DESCRIPTION

402-1.1 This item shall consist of a plant mixed, open-graded porous friction course, composed of mineral aggregate and bituminous material, mixed in a central mixing plant, and placed on a prepared surface in accordance with these specifications and shall conform to the dimensions and typical cross section as shown on the plans.

The porous friction course (PFC) shall be a free draining wearing surface of uniform thickness. The PFC must be placed on a prepared surface, which drains freely and does not allow ponding. The PFC shall not be applied over an existing PFC. Any existing PFC must be removed and the entire surface leveled prior to placement of a new PFC.

MATERIALS

402-2.1 AGGREGATE. The aggregate shall consist of crushed stone, crushed gravel, or crushed slag with or without other inert finely divided mineral aggregate. The aggregate shall be composed of clean, sound, tough, durable particles, free from clay balls, organic matter, and other deleterious substances. The portion of the material retained on the No. 4 sieve shall be known as coarse aggregate, the portion passing the No. 4 sieve and retained on the No. 200 sieve as fine aggregate, and the portion passing the No. 200 sieve as mineral filler.

a. Coarse Aggregate. Coarse aggregate shall contain at least 90 percent by weight crushed pieces having two or more fractured faces and 95 percent by weight particles with one or more fractured faces. The area of each face shall be equal to at least 75 percent of the smallest mid-sectional area of the piece. When two fractures are contiguous, the angle between the planes of fractures shall be at least 30° to count as two fractured faces. Fractured faces shall be obtained by crushing. The coarse aggregate shall not contain more than 10 percent, by weight of flat or elongated pieces as defined in ASTM D 4791 at a 1:5 ratio of minimum to maximum dimension. The percentage of wear shall not be greater than 25 percent when tested in accordance with ASTM C 131. The sodium sulfate soundness loss shall not exceed 12 percent after five cycles, when tested in accordance with ASTM C 88.

b. Fine Aggregate. Fine aggregate shall have a plasticity index of not more than 6.0 and a liquid limit of not more than 25 when tested in accordance with ASTM D 4318.

If necessary, natural sand may be used to obtain the gradation of aggregate blend or workability. The amount of sand to be added will be adjusted to produce mixtures conforming to requirements of this specification.

402-2.2 FILLER. If filler, in addition to that naturally present in the aggregate, is necessary, it shall meet the requirements of ASTM D 242. When mineral filler is required to be batched separately, hydrated lime in the amount of 1.5 percent maximum by weight of the total aggregate shall be batched as part of the added mineral filler. No additional compensation will be allowed the Contractor for furnishing and using hydrated lime or other approved mineral filler that may be required by this specification.

402-2.3 BITUMINOUS MATERIAL. Asphalt cement binder shall conform to ASTM D 6373 Performance Grade (PG) 70-28 for all projects located within the Lower Peninsula or 64-34P for all projects located in the Upper Peninsula, unless otherwise specified on the plans. A certificate of compliance from the manufacturer shall be included with the mix design submittal. Sources for asphalt
cement binder must be selected from an approved manufacturer in MDOT’s Materials Source Guide. Asphalt cement binder for each mix design shall be produced by a single manufacturer unless otherwise authorized by the Engineer.

The refined binder shall not be air-blown, oxidized, or produced from recycled engine oil bottoms (REOB). Asphalt modified with Styrene Butadiene Rubber (SBR), Styrene Butadiene (SB), or Styrene Butadiene Styrene (SBS) shall contain a minimum of 2.5% by weight of polymer solids. A sample of the proposed binder and a Fourier Transform Infrared (FTIR) scan which determined the styrene and butadiene peaks along with the percentage of polymer added shall be submitted to the Engineer for evaluation and acceptance prior to use.

Certified test results with test data indicating grade certification for the asphalt binder from the supplier plus a sample of the bitumen-synthetic rubber mixture shall be provided to the Engineer for each tank load shipped to the project or for each batch, whichever is smaller. Samples being tested shall contain the anti-stripping agent or additive. No material shall be used on the project before the test results are delivered to the Engineer. The Engineer may conduct independent acceptance tests on random samples by an ASTM D 3666 or AASHTO R-18 accredited lab. Material placed which does not meet specification requirements shall be removed and replaced at no additional cost to the owner in accordance with section 4.14. The Contractor shall submit test results to have a minimum Tensile Strength Ratio (TSR) value of .70, a minimum conditional tensile strength of 50 psi and a minimum unconditional tensile strength of 70 after one freeze and thaw cycle in accordance with AASHTO PP77.

402-2.4 ANTI-STRIPPING AGENT. Any anti-stripping agent or additive shall be heat stable, shall not change the asphalt cement viscosity beyond specifications, shall contain no harmful ingredients, shall be added in recommended proportion by approved method.

COMPOSITION

402-3.1 COMPOSITION OF MIXTURE. The porous friction course shall be composed of aggregate, filler, bituminous material-synthetic rubber mixture, and anti-stripping agent.

402-3.2 JOB MIX FORMULA. No bituminous mixture shall be produced for payment until the Engineer has given written approval of the job mix formula. The job mix shall be prepared by a certified laboratory at the Contractor’s expense and shall remain in effect for the duration of the project. The job mix formula shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate, the amount of anti-strip agent to be added (minimum of one half of one percent by weight), and a single temperature for the mixture as it is discharged into the hauling units. Silicone may be added to the mixture at a maximum rate of 1 ounce per 5,000 gallons of asphalt to facilitate laydown and rolling. Proper asphalt content shall be determined by mixing trial batches in the laboratory.

The job mix formula shall be submitted to the Engineer at least 10 days prior to the start of paving and shall include:

a. Percent passing each sieve size and gradation requirements.
b. Percent of asphalt cement.
c. Mixing temperature range.
d. Temperature of mix when discharged from the mixer.
e. Lay down temperature.
f. Percent of wear (LA abrasion).
g. Plasticity Index and Liquid Limit of fine aggregate.
h. Percent fractured faces.
i. Percent flat or elongated particles.

j. Anti-strip agent and amount used.

k. Tensile strengths and Tensile Strength Ratio (TSR).

l. Cantabro unaged abrasion percent.

m. Laboratory certifications.

n. Bituminous plant certifications.

The combined aggregate shall be of such size that the percentage composition by weight, as determined by laboratory sieves, will conform to the gradation shown in Table 2 when tested in accordance with ASTM C 136.

The gradations in Table 2 represent the limits, which determine the suitability of the aggregate for use from the source of supply. The aggregate, as finally selected, shall have a gradation within the limits designated in Table 2 and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve, or vice versa, but shall be uniformly graded from coarse to fine.

No change will be made to any component of the bituminous mix without a new job mix formula being submitted and approved by the Project Engineer before any additional material on the project is produced and placed. When unsatisfactory results or other conditions make it necessary, the Project Engineer may require a new job mix formula be established.

### Table 2. Aggregate-Porous Friction Course

<table>
<thead>
<tr>
<th>Percentage By Weight Passing Sieves, Bitumen and Mix Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3/4”</td>
</tr>
<tr>
<td>1/2”</td>
</tr>
<tr>
<td>3/8”</td>
</tr>
<tr>
<td>#4</td>
</tr>
<tr>
<td>#8</td>
</tr>
<tr>
<td>#30</td>
</tr>
<tr>
<td>#200</td>
</tr>
<tr>
<td>Bitumen</td>
</tr>
<tr>
<td>Temperature of Mix</td>
</tr>
</tbody>
</table>

The gradations shown are based on aggregates of uniform specific gravity. The percentages passing the various sieves will be subject to appropriate adjustments by the Contractors approved laboratory when aggregates of varying specific gravities are used. The adjustments to the job mix gradation curve should result in a curve of the same general shape as the median curve of the gradation band in Table 2 and fall within the gradation band.

The Asphalt Institutes Manual Series No. 2 (MS-2) contains a convenient procedure for “adjusting” the job mix gradation when aggregates of non-uniform specific gravity are proposed for use.

The bituminous content of porous friction courses shall be expressed as a percentage of the total mix by weight and shall be approved by the Engineer on the basis of laboratory tests. The materials used in the mix design shall be the same as those used on the project.

The bituminous content shall be within plus or minus 1 percent of the value obtained from the formula:

$$2Kc + 4.0$$
where \( K_c \) is the surface area constant for that part of the total dry aggregate that will pass a \( \frac{3}{4} \) in sieve and be retained on the No. 4 sieve. Procedures for determining \( K_c \) are contained in the Asphalt Institute’s Manual Series No. 2 (MS-2). The bituminous content so estimated is the percentage by weight of the total dry aggregates and must be converted to the percent by weight of the total mix in the approved job-mix formula.

The contractor’s laboratory used to develop the job mix formula shall meet the requirements of ASTM D 3666 or AASHTO R-18. The laboratory accreditation must be current and listed on the accrediting authority’s website. All test methods required for developing the JMF must be listed on the lab accreditation. A copy of the laboratory’s current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

The Cantabro Abrasion test will be performed as directed in ASTM D7064 Appendix X2 and the abrasion loss must be less than 20 percent. If the loss is greater than 20 percent the Contractor shall not start production until such out-of-tolerance conditions have been remedied.

**402-3.3 TEST SECTION.** At least one full day prior to full production, the Contractor shall prepare a quantity of bituminous mixture according to the approved job mix formula. The amount of mixture should be sufficient to construct a test section at least 8,000 square feet, placed with at least one complete longitudinal joint and of the same depth specified on the plans. The test section should be paved using the same paving lane widths as anticipated for full production paving. The test area will be designated by the Engineer. The underlying pavement on which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment to be used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section. No bituminous mixture shall be produced for payment prior to successful placement of and acceptance of a test strip by the Engineer.

If the test section should prove to be unsatisfactory, the necessary adjustments to plant operation, and/or placement procedures shall be made. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. When the test section does not conform to specification requirements the test section shall be removed and replaced at the Contractors expense. Full production shall not begin without approval of the Engineer. Test sections, which conform to specification requirements, shall be measured and paid in accordance with Paragraphs 402-5.1 and 402-6.1.

**CONSTRUCTION METHODS**

**402-4.1 WEATHER AND SEASONAL LIMITATIONS.** The porous friction course shall be constructed only on a dry surface when the atmospheric temperature is a minimum of 50 °F (at calm wind conditions less than 10 mph) and when the weather is not foggy, imminently rainy or rainy.

**402-4.2 BITUMINOUS MIXING PLANT.** Plants used for the preparation of bituminous mixtures shall conform to the requirements of AASHTO M156 with the following changes or be certified in accordance with the Department’s HMA Production Manual:

Requirements for all plants include:

1. Truck Scales. The bituminous mixture shall be weighed on approved scales furnished by the Contractor, or on public scales at the Contractor’s expense. Such scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. Scales shall conform to the requirements of Section 90.

2. Testing Laboratory. The Contractor or producer shall provide laboratory facilities for control and acceptance testing functions during periods of mix production, sampling, and testing and whenever materials subject to the provisions of these specifications are being supplied or tested. The laboratory
shall provide adequate equipment, space, and utilities as required for the performance of the specified tests. The testing laboratory to be provided may be the same, or in conjunction with, the contractor’s quality control lab.

(3) Inspection of Plant. The Engineer, or Engineer’s authorized representative, shall have access, at all times, to all parts of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and materials properties; and checking the temperatures maintained in the preparation of the mixtures.

402-4.3 HAULING EQUIPMENT. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth metal beds. Live-bottom trailers may be used in lieu of traditional tandem dump trucks. Petroleum products shall not be used for coating truck beds. To prevent the mixture from adhering to them, the beds shall be lightly coated with an approved asphalt release agent. The truck beds shall be raised to drain any excess solution before loading the mixture in the trucks. Each truck shall have a suitable cover to protect the mixture from adverse weather. Truck beds shall be insulated and covers shall be securely fastened so that the mixture will be delivered to the site at the specified temperature.

402-4.4 BITUMINOUS PAVERS. Bituminous pavers shall be self-contained, power-propelled units with an activated screed or strike-off assembly, heated if necessary, and shall be capable of spreading and finishing courses of bituminous plant-mix material which will meet the specified thickness, smoothness, and grade.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed. The screed or strike-off assembly shall effectively produce a finished surface of the required smoothness and texture without tearing, shoving, or gouging the mixture.

The paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture.

Pavers shall be equipped with an automatic grade control system capable of maintaining the screed elevation as specified herein. The control system shall be automatically activated from either a reference line or surface through a system of mechanical sensors or sensor-directed mechanisms or devices that will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface.

The controls shall be capable of working in conjunction with any of the following attachments:

a. Ski-Type device of not less than 30 feet in length or as directed by the Engineer.
b. Taut stringline (wire) set to grade.
c. Short ski or shoe.
d. Laser controls.
e. Paver speed must be less than 50 feet per minute

The controls shall be so arranged that independent longitudinal grade controls can be operated simultaneously on both sides of the machine or independently on either side. The electronic controls shall be arranged so that the machine can be controlled automatically, semi-automatically, or manually.

The automatic equipment shall be capable of controlling the grade to within plus or minus 1/8 in and the transverse slope to within plus or minus one tenth of one percent from the controlling grade.
The machine shall be equipped with a spirit level or other type of slope indicator that will continuously indicate the average transverse slope of the screen. Curvature of spirit level tubes shall be as required to produce a bubble movement of not less than 1/8 in for each 1/10th of 1% change in the transverse slope.

402-4.5 ROLLERS. Rollers shall be steel wheel. Split drum rollers are not acceptable. They shall be in good condition, capable of reversing without backlash, and operating at slow speeds to avoid displacement of the bituminous mixture. The wheels shall be equipped with adjustable scrapers and sprinkling apparatuses using a water soluble asphalt release agent, approved by the engineer, to prevent the bituminous mixture from sticking to the wheels. The number, type, and weight of rollers shall be sufficient to compact the mixture without detrimentally affecting the material.

402-4.6 PREPARATION OF MINERAL AGGREGATE. The aggregate for the mixture shall be dried and heated before the addition of asphalt cement and ensure a uniform mix temperature within the production limits of the Job Mix Formula as shown in Table 2. Do not allow aggregate to become contaminated with fuel during heating. Reduce the absorbed moisture in the aggregate until the asphalt cement does not separate from the aggregate in the prepared mixture.

402-4.7 PREPARATION OF BITUMINOUS MIXTURE. The bituminous mixture shall be prepared in a central mixing plant. The mixture shall be prepared at the temperature designated by the mix design and as required by the asphalt binder supplier but should not exceed a maximum of 350°F.

The dry aggregate shall be combined in the plant using the proportionate amounts of each aggregate size required to meet the specified gradation. The quantity of aggregate shall be determined, measured, and conveyed into the mixer.

The quantity of bituminous material for the calibrated amount for continuous mixers shall be determined by the certified laboratory that prepared the mix design. It shall be measured by weight and introduced into the mixer within the temperature range specified in the job mix formula. In no case shall the temperature of the aggregate be more than 25 °F above the temperature of the bituminous material. Mixing shall continue until all particles are coated uniformly. If the bituminous mixture is to be stored in storage silos or surge bins, it will be for less than two hours.

402-4.8 TRANSPORTATION AND DELIVERY OF THE MIXTURE. The mixture shall be placed at a temperature between 250 °F and 300 °F and in accordance with the job mix formula and as required by the asphalt binder supplier. Loads shall be sent from the plant so that all spreading and compacting of the mixture may be accomplished during daylight hours unless artificial lighting approved by the Engineer is provided. Excessive waiting or delay of haul trucks at the job site shall not be allowed and in no case will exceed two hours from loading to unloading and mix supplied at temperatures outside the specified range will not be accepted. Bleeding and rich spots resulting from segregation during transportation shall not be accepted.

402-4.9 SPREADING AND LAYING. Immediately before placing the porous friction course, the underlying course shall be cleared of all loose or deleterious material with power blowers, power brooms, or hand brooms as directed. A tack coat conforming to Item P-603 Bituminous Tack Coat shall be placed on all existing surfaces for bonding the PFC to the existing surface. Placement of the PFC must be delayed until the tack coat has properly cured.

The mixture shall be deposited from haul units directly into the laydown machine hopper and placed in a continuous operation.

Hauling over material already placed shall not be permitted until the material has been thoroughly compacted and allowed to cure for a period of at least 12 hours.
402-4.10 COMPACTION OF MIXTURE. After spreading, rolling shall be done immediately. Two or four passes, at the discretion of the Engineer (but generally two passes with the breakdown roller and two passes with the finish roller), with a steel wheel roller, shall be made for compaction. The compaction equipment number, size, type, operation and condition is subject to the Engineer’s approval. Care should be taken to avoid over rolling or rolling when material is too cool. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened using a water soluble asphalt release agent approved by the engineer. Rolling operations shall be conducted in such a manner that shoving or distortion will not develop. The amount of rolling shall be limited to only that necessary for compacting the porous friction course and bonding it to the underlying surface course. Any mixture, which becomes loose, broken, mixed with dirt, or in any way defective, shall be removed and replaced with fresh mixture and immediately compacted to conform to the surrounding area. Such rework shall be done at the Contractor’s expense. Spreading of the mixture shall be done carefully with particular attention given to making the operation as continuous as possible. Hand working shall be kept to an absolute minimum.

402-4.11 JOINTS. The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture, density, and smoothness as other sections of the course.

The roller shall not pass over the unprotected end of the freshly laid mixture except when approved by the Engineer and necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course, in which case the edge shall be cut back to its full depth and width on a straight line to expose vertical face.

Longitudinal joints which are irregular, damaged, or otherwise defective shall be cut back to expose a clean, sound surface for the full depth of the course. All contact surfaces with non-PFC surfaces shall be given a tack coat of bituminous material prior to placing any fresh mixture against the joint. The longitudinal joint shall be offset from any existing underlying course joint by at least 1 ft.

402-4.12 SHAPING EDGES. While the surface is being compacted and finished, the Contractor shall carefully shape the longitudinal outside edges of the PFC to a vertical face at the established edge. When transitioning from PFC to existing pavement, transverse edges shall be constructed with a finer graded bituminous mixture.

Edge lips shall not exceed 3 in; however, they are preferred to be less than 1.5 in.

402-4.13 SURFACE TESTS. The Contractor is responsible for supplying an acceptable metal 12 ft straight edge. After completion of final rolling, the finished surface shall be tested with the 12 ft straightedge and shall not vary more than 1/4 in. The 12 ft straight edge shall be applied parallel with and at right angles to the runway centerline in a pattern that includes longitudinal and transverse joints. The 12 ft straightedge shall be advanced approximately 1/2 its length in the line of measurement. Areas of the porous friction course exceeding the specified tolerances shall be removed, as directed by the Engineer, and replaced with new material at the Contractor’s expense. The Engineer shall immediately notify the Contractor of such unsatisfactory visual defects such as non-uniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture during rolling operations. Areas of the porous friction course, which possess such defects, shall be removed, as directed by the Engineer, and replaced with new material at the Contractors expense. Skin patching or hand working shall not be permitted.

402-4.14 ACCEPTANCE SAMPLING AND TESTING OF BITUMINOUS MATERIAL AND AGGREGATE. The Engineer, at no cost to the Contractor, shall perform all acceptance sampling and testing. The testing laboratory performing the testing shall meet the requirements of ASTM D 3666 or AASHTO R-18. Samples of the PFC mixture shall be taken from loaded trucks at the plant site or transversely across the mat immediately behind the paver screed, and tested to control uniformity in bituminous content and gradation. Samples shall be taken in accordance with ASTM D 979 and prepared
in accordance with ASTM D 2172 or ASTM D 6307. One sample shall be taken from each lot on a random basis in accordance with procedures contained in ASTM D 3665. A lot shall consist of 1,000 tons or 1/2 day’s production, whichever is less. The Engineer will notify the Contractor within 24 hours after receiving the official test results. Should the average bituminous content for any two consecutive lots not fall within job mix tolerances under 402-3.1, the Contractor shall cease production until such out-of-tolerance conditions have been remedied. Any material, placed after the contractor has been informed of two consecutive failing tests, shall be rejected, removed and replaced at the Contractor’s expense. All out-of-tolerance areas shall be deducted from the total square yards porous friction course for payment. If, in the Project Engineer’s judgement, such out-of-tolerance areas warrant removal, the porous friction course shall be removed and the underlying course shall be cleaned (ready for reconstruction), all at the Contractor’s expense.

Aggregate from each stockpile shall be sampled on a random basis and tested for gradation analysis in accordance with ASTM C 136. One sample shall be taken on a random basis in accordance with ASTM D 3665 for each lot. A lot shall consist of 500 tons or 1/4 day’s production, whichever is less. The Engineer will notify the Contractor within 24 hours after receiving the official test results. If any two consecutive samples fail to meet the tolerances of the job mix formula gradation, the Contractor shall cease plant production until such out-of-tolerance conditions have been remedied. Any material, placed after the contractor has been informed of two consecutive failing tests, shall be rejected, removed and replaced at the Contractor’s expense. All out-of-tolerance areas shall be deducted from the total square yards porous friction course for payment. If, in the Project Engineer’s judgement, such out-of-tolerance areas warrant removal, the porous friction course shall be removed and the underlying course shall be cleaned (ready for reconstruction), all at the Contractor’s expense.

The Engineer will notify the Contractor of unsatisfactory visual defects in the completed bituminous friction course such as non-uniform texture, roller marks, bleeding of bituminous material, cracking and shoving of the mixture during the roller operations, or nonconformance to the surface smoothness criteria specified. Unsatisfactory bituminous porous friction course shall be removed and replaced at the Contractor’s expense as directed by the Engineer.

402-4.15 BITUMINOUS AND AGGREGATE MATERIAL (CONTRACTOR’S RESPONSIBILITY). Samples of the bituminous and aggregate materials that the Contractor proposes to use, together with a statement of their source and character, shall be submitted for approval prior to use. The Contractor shall require the manufacturer or producer of the bituminous and aggregate materials to furnish material subject to this and all other pertinent requirements of the contract. Only those materials that have been tested and approved for the intended use shall be acceptable.

The Contractor shall furnish the vendor’s certified test reports for each load of bituminous material shipped to the project. The report shall be delivered to the Engineer before permission is granted to use the material. The vendor’s certified test report for the bituminous material shall not be interpreted as a basis for final acceptance. All test reports shall be subject to verification by testing sample materials received for use on the project.

402-4.16 PROTECTION OF PAVEMENT. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement until it has cured at least 12 hours or unless otherwise authorized by the Engineer. Newly constructed pavement areas shall not be opened to aircraft traffic until 24 hours after completion or unless otherwise authorized by the Engineer.

402-4.17 REMOVAL AND REPLACEMENT. If the Contractor is required to remove and replace the porous friction course for any reason identified in this specification, the removal and replacement shall be completed in accordance with this section at no cost to the owner.
The Contractor shall remove the unsatisfactory porous friction course and the underlying dense graded hot mix asphalt (HMA) course within the limits, determined by the engineer, to a minimum of 1.5” below the bottom of the porous friction course layer. However, in no case shall the remaining thickness of the underlying dense graded HMA lift be less than 1”. If the remaining thickness of the underlying dense graded HMA lift is less than 1”, the contractor shall be required to remove the full depth thickness of the lift. Note that the required removal depth is determined based on the thickness of the underlying dense graded HMA lift and not the total thickness of the dense graded HMA layer.

Removal of unsatisfactory material shall be completed by the use of a power operated cold milling machine and be performed in accordance with FAA specification P-101, unless another method is submitted by the Contractor and approved by the Engineer. The contractor shall be responsible for milling machine setup and grade control methods to ensure the material within the removal limits is removed to the proper depth as described above. Grade control methods shall be approved by the Engineer prior to removal of any material. When removal efforts are complete the Contractor shall be required to submit survey data, completed and stamped by the registered professional surveyor, to the Engineer for the purpose of grade verification. The milled surface shall vary by no more than + 1/4 inch from the planned grades, as submitted by the Contractor and approved by the Engineer. If the milled surface has areas exceeding + 1/4 inch from planned grades, the Contractor shall re-mill as required. The milled surface shall be surveyed at intervals of no greater than 25’ in both longitudinal and transverse direction.

Prior to the reapplication of the porous friction course material, the Contractor shall re-pave the removed portion of HMA in accordance with original specification governing the placement of the removed underlying dense graded HMA, as approved by the Engineer. After dense graded HMA paving is complete the Contractor shall be required to submit survey data, completed and stamped by the registered professional surveyor, to the Engineer for the purpose of grade verification. The surface shall be surveyed at intervals of no greater than 25’ in both longitudinal and transverse directions.

Following dense graded HMA paving, the contractor shall re-apply a porous friction course in accordance with this specification. Acceptance of the replacement porous friction course material and placement will be determined in accordance with applicable sections in this specification.

The entirety of the cost for removal and replacement, including all depth & grade control methods, as well as Contractor & Owner/Engineer efforts required for grade verification shall be the responsibility of the Contractor. In addition, the Contractor shall be responsible for any costs incurred by the Owner/Engineer for required quality assurance testing as outlined per this specification and all referenced specifications.

**METHOD OF MEASUREMENT**

402-5.1 Porous friction course shall be measured by the number of square yards of mixture used in the accepted work.

Only the areas of the porous friction course meeting the following thickness requirements shall be measured for payment:

To determine the thickness of the finished PFC, the Contractor shall take one core sample, at locations determined by the Project Engineer, not less than 2 in in diameter, at random from each unit of the completed PFC area. A unit of the completed area shall be 10,000 square yards of pavement.

When the measurement of any core is more than the maximum or less than the minimum allowable thickness, as shown in Table 3, additional cores shall be taken at 20 ft intervals (parallel to and at right angles to the runway centerline) until the completed PFC is within such maximum or minimum thickness
for the subunit being tested. Out-of-tolerance areas shall be deducted from the total square yards PFC for payment. If, in the Engineer’s judgment, such out of tolerance areas warrant removal, the PFC shall be removed and the underlying course shall be cleaned (ready for reconstruction), all at the Contractor’s expense.

Table 3. Allowable Finished PFC Thickness

<table>
<thead>
<tr>
<th></th>
<th>Nominal</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4 in aggregate</td>
<td>1.0</td>
<td>1.50</td>
<td>0.75</td>
</tr>
<tr>
<td>1/2 in aggregate</td>
<td>0.75</td>
<td>1.25</td>
<td>0.50</td>
</tr>
</tbody>
</table>

BASIS OF PAYMENT

402-6.1 Payment shall be made at the respective contract prices per square yard for porous friction course. The prices shall be full compensation for furnishing all materials; for all preparation and storage of materials; for cleaning the existing surface; for mixing, hauling, placing, and compacting the mixture (including initial test section); and for all tools, equipment, and incidentals necessary to complete each item. No separate payment is included in the contract for furnishing and batching mineral filler, or anti-stripping agents, should such items be required.

Rehabilitation of the existing pavement surface and the tack coat shall be measured and paid for at their respective contract prices.

Minimum and maximum thickness tolerances for either the 3/4” maximum aggregate size PFC or the 1/2” maximum aggregate size PFC as shown in Table 3 shall be observed. In addition, the average of core samples shall be greater than or equal to the nominal thickness shown in Table 3. See Section 402-5.1 for coring procedures. If the average of the cores required in section 5.1 does not meet or exceed the nominal thickness specified, an adjusted payment schedule shall be applied. The pay factor shall be calculated in accordance with Table 4 below.
Table 4. Price Adjustment Schedule

<table>
<thead>
<tr>
<th>3/4” Maximum Aggregate:</th>
<th>Lot Pay Factor (Percent of Contract Unit Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Thickness of Cores (per Lot)</td>
<td></td>
</tr>
<tr>
<td>&gt; 1 1/2”</td>
<td>75%</td>
</tr>
<tr>
<td>≥ 1” and ≤ 1 1/2”</td>
<td>100%</td>
</tr>
<tr>
<td>&lt; 1” and ≥ 7/8”</td>
<td>90%</td>
</tr>
<tr>
<td>&lt; 7/8” and ≥ 3/4”</td>
<td>60%</td>
</tr>
<tr>
<td>&lt; 3/4”</td>
<td>Reject ¹</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1/2” Maximum Aggregate:</th>
<th>Lot Pay Factor (Percent of Contract Unit Price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Thickness of Cores (per Lot)</td>
<td></td>
</tr>
<tr>
<td>&gt; 1 1/4”</td>
<td>75%</td>
</tr>
<tr>
<td>≥ 3/4” to ≤ 1 1/4”</td>
<td>100%</td>
</tr>
<tr>
<td>&lt; 3/4” and ≥ 5/8”</td>
<td>90%</td>
</tr>
<tr>
<td>&lt; 5/8” and ≥ 1/2”</td>
<td>60%</td>
</tr>
<tr>
<td>&lt; 1/2”</td>
<td>Reject ¹</td>
</tr>
</tbody>
</table>

¹The lot shall be removed and replaced. However, the Engineer may decide to allow the rejected lot to remain. In that case, if the Engineer and Contractor agree in writing that the lot shall not be removed, it shall be paid for at 50% of the contract unit price and the total project payment shall be reduced by the amount withheld for the rejected lot.

Porous friction course shall be limited to the maximum thickness shown in Table 3. At the discretion of the Engineer, PFC areas exceeding the maximum thickness may be removed and replaced at the Contractor’s expense in accordance with the procedure outlined in this specification. In no case shall payment for the total project payment, exceed 100% of the area of porous friction course completed and accepted.

Payment will be made under the nomenclature and seven digit item number specified in the plans and proposal for Porous Friction Course required per square yard. The first three digits of any item for work included under this specification shall be 402, ie. 402XXXX.

**TESTING REQUIREMENTS**

- ASTM C 88  Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- ASTM C 127  Density, Specific Gravity, and Absorption of Coarse Aggregates
- ASTM C 128  Density, Specific Gravity, and Absorption of Fine Aggregate
- ASTM C 131  Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
- ASTM C 136  Sieve Analysis of Fine and Coarse Aggregates
<table>
<thead>
<tr>
<th>ASTM C 566</th>
<th>Total Evaporable Moisture Content of Aggregate by Drying</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D 4791</td>
<td>Flat Particles, Elongated Particles or Flat and Elongated Particles in Coarse Aggregate</td>
</tr>
<tr>
<td>ASTM D 979</td>
<td>Sampling Bituminous Paving Mixtures</td>
</tr>
<tr>
<td>ASTM D 2172</td>
<td>Quantitative Extraction of Bitumen from Bituminous Paving Mixtures</td>
</tr>
<tr>
<td>ASTM D 3665</td>
<td>Random Sampling of Paving Materials</td>
</tr>
<tr>
<td>ASTM D 3666</td>
<td>Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials</td>
</tr>
<tr>
<td>ASTM D 4318</td>
<td>Liquid Limit, Plastic Limit, and Plasticity Index of Soils</td>
</tr>
<tr>
<td>ASTM D 6307</td>
<td>Standard Test Method for Asphalt Content of Hot Mix Asphalt by Ignition Method</td>
</tr>
<tr>
<td>ASTM D 7064</td>
<td>Open-Graded Friction Course (OGFC) Mix Design</td>
</tr>
<tr>
<td>AASHTO R-18</td>
<td>Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories</td>
</tr>
<tr>
<td>AASHTO PP77</td>
<td>Materials Selection and Mixture Design of Permeable Friction Courses</td>
</tr>
<tr>
<td>AASHTO M156</td>
<td>Requirements for Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.</td>
</tr>
</tbody>
</table>

**MATERIAL REQUIREMENTS**

<table>
<thead>
<tr>
<th>ASTM D 242</th>
<th>Mineral Filler for Bituminous Paving Mixtures</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM D6373</td>
<td>Standard Specification for Performance Graded Asphalt Binder</td>
</tr>
</tbody>
</table>

END OF ITEM P-402