 401.02.22) and the voids-in-mineral-aggregate, stability, and flow values meet the minimum requirements of Tables 401.02.22A and 401.02.22B then the binder from the new source may be used without

redesigning. The results of this testing shall be sent to the Contract Administration Division, Materials Section, through the District Materials Section. The mix with the new binder shall then be required to go through a new mix verification process as described in Section 401.6.2.

At no time shall different grades or sources of PG Binders be mixed together in the same storage tank. When it is necessary to switch to a new binder grade, or binder of the same grade from a different source, the tank shall be drawn down as far as possible, normally to the top of heating coils, before refilling with the new binder. The new binder shall be circulated thoroughly before restarting production.

**TABLE 401.4.2  
DESIGN AGGREGATE GRADATION REQUIREMENTS**

<b>TYPE OF MIX</b>	<b>Base-I</b>	<b>Base-II (Patch &amp; Level) Wearing-IV</b>	<b>Wearing-I (Scratch)</b>	<b>Wearing-III</b>
<b>SIEVE SIZE</b>	<b>Nominal Max Size 1 ½ in (37.5 mm)</b>	<b>Nominal Max Size ¾ in (19 mm)</b>	<b>Nominal Max Size 3/8 in (9.5 mm)</b>	<b>Nominal Max Size No. 4 (4.75 mm)</b>
<b>2 in (50 mm)</b>	<b>100</b>			
<b>1 ½ in (37.5 mm)</b>	<b>90 - 100</b>			
<b>1 in (25 mm)</b>	<b>90 max</b>	<b>100</b>		
<b>¾ in (19 mm)</b>	<b>-</b>	<b>90 - 100</b>		
<b>½ in (12.5 mm)</b>	<b>-</b>	<b>90 max</b>	<b>100</b>	
<b>3/8 in (9.5 mm)</b>	<b>-</b>	<b>-</b>	<b>85 - 100</b>	<b>100</b>
<b>#4 (4.75 mm)</b>	<b>-</b>	<b>-</b>	<b>80 max</b>	<b>90 - 100</b>
<b>#8 (2.36 mm)</b>	<b>15 - 36</b>	<b>20 - 50</b>	<b>30 - 55</b>	<b>90 max</b>
<b>#16 (1.18 mm)</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>40 - 65</b>
<b># 30 (600 µm)</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b>#50 (300 µm)</b>	<b>-</b>	<b>-</b>	<b>-</b>	<b>-</b>
<b># 200 (75 µm)</b>	<b>1.0 - 6.0</b>	<b>2.0 - 8.0</b>	<b>2.0 - 9.0</b>	<b>3.0 - 11.0</b>
<b>PERCENT ASPHALT</b>	<b>3 - 6</b>	<b>4 - 9</b>	<b>4 - 10</b>	<b>5 - 11</b>

**401.5 - TESTING:**

## 401.6.1

### 401.5.1 - Test Methods:

- MP 700.00.06 - Aggregate Sampling Procedures
- AASHTO T168 - Sampling Hot-Mix Asphalt
- AASHTO T11 - Materials Finer than No. 200 (75  $\mu$ m) Sieve in Mineral Aggregates by Washing
- AASHTO T27 - Sieve Analysis of Fine and Coarse Aggregates
- AASHTO T30 - Mechanical Analysis of Extracted Aggregate
- AASHTO T164 - Quantitative Extraction of Bitumen from Bituminous Paving Mixtures
- AASHTO T287 - Asphalt Content of Bituminous Mixtures by the Nuclear Method
- AASHTO TP53 - Asphalt Content of HMA by the Ignition Method
- AASHTO T245 - Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
- ASTM D5581 - Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus (For Base-I HMA only)
- AASHTO T166 - Bulk Specific Gravity of Compacted Bituminous Mixtures
- AASHTO T209 - Maximum Specific Gravity of Bituminous Paving Mixtures
- AASHTO T269 - Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
- ASTM D2950 - Test Method for Density of Bituminous Concrete by Nuclear Method

## 401.6 - CONTRACTORS QUALITY CONTROL:

**401.6.1 – Technician Requirements And Quality Control Plans:** Quality control of HMA is the responsibility of the Contractor. The Contractor shall maintain equipment and qualified personnel including at least one certified HMA Technician at each plant. The technician shall be in charge of all plant quality control activities such as mix proportioning and adjustment and all sampling and testing activities necessary to maintain the various properties of HMA within the limits of the specification. A certified HMA Inspector may handle sampling and testing activities under the supervision of the plant technician.

The Contractor shall maintain equipment and qualified personnel including at least one certified Compaction Technician at each project. A certified Compaction Technician shall perform all testing necessary to assure compaction of the HMA meets specification requirements. The Contractor, or Contractor-Producer, shall design a workable quality control plan, detailing the type and frequency of sampling, and testing deemed necessary to measure and control the magnitude of the various properties of the HMA governed by these Specifications. This plan, prepared in accordance with MP 401.03.50, shall be submitted to the Engineer for review prior to production of material under this

## Specification.

**401.6.2 - Plant Mix Formula Field Verification:** For each PMF, a mix design field verification shall be conducted during the first days of plant production using the guidelines established in MP 401.02.27. This field verification is for the purpose of demonstrating that the PMF can be produced within the specified tolerances set forth in MP 401.02.27. If the mix cannot be produced within these requirements, a new mix design will be required.

**401.6.3 – Quality Control Testing Requirements:** After the PMF field verification has been successfully completed, sampling frequency and requirements for quality control testing shall be as set forth in MP 401.02.27. If the Division determines that a mix cannot be consistently produced within the tolerance limits of the specified design properties, approval of the mix may be revoked and the contractor will be required to provide a new mix design.

## **401.7 - ACCEPTANCE TESTING:**

Acceptance testing of HMA is the responsibility of the Division.

**401.7.1 – Surface Tolerance:** It is the intent of these Specifications that projects with a total new pavement thickness of 3 inches (75 mm) and minimum length of two lots (1100 ft = 340 m) shall be constructed to provide a smooth riding surface. The smoothness of the riding surface will be determined by the Engineer using an inertial profilometer or Mays Ride Meter. The smoothness testing will generally be accomplished within 30 days after the project is complete.

The pavement will be divided into sampling LOTS of one-tenth (0.1) lane mile (0.16 km) each. Each LOT shall exhibit a smoothness measurement, expressed in inches per mile (millimeters per kilometer) equal to or less than that shown in the appropriate Table 401.7.1E or 401.7.1M. When a LOT is represented by a smoothness number greater than that shown in Tables 401.7.1E or 401.7.1M, the unit price shall be adjusted as in 401.13.2.

<b>TABLE 401.7.1E</b>	
<b>Total New Pavement Thickness</b>	<b>Smoothness</b>
3 inches to less than 4 inches	81 inches per mile or less
4 inches or greater	65 inches per mile or less

<b>TABLE 401.7.1M</b>	
<b>Total New Pavement Thickness</b>	<b>Smoothness</b>
75 mm to less than 100 mm	1250 mm/km or less
100 mm or greater	1000 mm/km or less

When compaction is completed on the course, it shall present a uniform surface, true line and grade, conforming to the cross section shown on the Plans. When tested with a straightedge, approximately 10 feet (3 meters) in length, and a template of the specified dimensions, the finished base course shall not show a deviation greater than ¼ inch (6 mm) and the finished wearing course shall not show a deviation from the required surface greater than 3/16 inch (5 mm).

The Contractor shall provide the straightedge and template for checking the surfaces, and an employee to use them under the direction of the Engineer. Any irregularity of the surface exceeding the limits specified shall be corrected. Depressions which develop after the initial rolling shall be corrected by loosening the mixture and adding new material. High places shall be corrected by removing excess material.

Areas of completed courses found to be defective shall be removed and replaced with approved mixtures laid in accordance with these specifications, and no additional compensation will be allowed for materials used or work involved in replacing defective areas.

**401.7.2 - Compaction:** Acceptance testing for compaction shall be performed in accordance with either the Lot-By-Lot method described in Section 401.7.2.1 or by the rollerpass procedure described in MP 401.05.20 based on the total new pavement thickness and the lift thickness provided in Table 401.7.2. Patching-and-leveling and scratch courses shall not be included in determining the total new pavement thickness. When HMA is placed in areas that require a nonuniform thickness or is tapered to a thin edge, the method of acceptance testing shall be determined by the Engineer.

**Table 401.7.2**

Mix Design Type	Total New Pavement Thickness	Lift Thickness <sup>(Note 1)</sup>	Compaction Method
Heavy	≥ 2.5 inches (63 mm)	≥ 1 inch (25 mm)	Lot-by-Lot
		< 1 inch (25 mm)	Rollerpass
Heavy	< 2.5 inches (63 mm)	> 1 inch (25 mm)	Lot-by-Lot
		≤ 1 inch (25 mm)	Rollerpass
Medium	≥ 3.0 inches (75 mm)	> 1 inch (25 mm)	Lot-by-Lot
		≤ 1 inch (25 mm)	Rollerpass
Medium	< 3.0 inches (75 mm)	All lifts	Rollerpass

**Note 1:** Any lift that is placed at a thickness of less than two times the nominal maximum aggregate size as specified in Table 401.4.2 shall be compacted using the rollerpass method

**401.7.2.1 – LOT-By-LOT Testing:** Randomly located nuclear density tests will be performed in accordance with the LOT-By-LOT test procedure described in MP 401.05.20. The pavement shall be divided into LOTS not exceeding 1000 feet (300 meters) of paving lane. A randomly located density test shall be conducted in each LOT. The density shall be within the range of 92.0 to 96.0% of the maximum density of the approved mix design or the maximum density established under Section 401.6.2, Plant Mix Formula Field Verification. If the density is outside the range, an additional five tests shall be conducted for the LOT and the average of these five tests used to judge acceptance of the LOT in accordance with Table 401.13.3.

Acceptance testing is not required on areas in which a full-size roller is restricted from properly compacting the mat. These areas shall be compacted to the satisfaction of the Engineer.

**401.7.3 – Thickness:** When a uniform thickness of three inches (75 mm) or more is specified, excluding resurfacing, cores shall be taken to verify the thickness of the compacted pavement.

Cores will be taken by the Division at random locations. The sampling frequency shall be approximately five cores per 2000 feet (600 meters) of two-lane construction, except that the sampling frequency shall normally be limited to a minimum of five and a maximum of 50 cores per project. The Division may elect to waive coring for short projects of less than 1000 feet (300 meters) in length or for projects where a paving mat of uniform thickness cannot be expected (for example: tapered paving mats or pavement widening projects).

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The Division may also elect to take additional cores when needed to resolve problems related to pavement thickness.

The thickness shall be considered acceptable if one or both of the following criteria is met.

- (A) The average thickness equals or exceeds the specified thickness.
- (B) The average thickness is less than the specified thickness, and the difference is not statistically significant at the 95% confidence level. (Standard one tail “t” test at 0.05 significance).

The calculated ‘t’ value shall be less than or equal to the standard ‘t’ val at the 95% confidence level. The method for calculating Criteria ‘B’ , shall be as follows:

$$t \leq t_{95} \quad \text{Where:}$$

$$t_{95} = \text{value from standard “t” table for 95\% confidence level.}$$

$$t = \frac{x_s - \bar{x}}{s} \sqrt{n-1}$$

$x_s$  = specified thickness

$\bar{x}$  = average thickness

$n$  = number of samples

$$s = \sqrt{\frac{\sum x^2 - \frac{(\sum x)^2}{n}}{n-1}}$$

$x$  = individual core thickness

If the average thickness is less than specified and is determined to be significant as determined by criteria ‘B’ , the Division shall decide on a course of action as described in Section 401.13.4.

### 401.8 - WEATHER RESTRICTIONS:

HMA shall only be placed when the surface is dry and when weather conditions are such that proper handling, finishing, and compaction can be accomplished. In no case however, shall HMA be placed when the surface temperature is below the minimum established in Table 401.8.

<b>TABLE 401.8</b>	
<b>Course Thickness</b>	<b>Minimum Surface Temperature</b>
3 inches (75 mm) and over	35 °F (2 °C)*
1.5 to 2.9 inches (38 to 74 mm)	40 °F (4 °C)
Less than 1.5 inches (38 mm)	50 °F (10 °C)

\*In lieu of 35 °F (2 °C), a minimum air temperature of 40 °F (4 °C) shall be used when paving directly on an aggregate base, subbase, or subgrade.

In addition to the above surface temperature requirements, no surface courses shall be placed when the air temperature is less than 40 °F (4 °C).

Mixtures shall be laid only on dry surfaces and only when, in the opinion of the Engineer, weather conditions are suitable.

**401.8.1 - Cold Weather Paving:** When the air temperature falls below 50 °F (10 °C) or the surface temperature fall below 60 °F (15 °C) the provisions for cold weather paving shall apply.

Paving shall be performed so that the transverse joints in adjacent lanes shall be no more than 50 feet (15 meters) apart at the end of each days paving operations.

The surface temperature shall be taken a minimum of once every hour and shall be taken in all shaded areas. The temperature requirements as listed in Section 401.8 shall apply.

It shall be the Contractor's responsibility to monitor the declining surface temperature to insure that material delivery from the plant be terminated so as to allow that all material can be placed prior to the surface temperature falling below the surface temperatures listed in Section 401.8.

The temperature of the delivered material and the mat temperature at the time final density is obtained shall be taken on every truckload. These temperatures shall be in accordance with Section 401.10.3 for delivered material and 401.10.4 for the mat temperature at the time final density is obtained.

## **401.9 - EQUIPMENT:**

**401.9.1 - Plants:** All plants in West Virginia producing HMA for the Division shall provide documented evidence of compliance with current requirements of the West Virginia Air Pollution Control Commission.

All plants which are not in West Virginia but producing HMA for the West Virginia Division of Highways shall provide documented evidence of compliance with current requirements of the laws and regulations of the State in which they are producing, applicable to air pollution.

All plants shall meet the requirements set forth in AASHTO M156.

## 401.9.5

**401.9.2 - Dust Collector:** An efficient dust collecting system shall be provided to prevent the loss of fine material. The material collected may be returned to the mixture at a uniform rate or discarded.

**401.9.3 - Truck Scales:** Truck scales shall be provided at each Plant, except that truck scales are not required at properly calibrated automatic batching plant facilities which are equipped with digital printout equipment, and which load the trucks directly from the mixer or weigh hopper in a surge or storage bin.

A weigher shall be provided by the producer. The weigher shall certify that the weight of the HMA, as determined either by the truck scales or from the digital printout of the batch weights, is correct.

Each truck shall be weighed empty prior to each load, except at automatic batch plants approved to operate without truck scales.

All truck scales shall be mounted on solid foundations which will insure them remaining plumb and level.

Approval and sealing of scales shall be conducted at the frequency determined by the West Virginia Division of Labor, Bureau of Weights and Measures, and when the plant is moved, or upon the request of the Engineer. The Engineer shall be notified of any scale malfunctions when material is being furnished to Division of Highways projects. The Division may, at its option, accept inspection and sealing by out of state agencies when the mixing plant is located outside West Virginia.

A digital recorder shall be required on all truck scales. The digital recorder shall produce a printed record of the gross, tare and net weights, and the time, date, truck identification, and project number. Provision shall be made for constant zero compensation and further provision shall be made so that the scales may not be manually manipulated during the printing process. The system shall be interlocked so as to allow printing only when the scale has come to rest. In case of breakdown of the automatic equipment, the Engineer may permit manual operation for a reasonable time, normally not to exceed 48 hours, while the equipment is being repaired.

The scales shall be of sufficient size and capacity to weigh the loaded trucks that are used for delivery of HMA from the plant.

**401.9.4 - Test Weights:** As part of its standard equipment, each plant which proportions aggregate by weight shall provide a minimum of ten 50 pound (22.68 kg) test weights for the purpose of maintaining the continued accuracy of weighing equipment.

Plants which proportion asphalt material by weight shall furnish, in addition to the above, one five pound (2.268 kg) test weight.

**401.9.5 - Surge and Storage Bins:** During the normal daily operation of the plant, HMA may be stored in a surge or storage bin for a maximum of 12 hours, provided the bin has received prior evaluation and acceptance through the District plant inspection. The temperature of the material at time of

placement and compaction shall be sufficient to properly perform these activities.

Longer silo storage times, up to 24 hours, may be permitted for dense graded HMA if the storage silo is insulated and/or heated to assure that the proper mix temperature is maintained. The gates at the bottom of the storage silo shall be adequately heated and sealed when the HMA is held for the extended period of time. An inert gas system may be used to purge the silo of oxygen to prevent oxidation of the asphalt. The HMA delivered from the storage silo shall meet all of the specification requirements.

When HMA is stored for the extended time period it shall not be used until the temperature has been checked and the HMA has been visually inspected for hardening of the mix and stripping of the asphalt from the aggregate. Approval of the extended storage time may be revoked if it is determined through inspection and/or testing that the extended storage is having a detrimental effect on the HMA.

Loading of trucks through the storage bin will only be permitted when a minimum 25 ton (23 Mg) buffer of material is being maintained or an amount as recommended by the bin manufacturer. Means shall be provided for loading the trucks directly from the mixer when the storage bin is not in operation.

**401.9.6 - Inspection of Equipment and Plant Operations:** The Engineer shall have access to the plant to assure the adequacy of the equipment in use, to inspect the conditions and operation of the plant, to verify weights, to verify the proportion and character of materials, and to determine if specified temperatures are being maintained in the preparation of the mixture.

**401.9.7 - Trucks for Transporting Mixture:** The inside surfaces of trucks shall be thinly coated with a soapy water or a mixture with not more than ten percent lubricating oil. The use of diesel fuel, kerosene, or similar solvent-based products which can dissolve the asphalt film from the aggregate particles will not be permitted. Any commercial release agent which can be certified as harmless to the mix may be used, however, the Division reserves the right to restrict any release agent that is shown to cause problems with the mix. In the case of mixtures composed of PG Binders which contain polymer modification, truck surfaces should be coated with a release agent recommended by the binder supplier. All excess coating material shall be removed from the truck bed prior to loading the HMA.

All truck beds shall be insulated with approved material. No trucks shall be used which cause segregation of the materials, which show large oil leaks, or which cause undue delays in delivery of material. All trucks shall be provided with a waterproof cover and a hole in the body for the purpose of conveniently checking the temperature of the load. Covers shall be suspended slightly above the mixture, shall extend over the sides of the truck, and shall be securely fastened to eliminate air infiltration and to prevent water from coming in contact with the mixture.

## 401.9.8

**401.9.8 - Laboratory:** A testing facility or laboratory, as described below, shall be provided within reasonable proximity of the HMA plant. Plant operations must be visible from within the laboratory.

The laboratory shall be of sufficient size to hold all laboratory test equipment and supplies with adequate floor space to allow the technicians to test samples in an efficient manner. The laboratory shall be furnished and maintained with adequate ventilation, heat, light, water, sink and drainage, electrical or gas outlets, or both, work table, shelves, and supply cabinets.

The laboratory shall be supplied with the equipment and materials listed below and these shall be maintained to meet the applicable requirements of ASTM or AASHTO.

- i. Hot plate, gas or electric.
- ii. Large ovens (as needed for heating and drying samples), gas or electric.
- iii. Unit weight container, ½ cubic feet (.014 cubic meter) - Required only when slag is used.
- iv. Balances of sufficient capacity and accuracy for conducting specified tests and plant calibration.
- v. A Division approved method of determining asphalt content [AASHTO T164 extraction, AASHTO T287 nuclear asphalt content gauge with printing capability, AASHTO TP53 asphalt content ignition oven, weigh ticket on automated plants].
- vi. Thermometers, dial type and glass, as required for conducting standard test procedures and monitoring mix temperatures.
- vii. Standard Gilson shaker or equivalent, with screens.
- viii. Ro-Tap shaker or equivalent, with 8 and/or 12 inch (200 and/or 300 mm) diameter screens.
- ix. Sample splitters for fine and coarse aggregates.
- x. Miscellaneous items (including sample splitting tools, scoops, square point shovel, aggregate sample pans, heat resistant gloves, measuring rules, brushes, flashlight, and glassware as needed).
- xi. Expendable supplies necessary for performance of tests.
- xii. Marshall equipment necessary to comply with AASHTO T245 and ASTM D5581, including a calibrated automatic testing apparatus having recording capabilities and compaction hammers.
- xiii. Equipment for determining the maximum specific gravity of asphalt mixtures as specified in AASHTO T209.
- xiv. Equipment for determining the in place density of asphalt mixtures meeting the requirements of ASTM D2950.
- xv. Non-contact infrared thermometer accurate to  $\pm 2$  °F ( $\pm 1$  °C).
- xvi. Equipment for determining the bulk specific gravity of compacted asphalt/ aggregate mixture using saturated surface dry specimens complying with AASHTO T166.

**401.9.9 - Spreading Equipment:** Spreading equipment shall be self-contained and of sufficient size, power and stability to receive, distribute and strike-off the asphalt mixture at rates and widths commensurate with the typical sections and other details shown on the plans. The spreading equipment shall be provided with an activated screed or strike-off assembly equipped to be heated. Approval of spreading equipment by the Engineer will be based on the demonstrated capability of the equipment to place the mixture to the required cross-section, profile and alignment in an acceptable, finished condition ready for compaction. Specialized equipment or hand methods approved by the Engineer may be employed to spread the asphalt mixture where the use of standard full scale spreading equipment is impractical due to the size or irregularity of the area to be paved.

Paving machines shall be equipped with mechanical or automatic grade and slope controls. The use of automatic grade and slope controls with a traveling straight edge shall be required only when specified on the Plans or in the Proposal. Both the grade and slope controls shall be in working order at all times. In the event of failure of the automatic controls, the Contractor will be permitted to finish the day's work using manual controls but will not be allowed to resume work the following day until the grade and slope controls are in proper working order.

**401.9.10 - Compaction Equipment:** Compaction may be performed by self-propelled steel-wheeled, pneumatic tired and/or vibratory rollers. Hand held rollers or vibrating plates may be used in small inaccessible areas if approved by the Engineer. Prior to use on any project the roller shall be inspected to see that it is in good mechanical condition. The total weight, weight per inch of width (steel-wheeled), and average ground contact pressure (pneumatic-tired) shall be documented.

#### **401.10 - PAVING OPERATIONS:**

**401.10.1 - Cleaning and Sweeping:** Immediately prior to the arrival of the paving mixture, the existing base or surface shall be thoroughly cleaned by the use of tools and equipment as may be required to remove all mud, dirt, dust, and other caked or loose material foreign to the type of treatment or surface being placed. The cleaning shall be done to a minimum width of one foot on each side beyond the width of the surface being placed.

#### **401.10.2 - Patching and Leveling and Scratch Courses:**

**401.10.2.1 - Patching and Leveling:** A tack coat shall be applied to the existing pavement prior to placing patching and leveling.

Patching and leveling shall be placed at various locations throughout the project to remove irregularities in the existing pavement such as dips, or to raise the outside edge of the existing pavement to provide a uniform template prior to placing a base or wearing course. Patching and leveling shall not be placed as a continuous layer or course over the full width and length of the project.

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Compaction of patching and leveling shall be performed with three-wheel (steel) or pneumatic tire rollers.

**401.10.2.2 - Scratch Course:** A tack coat shall be applied to the existing pavement prior to placing a scratch course.

The scratch course shall be placed to the limits designated on the plans. Scratch course can be placed with a paving machine or grader with shoes. The paving machine screed or grader blade shall be set to drag on the high areas of the existing pavement only depositing material in ruts and other depressions.

The wearing course or at least one lift of base course should be placed over the scratch course prior to maintaining traffic in the lane where the scratch course has been placed. All repairs to a scratch course due to traffic damage shall be at the contractors expense.

Compaction of a scratch course shall be performed with a three-wheel (steel) or pneumatic tire roller.

**401.10.3 - Spreading and Finishing:** Before spreading any material, the contact surfaces of curbs, gutters, manholes, and of adjacent Portland cement concrete pavement edges shall be painted or sealed with asphalt material. Exact edge of pavement, except on concrete, shall be established by a string or chalk line for a distance of not less than 500 feet (150 meters) ahead of the spreading operation.

For mixes produced with unmodified asphalts (such as PG 64-22 or PG 58-28) the temperature of the mixture at the time of placement shall be within the temperature requirements of the PMF. The PMF temperature range shall be within the master temperature range of 250 and 338 °F (121 and 170 °C). The mix temperature shall be monitored by inserting a dial type thermometer into the mix through the hole in the truck bed.

The temperature of the completed mix, when measured at the plant, shall be within the tolerance as established by the PMF. The first load, which demonstrates temperatures outside of that range may be accepted provided that the temperature is still within the master temperature range. However, no additional loads of material shall be run out of the plant until necessary steps are taken to reestablish the temperature of the mix within the plant tolerance. When measured at the project site, the temperature of the mix shall be within the tolerance established by the PMF. The first truck load of material which demonstrates temperatures outside of that range or any trucks in transit at that time may be accepted provided temperatures are within the master temperature range. However, the plant shall immediately be notified that no additional loads of material are to be dispatched until necessary action is taken to reestablish temperature within PMF specification limits.

When the surface temperature falls to within 10 °F (6 °C) of the weather restrictions included in Table 401.8 the mix temperature may be increased up to a maximum of 338 °F (170 °C) unless otherwise specified by the asphalt supplier. The temperature of each truckload of material shall be monitored for compliance. Any truckload of material which exceeds this maximum

temperature may be rejected by the Engineer.

Mixes produced with asphalts that contain modifiers for high or low temperature performance enhancement shall meet the temperature requirements recommended by the asphalt supplier which will be referenced on the PMF.

**401.10.4 - Rolling Procedure:** Shoulders, ramps, and similar areas shall be compacted in the same method as the mainline.

During rolling, roller wheels shall be kept moist with only enough water to avoid picking up material. Fuel oil on roller wheels or pneumatic tires is not allowed. Rollers shall move at a slow but uniform speed with the drive roll or wheels nearest the paver.

If rolling causes material displacement, the affected area shall be loosened at once with lutes or rakes and restored to their original grade with loose material before being re-rolled. Heavy equipment, including rollers, should not be permitted to stand on the finished surface before it has thoroughly cooled or set.

Mat temperature shall be measured using a non-contact infrared thermometer. The required density shall be obtained prior to the mat temperature reaching 175 °F (80 °C). The Contractor shall be allowed to lower this temperature to 165 °F (74 °C) if they can demonstrate during the first day of placement of each lift on each project that additional densification can be achieved without causing any pavement distress.

**401.10.5 - Joints:** The longitudinal joint in any layer shall offset that in the layer immediately below by approximately six inches; however, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises two lanes of the width, or at lane lines if the roadway is more than two lanes in width. The transverse joint in any layer shall offset that in the layer immediately below by approximately six feet (1 800 mm).

Joints between the existing and new HMA pavement shall be "heeled in" to the existing surface at the beginning and at the end of the project and at all other locations where the new pavement terminates against an existing HMA pavement. These joints as well as the transverse joints between one days production and the next shall be carefully constructed and shall be formed by cutting back into the existing section to expose the full depth of the course. All joints shall be squared up to the full vertical depth of the course to be placed, and a tack coat of asphalt material shall be applied if called for by the Engineer.

Joints adjacent to curbs, gutters, or adjoining pavement shall be formed by transporting back sufficient hot material to fill any space left uncovered by the paver. The joint shall be set up with lutes to a sufficient height to receive the full compactive effort from the rollers. After rolling, joints shall be at the same elevation as the adjacent lanes or sections and shall be free from ridges or depressions.

Transverse joints shall be checked for smoothness with a 10 foot (3 meter) straight edge provided by the Contractor. All surface irregularities shall be corrected prior to proceeding with paving operations.

## **401.11.2**

### **401.11 - PROTECTION OF PAVEMENT AND TRAFFIC CONTROL:**

The Contractor shall be responsible for the protection of HMA surfaces from damage by their equipment and personnel. When the construction of HMA surfaces is undertaken on projects under public traffic and the road surface is 16 feet (4.9 meters) wide or greater and the ADT is 400 or greater, the Contractor shall place No Passing Signs and Interim Pavement Markings to delineate the centerline or lane line of the roadway as required herein. The Contractor shall be responsible for maintaining both signs and markings until such time as the permanent markings are placed or thirty calendar days after completion of the final course whichever is less. No separate payment will be made for maintenance of these items but shall be included in the applicable pay items for initial installation. All Interim Markings shall be in conformance with the Manual on Uniform Traffic Control Devices (MUTCD), and shall be installed by the end of the work day by placing the markings as the paving operation progresses within 1000 feet (300 meters) of the paver. Interim Markings shall be Type VII A pavement markings meeting the requirements of Section 715.40.4.1. Payment of Interim Pavement Markings shall be incidental to the 401 Items. Removal of Interim Markings shall not be required between lifts or after placement of the final markings.

#### **401.11.1 - Interim Traffic Control for Two-Lane, Two-Way Roadways:**

Prior to any work which will cover the centerline, the Contractor shall install 24 inch x 30 inch (600 mm x 750 mm) “DO NOT PASS” (R4-1) signs on permanent post at the beginning of each no passing zone throughout the length of the project. These signs shall be placed at the beginning of each no passing zone and shall be repeated every 2500 feet (750 meters) as required. Payment shall be made under Item 636011-\*, “Traffic Control Devices”.

To delineate the centerline of the roadway, the Contractor shall install yellow Interim Pavement Markings measuring 4 inch x 4 inch (100 mm x 100 mm) along the centerline of the roadway on 20 foot (6 meter) centers.

**401.11.1.1 - Temporary Pavement Markings with ADT of 3,000 or Greater:** The Interim Pavement Markings described in Section 401.11.1 shall be permitted only for a period up to three calendar days after completion of the final course. Within this time the Contractor shall install full compliance centerline Temporary Pavement Markings (i.e. passing and no passing zones delineated) in conformance with Sections 636 and 663. Payment shall be made under Item 636008-\*, “Temporary Pavement Marking Paint”.

#### **401.11.2 - Interim Traffic Control for One-Way Multilane Roadways:**

On all one-way multilane roadways, the Contractor shall install white Interim Pavement Markings measuring 4 inches x 48 inches (100 mm x 1200 mm) along the lane line. Interim Pavement Markings shall be placed on 40 foot (12 meter) centers.

**401.11.2.1 - Temporary Pavement Markings:** Prior to the left lane being open to traffic, the Contractor shall install a four inch yellow edge line. These markings shall be in conformance with Sections 636 and 663. Payment shall be made Item 636008-\*, “Temporary Pavement Marking Paint”.

**401.11.3 - Interim Traffic Control for Two-Way Three-Lane Roadways:** Prior to any work which will cover the centerline and/or lane lines, the Contractor shall install 24 inch x 30 inches (600 mm x 750 mm) “DO NOT PASS” (R4-1) signs on permanent post at the beginning of each no passing zone throughout the length of the project as required. “DO NOT PASS” signs in both directions will be required for Center Left Turn Lanes. These signs shall be placed at the beginning of each no passing zone and shall be repeated every 2500 feet (750 meters) as required. Signs shall be maintained by the Contractor until temporary or permanent markings are installed. Payment shall be made under Item 636011-\*, “Traffic Control Devices”.

The Contractor shall install Interim Pavement Markings measuring 4 inches x 48 inches (100 mm x 1200 mm). Where truck climbing lanes exist, the centerline shall be marked with two parallel yellow lines separated by a four inch (100 mm) space placed on 40 foot (12 meter) centers. Lane lines shall be marked with white lines placed on 40 foot (12 meter) centers. Where center left-turn lanes exist, the center lane shall be marked with two parallel yellow lines separated by four inches (100 mm) space placed on 40 foot (12 meter) centers on both sides of the center lane.

**401.11.3.1 - Temporary Pavement Markings:** The Interim Pavement Markings described in Section 401.11.3 shall be permitted only for a period of up to three calendar days after completion of the final course. Within this time the Contractor shall install full compliance centerline and lane line Temporary Pavement Markings in conformance with Sections 636 and 663. Payment shall be made under Item 636008-\*, “Temporary Pavement Marking Paint”.

**401.11.4 - Interim Traffic Control for Two-Way Four-Lane and Five-Lane Roadways:** On all two-way four-lane and five-lane highways, the Contractor shall install Interim Pavement Markings measuring 4 inch x 48 inch (100 mm x 1200 mm) along the lane line and centerline where required. Centerlines shall be marked with two parallel yellow lines separated by a four inch (100 mm) space placed on 40 foot (12 meter) centers. On five-lane roadways these markings shall be placed on both sides of the center left turn lane. Lane lines shall be marked with white lines placed at 40 foot (12 meter) centers.

**401.11.4.1 - Temporary Pavement Markings:** The Interim Pavement Markings described in Section 401.11.4 shall be permitted only for a period of up to three calendar days after completion of the final course. Within this time the Contractor shall install full compliance lane line and centerline or left edge line Temporary Pavement Markings in conformance with Sections 636 and

**401.13**

663. Payment shall be made under Item 636008-\*, "Temporary Pavement Marking Paint".

**401.11.5 - Seasonal Temporary Markings:** Unless otherwise described above, if it becomes necessary to open the roadway to traffic whether on the base or final course, for longer than 14 calendar days, the Contractor shall install full compliance Temporary Pavement Markings in conformance with Section 636 and 663. Payment shall be made under Item 636008-\*, "Temporary Pavement Marking Paint".

**401.12 - METHOD OF MEASUREMENT:**

The quantities of work done will be measured in square yards, tons or cubic yards, as designated, for "Hot-Mixed Asphalt Base Course" or "Hot-Mix Asphalt Wearing Course," incorporated into the completed and accepted work. Measurement of "Hot-Mix Asphalt Patching and Leveling Course" will be on the basis of tonnage (Mg) only.

When measured by the square yard (square meter), the quantity will be determined as follows: The width for measurement will be the width of the pavement shown on the typical cross section of the Plans and additional widening where called for, or as otherwise directed in writing by the Engineer. The length will be measured on the surface along the centerline of each roadway or ramp.

When measured by the ton, the quantity will be determined by the Contractor from the total weigh slips for each vehicle load weighed upon an approved standard scale or from digital printout slips from an automatic batching plant, and certified by the Contractor as correct.

When measured by cubic yard, the quantity will be the number of cubic yards established in the proposal, determined by the dimensions on the plans or contract document, subject to adjustment as provided in 104.2 and 109.2.

Any patching or leveling mixture placed on a subbase or base course constructed in the same Contract with the HMA items shall be at the expense of the Contractor. No additional compensation will be allowed for the material or any work incidental to its placement.

**401.13 - BASIS OF PAYMENT:**

The quantities determine as provided above, will be paid for at the contract unit price for the items listed below, which prices and payment shall be full compensation for furnishing all the materials and doing all the work herein prescribed in a workmanlike and acceptable manner, including all labor, tools, equipment, field laboratory, supplies, and incidentals necessary to complete the work.

The conditioning, cleaning, and sweeping of the existing base or underlying surface shall be considered as part of the construction of the appropriate items listed in 401.14, and no additional compensation will be allowed for "Cleaning and Sweeping".

### 401.13.1

There will be no additional compensation for tack coat material used for minor (spot) areas to be patched and leveled; the cost of this tack coat material will be included in the unit bid price for Item 401-3.

There will be no additional compensation for Interim Pavement Markings.

**401.13.1** - If HMA is found not in compliance with the provisions of 401.6.3, production shall cease until the Contractor demonstrates that the PMF can be met.

**401.13.2** – When a LOT of HMA pavement is represented by a smoothness value larger than that shown in Tables 401.7.1E or 401.7.1M, the unit price of the LOT (surface course only) shall be determined as follows:

**ENGLISH VERSION:**

Reduced Unit Price = Unit Bid Price X [(127.86 – As)/100]

Where A = 0.429 when specified smoothness is 65 in/mi

Where A = 0.341 when specified smoothness is 81 in/mi

Where s = Smoothness value measured as per 401.7.1

**METRIC VERSION:**

Reduced Unit Price = Unit Bid Price X [(127 – As)/100]

Where A = 0.0274 when specified smoothness is  
1000mm/km

Where A = 0.0218 when specified smoothness is 1250  
mm/km

Where s = smoothness value measured as per 401.7.1

When the measured smoothness value exceeds the specified value by 50 percent or more the LOT so measured shall be corrected, at the Contractor's expense, to comply with Tables 401.7.1E or Table 401.7.1M.

**401.13.3** - When a LOT of HMA pavement does not meet the density requirements of 401.7.2, the price shall be adjusted as follows:

<b>TABLE 401.13.3 ADJUSTMENT OF CONTRACT PRICE FOR PAVEMENT DENSITY NOT WITHIN TOLERANCE OF DENSITY</b>	
<b>Percent of Density</b>	<b>Percent of Contract Price to be Paid</b>
Greater than 96%	*
92% to 96%	100
91%	98
90%	96
89%	92
88%	88
Less Than 88%	*

\*The Division will make a special evaluation of the material and determine the appropriate action.

**401.13.4** - When a LOT of HMA pavement is determined to be statistically non-conforming in accordance with criteria 'B' of Section 401.7.3, the Division will review the plans and project records to determine if there is an acceptable explanation for this deficiency. If it is determined that a deficiency does exist, one of the following adjustments may be used. If the deficiency is less than  $\frac{3}{4}$  inch (19 mm), the Division may choose to accept the material at a price equal to the bid price times the ratio of the average thickness divided by the specified thickness. If the deficiency is  $\frac{3}{4}$  inch (19 mm) or greater, the Division may require that an additional lift of material [specified to the nearest  $\frac{1}{4}$  inch (6 mm) of the deficiency] be placed at the Contractor's expense. Retesting of the overlay will be at the expense of the Contractor in accordance with MP 109.00.20.

#### **401.14 - PAY ITEMS:**

<b>ITEM</b>	<b>DESCRIPTION</b>	<b>UNIT</b>
401001-*	TYPE, HOT-MIX ASPHALT BASE COURSE, **, TYPE "type"	TON (MG)
401002-*	HOT-MIX ASPHALT WEARING COURSE, **, TYPE "type"	TON (MG)
401003-*	HOT-MIX ASPHALT PATCHING AND LEVELING COURSE, **, TYPE "type"	TON (MG)
401004-*	HOT-MIX ASPHALT BASE COURSE, TYPE "type"	SQUARE YARD (SQUARE METER)
401005-*	HOT-MIX ASPHALT WEARING COURSE, TYPE "type"	SQUARE YARD (SQUARE METER)
401007-*	SCRATCH COURSE, **, TYPE "type"	TON (MG)

\* Sequence number; \*\* Type of Aggregate