ASPHALT CONCRETE FRICTION COURSES.
(REV 9-23-14)

SECTION 337 is deleted and the following substituted:

SECTION 337
ASPHALT CONCRETE FRICTION COURSES

337-1 Description.

Construct a bonded asphalt concrete friction course pavement as defined in these specifications.

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.

337-2.2 Asphalt Binder: Use a PG 76-22 asphalt binder meeting the requirements of 916-1.

337-2.3 Polymer-Modified Emulsion Membrane: The Polymer Modified Emulsion Membrane shall be a styrene-butadiene block co-polymer (SB) modified asphalt emulsion. Polymer modification of the base asphalt shall be completed prior to emulsification. The emulsion shall be smooth and homogeneous and conform to the following requirements:

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Test On Emulsion:	Method	Minimum	Maximum
Viscosity @ 77ºF SSF	AASHTO T-59	20	100
Sieve Test, %	AASHTO T-59		0.1
24-Hour Storage Stability, % (1)	AASHTO T-59		1
Residue from Distillation @ 400ºF % (2)	AASHTO T-59	63	
Oil portion from distillation ml of oil per 100 g emulsion			2
Demulsibility -35 ml 0.02 N $CaCl_2$ or 35 ml, 08 % dioctyl sodium sulfosuccinate	AASHTO T-59	60	
Test in Residue from Distillation:			
Solubility in TCE, % (3)	AASHTO T-44	97.5	
Elastic Recovery, 50ºF, 20 cm elongation % (4)	AASHTO T-301	60	
Penetration @ 77ºF, 100 g, 5 sec, 0.1 mm	AASHTO T-49	60	150

(Note 1) After standing undisturbed for 24 hours, the surface shall show no white, milky colored substance, but shall be a smooth homogeneous color throughout.
(Note 2) AASHTO T-59 with modifications to include a 400 ± 10 ºF maximum temperature to be held for a period of 15 minutes.
(Note 3) ASTM D5546, Test Method for Solubility of Polymer-Modified Asphalt Materials in 1,1,1-Trichloroethane may be substituted where polymers block the filter in Method D2042.
(Note 4) ASTM D6084, Standard Test Method for Elastic Recovery of Bituminous Materials by Ductilometer with exception that the elongation is 20 cm and the test temperature is 50ºF.

337-2.4 Coarse Aggregate: Meet the requirements of Section 901, and any additional

requirements or modifications specified herein for the mixture.

337-2.5 Fine Aggregate: Meet the requirements of Section 902, and any additional requirements or modifications specified herein for the mixture.

337-2.6 Hydrated Lime: Meet the requirements of AASHTO M 303, Type 1.

Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications.

337-2.7 Liquid Anti-strip Additive: Meet the requirements of 916-5 and be listed on the Department's Approved Product List (APL).

337-2.8 Fiber Stabilizing Additive: Use either a mineral or cellulose fiber stabilizing additive. Meet the following requirements:

337-2.8.1 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)
   - 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.

337-2.8.2 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.

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337-3 General Composition of Mixes.

337-3.1 General: This project consists of a FC-5 bonded friction course mixture. The FC-5 bonded friction course mixture will be applied over a thick polymer modified membrane described in this Developmental Specification. Use a bituminous mixture composed of aggregate (coarse, fine, or a mixture thereof), asphalt binder, fibers, and hydrated lime. Size, uniformly grade and combine the aggregate fractions in such proportions that the resulting mix meets the requirements of this Developmental Specification. The use of RAP material will not be permitted.

337-3.2 Mixture Component Requirements:

337-3.2.1 Aggregates: Use an aggregate blend which consists of either 100% crushed granite, 100% crushed Oolitic limestone or 100% other crushed materials (as approved by the Engineer for friction courses per Rule 14-103.005, Florida Administrative Code).

Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12% silica material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use.

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: www.dot.state.fl.us/statematerialsoffice/quality/programs/qualitycontrol/materialslistings/sources/frictioncourse.pdf .

337-3.2.2 Asphalt Binder: Use a PG 76-22 asphalt binder.

337-3.2.3 Hydrated Lime: Add the lime at a dosage rate of 1.0% by weight of the total dry aggregate.

337-3.2.4 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.

337-3.3 Grading Requirements:

Use a mixture with a gradation meeting the requirements specified in Table 337-1.

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Table 337-1
FC-5 Bonded Friction Course 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

337-4 Mix Design.

337-4.1 FC-5 Bonded Friction Course: The Department will design the FC-5 bonded friction course mixture. 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 within the following ranges based on aggregate type:

Aggregate Type	Binder Content
Crushed Granite	5.5 - 7.0
Crushed Limestone (Oolitic)	6.5 - 8.0

337-4.2 Revision of Mix Design: Meet the requirements of 334-3.3. 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. Provide 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 Mixture Acceptance: 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 312-11 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 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 334-6 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 334-5 (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 ± 0.60
Passing 3/8 inch Sieve (%)	Target ± 7.50
Passing No. 4 Sieve (%)	Target ± 6.00
Passing No. 8 Sieve (%)	Target ± 3.50

(1) Tolerances for sample size of n = 1 from the verified mix design

337-6.2 Individual Test Tolerances for Production: Terminate the LOT if any of the following Quality Control failures occur:

1) An individual test result of a sublot for asphalt binder content does not meet the requirements of Table 337-2,

2) Two consecutive test results 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,

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 Quality Control Manager(s) and/or Asphalt Plant Level II technician(s) responsible for the decision to resume production after a quality control failure, as identified in 105-8.6.4. 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.

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In the event that a Quality Control failure is not addressed as defined above, the Engineer's approval will be required prior to resuming production after any future Quality Control 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 Mixture: When using surge or storage bins in the normal production of FC-5, do not leave the mixture in the surge or storage bin for more than one hour.

337-7.2 Longitudinal Grade Controls for Friction Course: Use either longitudinal grade control (skid, ski or traveling stringline) or a joint matcher.

337-7.3 Surface Preparation: Manhole covers, drains, grates catch basins and other such utility structures shall be protected and covered with plastic or building felt prior to paving and also shall be clearly referenced for location and adjustment after paving. Thermoplastic traffic markings shall be removed if greater than 0.2" thickness. Pavement cracks and joints greater than 0.25" wide shall be cleaned and filled as approved by the Engineer. The entire pavement surface to be overlaid shall be thoroughly cleaned, giving specific attention to accumulated mud, hot mix asphalt build-up, tack tracking and debris. Milling pressurized water and/or vacuum systems may be required to insure a clean surface.

337-7.4 Bonded Friction Course Paving Equipment: Use a self-priming paver, designed and built for the purpose of applying the bonded asphalt concrete friction course. The self-priming machine shall be capable of spraying the Polymer Modified Emulsion Membrane, applying the hot asphalt concrete overlay and leveling the surface of the mat in one pass at the rate of 30.5 - 92 ft/minute. The self-priming paving machine shall incorporate a receiving hopper, feed conveyor, insulated storage tank for Polymer Modified Emulsion Membrane, Polymer Modified Emulsion Membrane spray bar and a variable width, heated, tamper bar screed. The screed shall have the ability to crown the pavement at the center both positively and negatively and have vertically adjustable extensions to accommodate the desired pavement profile.

337-7.5 Polymer Modified Emulsion Membrane: The Polymer Modified Emulsion Membrane shall be sprayed by a metered mechanical pressure spray bar at a temperature of 140 – 180 °F. The sprayer shall accurately and continuously monitor the rate of spray and provide a uniform application across the entire width to be overlaid. The target rate of application shall be in the range of 0.15 – 0.30 gal/yd^2 as recommended by the Contractor. Adjustments to the spray rate shall be made based upon the existing pavement surface conditions and recommendations of the Polymer Modified Emulsion Membrane supplier. The actual spray rate shall be verified by the Engineer at the job site during construction.

No wheel or other part of the paving machine shall come in contact with the Polymer Modified Emulsion Membrane before the hot mix asphalt friction course is applied.

The hot mix asphalt concrete shall be applied at the appropriate temperature indicated on the mix design and shall be spread over the Polymer Modified Emulsion Membrane immediately after the application of the Polymer Modified Emulsion Membrane. The hot mix asphalt friction course shall be placed over the full width of the Polymer Modified Emulsion Membrane with a heated, combination vibratory-tamping bar screed.

Do Not Use Without
CO Specs Authorization

337-7.6 Application: Immediately cease transportation of the asphalt mixture from the plant when rain begins at the roadway. Do not place the asphalt mixture while rain is falling, or when there is water on the surface to be covered. A damp pavement surface is acceptable for placement of Polymer Modified Emulsion Membrane if it is free of standing water and favorable weather conditions are expected to follow.

Allow the pavement temperature to cool to a temperature of not greater than 175°F prior to opening the pavement to traffic.

337-7.7 Temperature Requirements for FC-5 Bonded Friction Course:

337-7.7.1 Air Temperature at Laydown: Spread the mixture only when the air temperature (the temperature in the shade away from artificial heat) is at or above 65ºF. As an exception, place the mixture at temperatures no lower than 60ºF, only when approved by the Engineer based on the Contractor's demonstrated ability to achieve a satisfactory surface texture and appearance of the finished surface.

337-7.7.2 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 on the mix design.

337-7.8 Compaction of FC-5 Bonded Friction Course: Provide two, static steel-wheeled rollers, with an effective compactive weight in the range of 135 to 200 PLI, determined as follows:

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

(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 lb. per linear inch (PLI) of drum width.

337-7.9 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.

337-7.10 Transportation Requirements: Cover all loads of friction course mixture with a tarpaulin, or waterproof cover, meeting requirements of 320-7.

337-8 Thickness of Friction Course.

The total thickness of the FC-5 Bonded 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 based on the combined aggregate bulk specific gravity of the asphalt mix being used as shown in the following equation:

$$\text{Spread rate (lbs. per square yard)} = t \times G_{sb} \times 40.5$$

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

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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 lbs. per square yards. 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 Bonded Friction Course.

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 binder 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 binder. 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 binder. 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 binder 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 binder. 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

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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 Quality Control Records: Maintain adequate Quality Control 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 HMA plant, that the material has been pretreated in conformance with these specifications. Include also the date the material was pretreated.

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337-10 Failing Material.

Meet the requirements of 334-5.9. Use the Master Production Range defined in Table 337-2 in lieu of Table 334-5.

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. The pay quantity will be based on the project average spread rate, limited to a maximum of 105% of the spread rate determined in accordance with 337-8 or as set by the Engineer. The project average spread rate is calculated by totaling the arithmetic mean of the average daily spread rate values for each layer.

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 a Certification of Quantities, using the Department's current approved form, for the certified asphalt concrete friction course pay item. Submit this certification to the Engineer no later than Twelve O'clock noon Monday after the estimate cut-off or as directed by the Engineer, based on the quantity of asphalt produced and accepted on the roadway per Contract. The certification must include the Contract Number, FPID Number, Certification Number, Certification Date, period represented by Certification and the tons produced for each asphalt pay item.

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. Perform all calculations with the Department's Asphalt Plant - Pay Factor Worksheets.

337-12.2 FC-5 Bonded Friction Course: 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. The Small Quantity Pay Table for FC-5 Mixtures replaces the Small Quantity Pay Table for Dense Graded Mixtures in the Department's Asphalt Plant - Pay Factor Worksheets.
3. Table 337-3 replaces Table 334-7.
4. The Composite Pay Factor equation in 334-8.3 is replaced with the following:

CPF = [(0.20 x PF 3/8 inch) + (0.30 x PF No. 4) + (0.10 x PF No. 8) + (0.40 x PF AC)]

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Table 337-3
Specification Limits for FC-5 Bonded Friction Course

Quality Characteristic	Specification Limits
Asphalt Binder Content (%)	Target ± 0.45
Passing 3/8 inch sieve (%)	Target ± 6.00
Passing No. 4 sieve (%)	Target ± 4.50
Passing No. 8 sieve (%)	Target ± 2.50

337-12.3 Payment: Payment will be made under:

Item No. 901-337-8-Bonded Asphalt Concrete Friction Course - per ton.