

## SECTION 337 ASPHALT CONCRETE FRICTION COURSES

### **337-1 Description.**

Construct an asphalt concrete friction course pavement with the type of mixture specified in the Contract Documents, or when offered as alternates, as selected. This Section specifies mixes designated as FC-5, FC-9.5, and FC-12.5.

Obtain Superpave asphalt concrete friction course from a plant that is currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105. Producers must meet the plant and equipment requirements of Section 320, as modified herein. Meet the general construction requirements of Section 330, as modified herein.

### **337-2 Materials.**

**337-2.1 General Requirements:** Meet the requirements specified in Division III as modified herein. The Engineer will base continuing approval of material sources on field performance. Warm mix technologies (additives, foaming techniques, etc.) listed on the Department's website may be used in the production of the mix. The URL for obtaining this information is: <http://www.fdot.gov/materials/mac/production/warmmixasphalt/>.

**337-2.2 Asphalt Binder:** Meet the requirements of Section 916, and any additional requirements or modifications specified herein for the various mixtures.

**337-2.3 Coarse Aggregate:** Meet the requirements of Section 901, and any additional requirements or modifications specified herein for the various mixtures.

**337-2.4 Fine Aggregate:** Meet the requirements of Section 902, and any additional requirements or modifications specified herein for the various mixtures.

**337-2.5 Hydrated Lime:** Meet the requirements of AASHTO M 303-89 (2010), Type 1. Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications.

**337-2.6 Liquid Anti-strip Additive:** Meet the requirements of 916-4 and be listed on the Department's Approved Product List (APL).

**337-2.7 Fiber Stabilizing Additive (Required for FC-5 only):** Use either a mineral or cellulose fiber stabilizing additive. Meet the following requirements:

**337-2.7.1 Mineral Fibers:** Use mineral fibers (made from virgin basalt, diabase, or slag) treated with a cationic sizing agent to enhance the disbursement of the fiber, as well as to increase adhesion of the fiber surface to the bitumen. Meet the following requirements for physical properties:

1. Size Analysis
  - Average fiber length: 0.25 inch (maximum)
  - Average fiber thickness: 0.0002 inch (maximum)
2. Shot Content (ASTM C612-10)
  - Percent passing No. 60 Sieve: 90 - 100
  - Percent passing No. 230 Sieve: 65 - 100

Provide certified test results for each batch of fiber material indicating compliance with the above tests.

**337-2.7.2 Cellulose Fibers:** Use cellulose fibers meeting the following requirements:

1. Fiber length: 0.25 inch (maximum)
  2. Sieve Analysis
    - a. Alpine Sieve Method  
Percent passing No. 100 sieve: 60-80
    - b. Ro-Tap Sieve Method  
Percent passing No. 20 sieve: 80-95  
Percent passing No. 40 sieve: 45-85  
Percent passing No. 100 sieve: 5-40
  3. Ash Content: 18% non-volatiles (plus or minus 5%)
  4. pH: 7.5 (plus or minus 1.0)
  5. Oil Absorption: 5.0% (plus or minus 1.0) (times fiber weight)
  6. Moisture Content: 5.0% by weight (maximum)
- Provide certified test results for each batch of fiber material indicating compliance with the above tests.

### **337-3 General Composition of Mixes.**

**337-3.1 General:** Use a bituminous mixture composed of aggregate (coarse, fine, or a mixture thereof), asphalt binder, and in some cases, fibers and/or hydrated lime. Size, uniformly grade and combine the aggregate fractions in such proportions that the resulting mix meets the requirements of this Section.

#### **337-3.2 Specific Component Requirements by Mix:**

##### **337-3.2.1 FC-5:**

**337-3.2.1.1 Aggregates:** Use an aggregate blend which consists of either 100% crushed granite and/or granitic gneiss or 100% crushed limestone and/or crushed shell rock. Do not blend granite and/or granitic gneiss with limestone and/or shell rock for FC-5 mixtures.

A list of aggregates approved for use in friction course may be available on the Department's website. The URL for obtaining this information, if available, is: <https://mac.fdot.gov/>.

**337-3.2.1.2 Asphalt Binder:** Use an asphalt binder as called for in the Contract Documents meeting the requirements of Section 916.

**337-3.2.1.3 Hydrated Lime:** Add the lime at a dosage rate of 1.0% by weight of the total dry aggregate to mixes containing granite.

**337-3.2.1.4 Liquid Anti-strip Additive:** Use a liquid anti-strip additive for mixtures containing limestone aggregate.

**337-3.2.1.5 Fiber Stabilizing Additive:** Add either mineral fibers at a dosage rate of 0.4% by weight of the total mix, or cellulose fibers at a dosage rate of 0.3% by weight of total mix.

##### **337-3.2.2 FC-9.5 and FC-12.5:**

**337-3.2.2.1: Aggregates:** Use an aggregate blend of approved friction course aggregates that consists of crushed granite, crushed granitic gneiss, crushed limestone, crushed shell rock, or a combination of the above. As an exception, mixes that contain a minimum of 60% of approved friction course aggregates of crushed granite and/or crushed granitic gneiss may either contain: up to 40% fine aggregate from other sources of aggregate not approved for friction courses or a combination of up to 20% RAP and the remaining fine aggregate from other sources of aggregate not approved for friction courses. Mixtures utilizing High Polymer (HP) binder are not allowed to contain RAP.

A list of aggregates approved for use in friction course may be available on the Department's website. The URL for obtaining this information, if available, is: <https://mac.fdot.gov/>.

**337-3.2.2.2: Asphalt Binder:** Use an asphalt binder as called for in the Contract Documents meeting the requirements of Section 916.

**337-3.3 Grading Requirements:**

**337-3.3.1 FC-5:** Use a mixture having a gradation at design within the ranges shown in Table 337-1.

Table 337-1 FC-5 Gradation Design Range									
3/4 inch	1/2 inch	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	No. 200
100	85-100	55-75	15-25	5-10	--	--	--	--	2-4

**337-3.3.2 FC-9.5:** Meet the design gradation requirements for a SP-9.5 Superpave fine mix as defined in 334-3.2.2.

**337-3.3.3 FC-12.5:** Meet the design gradation requirements for a SP-12.5 Superpave fine mix as defined in 334-3.2.2.

**337-4 Mix Design.**

**337-4.1 FC-5:** The Department will design the FC-5 mixtures. Furnish the materials and all appropriate information (source, gradation, etc.) as specified in 334-3.2.7. The Department will have two weeks to design the mix.

The Department will establish the design binder content for FC-5 within the following ranges based on aggregate type:

Aggregate Type	Binder Content
Crushed Granite and/or Granitic Gneiss	5.5 - 7.5
Crushed Limestone and/or Shell Rock	6.0 - 8.0

**337-4.2 FC-9.5 and FC-12.5:** Provide a mix design conforming to the requirements of 334-3.2 unless otherwise designated in the plans.

**337-4.3 Revision of Mix Design:** For FC-5, FC-9.5 and FC-12.5, meet the requirements of 334-3.3. For FC-5, all revisions must fall within the gradation limits defined in Table 337-1.

**337-5 Contractor's Process Control.**

Provide the necessary process control of the friction course mix and construction in accordance with the applicable provisions of 320-2, 330-2 and 334-4.

The Engineer will monitor the spread rate periodically to ensure uniform thickness. Perform quality control procedures for daily monitoring and control of spread rate variability. If the spread rate varies by more than 5% of the spread rate set by the Engineer in accordance with 337-8, immediately make all corrections necessary to bring the spread rate into the acceptable range.

**337-6 Acceptance of the Mixture.**

**337-6.1 FC-9.5 and FC-12.5:** Meet the requirements of 334-5.

**337-6.2 FC-5:** Meet the requirements of 334-5 with the following exceptions:

1. The mixture will be accepted with respect to gradation ( $P_{-3/8}$ ,  $P_{-4}$ , and  $P_{-8}$ ), and asphalt binder content ( $P_b$ ) only.
2. Testing in accordance with AASHTO T 312-12 and FM 1-T 209 (and conditioning prior to testing) will not be required as part of 334-5.1.1.
3. The standard LOT size of FC-5 will be 2,000 tons, with each LOT subdivided into four equal sublots of 500 tons each.
4. The Between-Laboratory Precision Values described in Table 334-5 are modified to include ( $P_{-3/8}$ ,  $P_{-4}$ , and  $P_{-8}$ ) with a maximum difference per FM 1-T 030 (Figure 2).
5. Table 334-4 (Master Production Range) is replaced by Table 337-2.
6. The mixture will be accepted on the roadway with respect to surface tolerance in accordance with 334-5.8. No density testing will be required for these mixtures.

Table 337-2 FC-5 Master Production Range	
Characteristic	Tolerance (1)
Asphalt Binder Content (%)	Target $\pm$ 0.60
Passing 3/8 inch Sieve (%)	Target $\pm$ 7.50
Passing No. 4 Sieve (%)	Target $\pm$ 6.00
Passing No. 8 Sieve (%)	Target $\pm$ 3.50
(1) Tolerances for sample size of $n = 1$ from the verified mix design	

**337-6.2.1 Individual Test Tolerances for FC-5 Production:** Terminate the LOT if any of the following Quality Control (QC) failures occur:

1. An individual test result of a subplot for asphalt binder content does not meet the requirements of Table 337-2,
2. Two consecutive test results within the same LOT for gradation on any of the following sieve sizes ( $P_{-3/8}$ ,  $P_{-4}$ , and  $P_{-8}$ ) do not meet the requirements of Table 337-2. The two consecutive failures must be on the same sieve.

When a LOT is terminated due to a QC failure, stop production of the mixture until the problem is resolved to the satisfaction of the QC Managers and/or Asphalt Plant Level II Technicians responsible for the decision to resume production after a QC failure, as identified in Section 105. In the event that it can be demonstrated that the problem can immediately be or already has been resolved, it will not be necessary to stop production. When a LOT is terminated, make all necessary changes to correct the problem. Do not resume production until appropriate corrections have been made. Inform the Engineer of the problem and corrections made to correct the problem. After resuming production, sample and test the material to verify that the changes have corrected the problem. Summarize this information and provide it to the Engineer prior to the end of the work shift when production resumes.

In the event that a QC failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future QC failures.

Address any material represented by a failing test result in accordance with 334-5.9.5. Any LOT terminated under this Subarticle will be limited to a maximum Pay Factor of 1.00 (as defined in 337-12.3) for each quality characteristic.

### **337-7 Special Construction Requirements.**

**337-7.1 Hot Storage of FC-5 Mixtures:** When using surge or storage bins in the normal production of FC-5, do not leave mixtures containing mineral fibers in the surge or storage bin for more than one hour. Do not leave mixtures containing cellulose fibers in the surge or storage bin for more than 1-1/2 hours.

**337-7.2 Longitudinal Grade Controls for Open-Graded Friction Courses:** On FC-5, use either longitudinal grade control (skid, ski or traveling stringline) or a joint matcher.

#### **337-7.3 Temperature Requirements for FC-5:**

**337-7.3.1 Air Temperature at Laydown:** Meet the requirements of Table 330-1.

**337-7.3.2 Temperature of the Mix:** Heat and combine the asphalt binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 320-6.3. Meet all requirements of 330-6.1.3 at the roadway. The target mixing temperature shall be established by the Contractor. The target mixing temperature may be reduced when using warm mix technology.

**337-7.4 Compaction of FC-5:** Provide two, static steel-wheeled rollers, with an effective compactive weight in the range of 135 to 200 pounds per linear inch (PLI), determined as follows:

$$PLI = \frac{\text{Total Weight of Roller (pounds)}}{\text{Total Width of Drums (inches)}}$$

(Any variation of this equipment requirement must be approved by the Engineer.) Establish an appropriate rolling pattern for the pavement in order to effectively seat the mixture without crushing the aggregate. In the event that the roller begins to crush the aggregate, reduce the number of coverages or the PLI of the rollers. If the rollers continue to crush the aggregate, use a tandem steel-wheel roller weighing not more than 135 PLI of drum width.

#### **337-7.5 Temperature Requirements for FC-9.5 and FC-12.5:**

**337-7.5.1 Air Temperature at Laydown:** Meet the requirements of Table 330-1.

**337-7.5.2 Temperature of the Mix:** Heat and combine the asphalt binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, meeting the requirements of 320-6.3. Meet all requirements of 330-6.1.3 at the roadway.

**337-7.6 Prevention of Adhesion:** To minimize adhesion to the drum during the rolling operations, the Contractor may add a small amount of liquid detergent to the water in the roller.

At intersections and in other areas where the pavement may be subjected to cross-traffic before it has cooled, spray the approaches with water to wet the tires of the approaching vehicles before they cross the pavement.

**337-7.7 Transportation Requirements of Friction Course Mixtures:** Cover all loads of friction course mixtures with a tarpaulin, or waterproof cover, meeting requirements of 320-7.

### **337-8 Thickness of Friction Courses.**

**337-8.1 FC-9.5 and FC-12.5:** The thickness of the friction course layer will be the plan thickness as shown in the Contract Documents. For construction purposes, the plan thickness will be converted to spread rate as defined in 334-1.4.

Plan quantities are based on a  $G_{mm}$  of 2.540, corresponding to a spread rate of 110 lbs/yd<sup>2</sup>-in. Pay quantities will be based on the actual maximum specific gravity of the mix being used.

**337-8.2 FC-5:** The total thickness of the FC-5 layer will be the plan thickness as shown in the Contract Documents. For construction purposes, the plan thickness will be converted to spread rate based on the combined aggregate bulk specific gravity of the asphalt mix being used as shown in the following equation:

$$\text{Spread rate (lbs/yd}^2\text{)} = t \times G_{sb} \times 40.5$$

Where:  $t$  = Thickness (in.) (Plan thickness)

$G_{sb}$  = Combined aggregate bulk specific gravity from the verified mix design

The weight of the mixture shall be determined as provided in 320-3.2.

Plan quantities are based on a  $G_{sb}$  of 2.635, corresponding to a spread rate of 80 pounds per square yard for a 3/4 inch layer. Pay quantities will be based on the actual combined aggregate bulk specific gravity ( $G_{sb}$ ) of the mix being used.

### **337-9 Special Equipment Requirements for FC-5.**

**337-9.1 Fiber Supply System:** Use a separate feed system to accurately proportion the required quantity of mineral fibers into the mixture in such a manner that uniform distribution is obtained. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes. Control the proportion of fibers to within plus or minus 10% of the amount of fibers required. Provide flow indicators or sensing devices for the fiber system, interlocked with plant controls so that the mixture production will be interrupted if introduction of the fiber fails.

When a batch plant is used, add the fiber to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time by 8 to 12 seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Ensure that the fibers are uniformly distributed prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the fiber with the aggregate prior to the addition of the asphalt rubber. Add the fiber in such a manner that it will not become entrained in the exhaust system of the drier or plant.

**337-9.2 Hydrated Lime Supply System:** For FC-5 mixes containing granite, use a separate feed system to accurately proportion the required quantity of hydrated lime into the mixture in such a manner that uniform coating of the aggregate is obtained prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant. Interlock the proportioning device with the aggregate feed or weigh system to maintain the correct proportions for all rates of production and batch sizes and to ensure that all mixture produced is properly treated with hydrated lime. Control the proportion of hydrated lime to within plus or minus 10% of the amount of hydrated lime required. Provide and interlock flow indicators or sensing devices for the hydrated lime system with plant controls so that the mixture production will be interrupted if introduction of the hydrated lime fails. The addition of the hydrated lime to the aggregate may be accomplished by Method A or B as follows:

**337-9.2.1 Method A - Dry Form:** Add hydrated lime in a dry form to the mixture according to the type of asphalt plant being used.

When a batch plant is used, add the hydrated lime to the aggregate in the weigh hopper or as approved and directed by the Engineer. Increase the batch dry mixing time

by eight to twelve seconds, or as directed by the Engineer, from the time the aggregate is completely emptied into the pugmill. Uniformly distribute the hydrated lime prior to the addition of asphalt rubber into the pugmill.

When a drum-mix plant is used, add and uniformly disperse the hydrated lime to the aggregate prior to the addition of the asphalt rubber. Add the hydrated lime in such a manner that it will not become entrained in the exhaust system of the drier or plant.

**337-9.2.2 Method B - Hydrated Lime/Water Slurry:** Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate. Provide a solution consisting of hydrated lime and water in concentrations as directed by the Engineer. Use a plant equipped to blend and maintain the hydrated lime in suspension and to mix it with the aggregates uniformly in the proportions specified.

**337-9.3 Hydrated Lime Pretreatment:** For FC-5 mixes containing granite, as an alternative to 337-9.2, pretreat the aggregate with hydrated lime prior to incorporating the aggregate into the mixture. Use a feed system to accurately proportion the aggregate and required quantity of hydrated lime, and mix them in such a manner that uniform coating of the aggregate is obtained. Control the proportion of hydrated lime to within plus or minus 10% of the amount required. Aggregate pretreated with hydrated lime in this manner shall be incorporated into the asphalt mixture within 45 days of pretreatment.

**337-9.3.1 Hydrated Lime Pretreatment Methods:** Pretreat the aggregate using one of the following two methods:

Pretreatment Method A - Dry Form: Add the required quantity of hydrated lime in a dry form to the aggregate. Assure that the aggregate at the time of pretreatment contains a minimum of 3% moisture over saturated surface dry (SSD) conditions. Utilize equipment to accurately proportion the aggregate and hydrated lime and mix them in such a manner as to provide a uniform coating.

Pretreatment Method B - Hydrated Lime/Water Slurry: Add the required quantity of hydrated lime (based on dry weight) in a hydrated lime/water slurry form to the aggregate. Provide a solution consisting of hydrated lime and water in a concentration to provide effective treatment. Use equipment to blend and maintain the hydrated lime in suspension, to accurately proportion the aggregate and hydrated lime/water slurry, and to mix them to provide a uniform coating.

**337-9.3.2 Blending QC Records:** Maintain adequate QC records for the Engineer's review for all pretreatment activities. Include as a minimum the following information (for each batch or day's run of pretreatment): pretreatment date, aggregate certification information, certified test results for the hydrated lime, aggregate moisture content prior to blending, as-blended quantities of aggregate and hydrated lime, project number, customer name, and shipping date.

**337-9.3.3 Certification:** In addition to the aggregate certification, provide a certification with each load of material delivered to the hot mix asphalt plant, that the material has been pretreated in conformance with these specifications. Include also the date the material was pretreated.

### **337-10 Failing Material.**

Meet the requirements of 334-5.9. For FC-5, use the Master Production Range defined in Table 337-2 in lieu of Table 334-4.

**337-11 Method of Measurement.**

For the work specified under this Section (including the pertinent provisions of Sections 320 and 330), the quantity to be paid for will be the weight of the mixture, in tons. For each pay item, the pay quantity will be based on the quantity placed on the project, limited to 105% of the adjusted plan quantity for the pay item. For dense-graded mixes, the adjusted plan quantity will be determined by dividing the pay item’s original plan quantity (including any Engineer approved quantity revisions) by the design  $G_{mm}$  stated in 334-1.4, then multiplying it by the tonnage-weighted average  $G_{mm}$  of the mixes used for the pay item. For open graded mixes, the adjusted plan quantity will be determined by dividing the pay item’s original plan quantity (including any Engineer approved quantity revisions) by the design  $G_{sb}$  stated in 337-8.2, then multiplying it by the tonnage-weighted average  $G_{sb}$  of the mixes used for the pay item.

The bid price for the asphalt mix will include the cost of the asphalt binder (asphalt rubber (or polymer), asphalt cement, ground tire rubber, anti-stripping agent, blending and handling) and the tack coat application as directed in 300-8, as well as fiber stabilizing additive and hydrated lime (if required). There will be no separate payment or unit price adjustment for the asphalt binder material in the asphalt mix. The weight will be determined as provided in 320-3.2 (including the provisions for the automatic recordation system).

Prepare and submit a Certification of Quantities to the Engineer in accordance with 9-2.1.2.

**337-12 Basis of Payment.**

**337-12.1 General:** Price and payment will be full compensation for all the work specified under this Section (including the applicable requirements of Sections 320 and 330).

Based upon the quality of the material, a pay adjustment will be applied to the bid price of the material as determined on a LOT by LOT basis. The pay adjustment will be assessed by calculating a Pay Factor for individual quality characteristics. The pay adjustment will be computed by multiplying a Composite Pay Factor for the LOT by the bid price per ton.

**337-12.2 FC-9.5 and FC-12.5:** Meet the requirements of 334-8.

**337-12.3 FC-5:** Meet the requirements of 334-8 with the following exceptions:

1. Pay factors will be calculated for asphalt binder content and the percentages passing the 3/8 inch, the No. 4, and the No. 8 sieves only.
2. Table 337-3 replaces Table 334-6.
3. Table 337-4 replaces Table 334-7.
4. The Composite Pay Factor equation in 334-8.3 is replaced with the following:

$$CPF = [(0.20 \times PF \text{ 3/8 inch}) + (0.30 \times PF \text{ No. 4}) + (0.10 \times PF \text{ No. 8}) + (0.40 \times PF \text{ AC})]$$

Table 337-3 Small Quantity Pay Table for FC-5		
Pay Factor	1-Test Deviation	2-Test Average Deviation
Asphalt Binder Content (%)		
1.00	0.00-0.50	0.00-0.35
0.90	0.51-0.60	0.36-0.42
0.80	>0.60	>0.42
3/8 inch Sieve (%)		



Table 337-3 Small Quantity Pay Table for FC-5		
Pay Factor	1-Test Deviation	2-Test Average Deviation
1.00	0.00-6.50	0.00-4.60
0.90	6.51-7.50	4.61-5.30
0.80	>7.50	>5.30
No. 4 Sieve (%)		
1.00	0.00-5.00	0.00-3.54
0.90	5.01-6.00	3.55-4.24
0.80	>6.00	>4.24
No. 8 Sieve (%)		
1.00	0.00-3.00	0.00-2.12
0.90	3.01-3.50	2.13-2.47
0.80	>3.50	>2.47

Table 337-4 Specification Limits for FC-5	
Quality Characteristic	Specification Limits
Asphalt Binder Content (%)	Target $\pm$ 0.45
Passing 3/8 inch sieve (%)	Target $\pm$ 6.00
Passing No. 4 sieve (%)	Target $\pm$ 4.50
Passing No. 8 sieve (%)	Target $\pm$ 2.50

**337-12.4 Payment:** Payment will be made under:

Item No. 337- 7- Asphaltic Concrete Friction Course - per ton.