

SECTION 337
ASPHALT CONCRETE FRICTION COURSES

337-1 Description.

Construct an asphalt concrete friction course. This Section specifies mixes designated as Friction Course 2 (FC-2), Friction Course 3 (FC-3), Friction Course 5 (FC-5) and Friction Course 6 (FC-6).

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 Rubber Binder: Meet the requirements of Section 336, 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 M303 Type 1. Provide certified test results for each shipment of hydrated lime indicating compliance with the specifications.

337-2.6 Fiber Stabilizing Additive (Required for FC-5 only): Use either a mineral or cellulose fiber stabilizing additive. Meet the following requirements:

337-2.6.1 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 length0.25 inch [6.0 mm] (maximum)
 - Average fiber thickness0.0002 inch [0.005 mm] (maximum)
2. Shot Content (ASTM C612)
 - Percent passing No. 60 [250 µm] Sieve90 - 100
 - Percent passing No.230 [63 µm] Sieve65 - 100

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

337-2.6.1.1 Notice of Patented Process: Take notice that the use of mineral fibers treated with cationic sizing agent and the size analysis range for average fiber thickness are subject to U.S. Patent No. 4,613,376, held by Fiberand Corporation, 7150 Southwest 62nd Avenue, South Miami, Fl. 33143. Obtain all mineral fibers required to meet the FC-5 requirements of this Contract only from Fiberand Corporation or a duly authorized licensee of Fiberand. Assume responsibility, pursuant to 7-3, for obtaining any and all necessary rights to use such processes and pay any and all royalties, license fees or other costs incurred in order to meet the FC-5 requirements of this Contract. Include any and all royalties, license fees and other costs arising due to the existence of U.S. Patent No. 4,613,376 in the bid unit price for friction course FC-5.

337-2.6.2 Cellulose Fibers: Use cellulose fibers meeting the following requirements:

1. Fiber length0.25 inch [6.0 mm] (maximum)
2. Sieve Analysis
 - a. Alpine Sieve Method
 - Percent passing No. 100 [150 µm] sieve60-80
 - b. Ro-Tap Sieve Method
 - Percent passing No. 20 [850µm] sieve80-95

Percent passing No. 40 [425µm] sieve	45-85
Percent passing No. 100 [150µm sieve.....	5-40
3. Ash Content:	18% non-volatiles (±5%)
4. pH:	7.5 (±1.0)
5. Oil Absorption:	5.0 (±1.0) (times fiber weight)
6. Moisture Content:	5.0 (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 rubber 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. The use of RAP material will not be permitted.

337-3.2 Specific Component Requirements by Mix:

337-3.2.1 FC-2:

337-3.2.1.1 Aggregates: In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed granite, crushed slag, or lightweight aggregates approved by the Engineer. Crushed limestone from the Oolitic formation may be used if it contains a minimum of 12% non-carbonate material as determined by FM 5-510 and the Engineer grants approval of the source prior to its use. Aggregates other than those listed above may be used if approved by the Engineer.

337-3.2.1.2 Asphalt Rubber: Use an ARB-12 asphalt rubber.

337-3.2.2 FC-3:

337-3.2.2.1 Aggregates: In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed gravel, crushed granite, crushed slag, or crushed limestone from the Oolitic formation as specified for use in FC-2. Aggregates other than those listed above may be used if approved by the Engineer.

In addition to the requirements of Section 902, meet the following fine aggregate requirements. Use crushed screenings or a combination of crushed screenings and local materials. Use crushed screenings composed of hard, durable particles resulting from crushing or processing the coarse aggregate as specified above. Screenings from other approved sources may be used provided that the total of these screenings along with silica sand or local materials does not exceed 40%. Ensure that not more than 20% by weight of the total aggregate used is silica sand or local materials defined in Section 902.

337-3.2.2.2 Asphalt Rubber: Use an ARB-5 asphalt rubber.

337-3.2.3 FC-5:

337-3.2.3.1 Aggregates: Use an aggregate blend which consists of either 100% crushed granite or 100% crushed Oolitic limestone.

In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed granite or crushed limestone. Use crushed limestone from the Oolitic formation, which contains a minimum of 12% non-carbonate material (as determined by FM 5-510), and has been approved for this use.

In addition to the requirements of Section 902, meet the following fine aggregate requirements. Use either crushed granite screenings, or crushed Oolitic limestone screenings for the fine aggregate.

337-3.2.3.2 Asphalt Rubber: Use an ARB-12 asphalt rubber.

337-3.2.3.3 Hydrated Lime: Add the lime at a dosage rate of 1.0% by weight of the total dry aggregate to mixes containing granite.

337-3.2.3.4 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.

337-3.2.4 FC-6:

337-3.2.4.1: Aggregates: Use coarse and fine aggregate components which also meet the aggregate requirements for an SP-9.5 or SP-12.5 Superpave mix as specified in Section 334.

In addition to the requirements of Section 901, meet the following coarse aggregate requirements. Use either crushed granite, crushed slag, crushed river gravel, lightweight aggregate (that has been approved for this use), or crushed limestone for the coarse aggregate component. Use crushed limestone from the Oolitic formation, which contains a minimum of 12% non-carbonate material (as determined by FM 5-510), and is approved for this use. In addition, other types of aggregates may be used if approved for this use by the Engineer.

In addition to the requirements of Section 902, meet the following fine aggregate requirements. Use crushed screenings or a combination of crushed screenings and local materials for the fine aggregate components. Use crushed screenings composed of hard, durable particles resulting from the crushing or processing of coarse aggregate as specified above. In addition, screenings from other approved sources may be used provided that the total of these screenings (along with silica sand or local materials) does not exceed 40%.

337-3.2.4.2: Asphalt Rubber: Use an ARB-5 asphalt rubber.

337-3.3 Grading Requirements:

337-3.3.1 FC-2 and FC-3: Use a mixture with a gradation within the design range specified in Table 331-1.

337-3.3.2 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 [19.00 mm]	1/2 inch [12.50 mm]	3/8 inch [9.50 mm]	No.4 [4.75 mm]	No.10 [2.00 mm]	No. 40 [425 µm]	No. 80 [180µm]	No. 200 [75 µm]
100	85-100	55-75	15-25	5-10	-	-	2-4

337-3.3.3 FC-6: Meet the design gradation requirements for a SP-9.5 Superpave mix passing below the restricted zone, or the design gradation requirements for a SP-12.5 Superpave mix passing above the restricted zone, as specified in Section 334.

337-4 Mix Design.

337-4.1 FC-2 and FC-5: The Department will design the FC-2 and FC-5 mixtures. Furnish materials and the appropriate information (source, gradation, etc.) as specified in 331-4.3. The Department will have two weeks to design the mix.

The Department will establish the design binder content for FC-2 within the following ranges based on aggregate type:

Aggregate Type	Binder Content % by weight of total mix
Crushed Granite	5.5-7.0
Crushed Slag	6.0-8.0
Crushed Limestone (Oolitic)	6.5-7.5
Lightweight	12.5-15.0

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	5.5 - 7.0
Crushed Limestone (Oolitic)	6.5 - 7.5

337-4.2 FC-3: Provide a mix design conforming to the requirements of 331-4.3. Submit data showing that the mix design meets the requirements of Table 331-2 using conventional AC-30. Then, for production, substitute the asphalt rubber binder at the optimum conventional binder content and show it as the optimum binder content on the verified mix design.

337-4.3 FC-6: Provide a mix design conforming to the requirements of 334-4.2 for Traffic Level 4 unless otherwise designated in the plans. Develop the mix design using conventional AC-30. Then substitute the asphalt rubber at the optimum conventional binder content for production and show as the optimum binder content on the approved mix design.

337-5 Contractor's Quality Control.

Provide the necessary quality control of the friction course mix and construction in accordance with the applicable provisions of Section 330 and 331-4.4 for FC-2, FC-3 and FC-5, and Section 330 and 334-4.4 for FC-6. After the mix design has been approved, furnish the material to meet the approved mix design in accordance with the provisions of 331-4.4.2 and Table 331-3 for FC-2, FC-3 and FC-5, and 334-4.4 for FC-6. Calibrate the plant in accordance with 331-4.4.3 and Table 331-3.

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 Mix.

337-6.1 Acceptance at the Plant: The bituminous mix will be accepted at the plant with respect to gradation and asphalt content in accordance with the applicable requirements of 331-5 for FC-2, FC-3 and FC-5, and 334-5 for FC-6, with the exception that the asphalt content of the mixture will be determined in accordance with FM 5-563, and the gradation will be determined in accordance with FM 1-T 030.

337-6.2 Acceptance on the Roadway: The FC-3 mix will be accepted on the roadway with respect to density in accordance with the applicable provisions of 330-11. There will be no density requirements for FC-2 and FC-5.

The FC-2, FC-3 and FC-5 mixtures will be accepted on the roadway with respect to surface tolerance in accordance with the applicable provisions of 330-13.

The FC-6 mix will be accepted on the roadway with respect to density and surface tolerance in accordance with the applicable provisions of 334-5.4.

337-6.3 Additional Tests: The provisions of 331-5.5 will apply to FC-2, FC-3 and FC-5. The provisions of 334-5.5 will apply to FC-6.

337-7 Special Construction Requirements

337-7.1 Hot Storage of FC-2 and FC-5 Mixtures: When using surge or storage bins in the normal production of FC-2 and 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 Open-Graded Friction Courses: On FC-2, do not use a longitudinal grade control (skid, ski, or traveling stringline). Use a joint matcher. On FC-5, use either longitudinal grade control (skid, ski or traveling stringline) or a joint matcher.

337-7.3 Temperature Requirements for FC-2:

337-7.3.1 Air Temperature at Laydown: Spread the mixture only when the air temperature, taken as the temperature in the shade away from artificial heat, is at or above 60°F [15°C].

337-7.3.2 Temperature of the Mixture: Heat and combine the asphalt rubber binder and aggregate in a manner which will produce a mixture having a temperature, when discharged from the plant, of 290°F [145°C], or as directed by the Engineer. Meet the temperature tolerance requirements specified in Table 330-2. Meet all other requirements of 330-7.3.

337-7.4 Compaction of FC-2: Perform only seal rolling using a tandem steel-wheel roller. Do not allow the weight of the steel-wheel roller to exceed 135 lb/in (PLI) [2.4 kg/mm] of drum width.

Non SI Units

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

SI Units

$$\frac{\text{kg}}{\text{mm}} = \frac{\text{Total Weight of Roller (kilograms)}}{\text{Total Width of Drums (millimeters)}}$$

Perform seal rolling with a single coverage and with a nominal amount of overlap. Where the lane being placed is adjacent to a previously laid mat, do not pinch the longitudinal joint with the roller on the cold mat. Pinch the longitudinal joint with the roller on the mat being rolled, overlapping onto the cold mat by no more than 3 inches [75 mm]. Never allow a roller on the mat after completing the seal rolling.

337-7.5 Temperature Requirements for FC-3:

337-7.5.1 Air Temperature at Laydown: Spread the mixture only when the air temperature, taken in the shade away from artificial heat, is at or above 45°F [7°C].

337-7.5.2 Temperature of the Mixture: Heat and combine the asphalt rubber binder and aggregate in a manner which will produce a mixture having a temperature, when discharged from the plant, of 310°F [155°C], or as directed by the Engineer. Meet the temperature tolerance requirements specified in Table 330-2. Meet all other requirements of 330-7.3.

337-7.6 Temperature Requirements for FC-5:

337-7.6.1 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 65°F [18°C].

337-7.6.2 Temperature of the mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, of 320°F [160°C], or as specified by the Engineer. The tolerance from this established temperature is specified in Table 330-2. All other requirements of 330-7.3 will apply to FC-5, except any load or portion of a load of asphalt mix at the plant or on the road with a mix temperature exceeding 345°F [175°C] will be rejected.

337-7.7 Compaction of FC-5: Provide 2, 8-10 ton static steel-wheeled rollers. (Any variation of this equipment requirement must be approved by the Engineer.) The Engineer will establish the appropriate rolling pattern for the pavement. If the rollers crush the aggregate, use a tandem steel-wheel roller weighing not more than 135 lb/in (PLI) [2.4 kg/mm] of drum width as determined in accordance with 337-7.4.

337-7.8. Temperature Requirements for FC-6:

337-7.8.1 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 45°F [7°C].

337-7.8.2 Temperature of the mix: Heat and combine the asphalt rubber binder and aggregate in a manner to produce a mix having a temperature, when discharged from the plant, of 310°F [155°C]. The tolerance from this established temperature is specified in Table 330-2. All other requirements of 330-7.3 will apply to FC-6.

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 of Friction Course Mixtures: Cover all loads of friction course mixtures with a tarpaulin.

337-8 Thickness of Friction Courses.

The thickness of the friction courses will be based on the spread rate set by the Engineer. Plan quantities are based on the maximum spread rate within the ranges shown below. Pay quantities may be less, based on the spread rate set by the Engineer.

337-8.1 Spread Rate for FC-2: For FC-2 with granite, oolitic limestone, or other conventional aggregate, the Engineer will set the spread rate within the range of 50 - 60 lb/yd² [27 - 34 kg/m²]. For FC-2 with lightweight aggregate, the Engineer will set the spread rate within the range of 28 - 35 lb/yd² [15 - 19 kg/m²].

337-8.2 Spread rate for FC-3: The Engineer will set the spread rate within the range of 100 - 110 lb/yd² [54 - 60 kg/m²].

337-8.3 Spread Rate of FC-5: The Engineer will set the spread rate within the range of 70 - 80 lb/yd² [38 - 44 kg/m²].

337-8.4 Spread Rate of FC-6: The Engineer will set the spread rate within the range of 150 - 160 lb/yd² [80 - 88 kg/m²].

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.

337-10 Method of Measurement.

The quantity to be paid for will be the weight, in tons [metric tons], as determined in accordance with 320-2 (including provisions for the automatic recordation system). The pay quantity will be based on the average spread rate for the project, limited to a maximum of 105% of the spread rate set by the Engineer in accordance with 337-8.

337-11 Basis of Payment.

Price and payment will be full compensation for all the work specified under this Section, including the cost of the asphalt rubber (asphalt cement, ground tire rubber, anti-stripping agent, blending, and handling), as well as fiber stabilizing additive and hydrated lime (if required).

Payment will be made under:

Item No. 337- 7-	Asphaltic Concrete Friction Course -per ton.
Item No. 2337- 7-	Asphaltic Concrete Friction Course -per metric ton.