Fiber Reinforced Asphalt Concrete (FRAC) Guide Specification for Highway Construction

Division 400 - Asphalt Pavements and Surface Treatments

SECTION 4XX – FIBER REINFORCED ASPHALT CONCRETE (FRAC) PAVEMENT

Fiber Reinforced Asphalt Concrete (FRAC) is the generic term used to describe the production, paving, and compaction achieved through the application of one of several Fiber technologies.

Some modifications to HMA plants may be necessary to accommodate the FRAC technologies as noted in Section 4XX.03 Construction.

Production and paving temperatures for FRAC may need to be carefully evaluated similarly to when using Reclaimed Asphalt Pavement (RAP) increased haul distances, decreased ambient temperatures, or other project specific conditions.

All provisions for the production and placement of conventional HMA mixtures as stipulated in [*applicable Agency specification*] are in force except as noted below.

4XX.01 Description

Construct one or more courses of plant produced Fiber Reinforced Asphalt Concrete (FRAC) pavement on a prepared foundation, using virgin aggregate or a combination of virgin and/or reclaimed aggregate material (RAM) and prescribed manufactured fiber technology. Use of RAP materials, consisting of cold milled, crushed, or processed bituminous asphalt mixture; and reclaimed asphalt shingles (RAS) are permitted at the current [*Agency specified*] percentages, provided that the mixture meets all the requirements of these specifications.

4XX.02 Material

FRAC may be produced by one or a combination of several synthetic fiber types and dosage rates. Fibers need to be added at production temperatures between 300F and the max allowable as specified in section XXX, to the hot aggregates, allow minimum 5 seconds dry mixing time, just before introduction of the liquid asphalt. *(Note: The upper temperature range is appropriate for modified asphalt binders and mixtures that include higher percentages of reclaimed asphalt pavement.)*

Provide materials as specified in:

Aggregate	Subsection XXX
Liquid Antistrips	Subsection XXX
Asphalt Binder	Subsection XXX
HMA Additives	Subsection XXX
Lime for Asphalt Mixtures	Subsection XXX
Mineral Filler	Subsection XXX
Reclaimed Asphalt Pavement	Subsection XXX
Reclaimed Aggregate Material	Subsection XXX
Reclaimed Asphalt Shingles	Subsection XXX

Aramid Fibers:

Length...……..3/4" (19mm)
Form……Monofilament
Acid/Alkali Resistance……...….Inert
Tensile Strength……400,000 p.s.i.
Specific Gravity…….....1.44
Operating Temperatures.....-300^{O}F to 800^{O}F (-73^{O}C to 427^{O}C)

Polyolefin Fibers:

Length...……...3/4" (19mm)
Form……Fillibrated
Acid/Alkali Resistance…….Inert
Tensile Strength……....N/A*
Specific Gravity……....0.91
Operating Temperatures.....N/A*

* Fibers will partially melt or become plastically deformed during asphalt mix production.

4XX.03 Construction

A. *Mix Design*. For FRAC produced at one (1) pound of fibers per one (1) ton of Asphalt mix the Job Mix Formula (JMF) will not require any modifications or design alterations. For higher dosages of fiber in the mix develop and submit a job mix formula for each mixture according to AASHTO R 35 or [*Agency specified procedure*]. Each job mix formula must be capable of being produced, placed, and compacted as specified. Apply all mix design requirements for HMA to the development of the FRAC mix design.

(Note to Contracting Agency: Job mix formulas for FRAC mixtures are currently developed with conventional HMA mix design practices and the fibers are included afterward. For fiber dosage above 1lb/ton, the Contracting Agency and Fiber producer must ensure the fibers do not adversely affect the asphalt binder performance grade and FRAC mixture performance during the development and verification of the FRAC job mix formula. All acceptance and performance testing must be conducted with and without the Fiber technology added. A specific mix design recommended practice is expected upon the completion of Arizona State University research project which is schedule for completion November 2014).

1. Fiber Supply System. Add fiber through specialized equipment that can accurately proportion and/or meter, by weight (mass), the proper amount per batch for batch plants, or continuously and in a steady uniform manner for drum plants. If approved by the Manufacturer's Representative, pre-weighed dissolvable bags can add fiber manually for HMA mixes only (bags may not fully dissolve in WMA mixes).

Provide proportioning devices that are interlocked with the plant system and controlled to ±10% of the mass (weight) of the fibers required. Perform an equipment calibration to the satisfaction of the Representative to show that the fiber is being accurately metered and uniformly distributed into the mix, or use pre-weighed bags through a feeder system equipped with electronic counting devices capable of date and time stamp print outs.

Include the following on the fiber supply system:

- Low-level indicators (loose fiber feeders only).
- No-flow indicators (loose fiber feeders only).
- A printout of feed rate status in pounds (kg)/minute, or date and time stamp each bag by print out.
- A section of transparent pipe in the fiber supply line for observing consistency of the flow or feed (loose fiber feeder only).

Have a Manufacturer's representative approve all fiber addition systems.

When a batch plant is used, add the fiber to the aggregate in the weigh hopper and increase the dry batch, minimum of five seconds, and wet mixing time by a few seconds, to ensure that the fiber bags dissolve

and are uniformly distributed. If clumping is present, increase wet mixing time.

When a drum plant is used, examine the system so the fibers do not become entangled in the exhaust system. If there is any evidence of fiber in the bag-house or wet washer fines, relocate the liquid asphalt binder line and/or the fiber line so that the fiber is captured by liquid asphalt spray and incorporated into the mix. If there is any evidence of clumps of fibers at the discharge chute, increase the dry mixing time and/or intensity. Store the fibers in a dry environment.

Submit a written job mix formula for review and approval at least [XX] calendar days before production, or when sources of asphalt binder, aggregates, or other components of the mix change.

Submit the following information:

1. **All information required in the report section of AASHTO R 35 or [*Agency specified procedure*].**
2. **FRAC technology and/or additives information.**
3. **FRAC technology manufacturer's established recommendations for usage.**
4. **FRAC technology manufacturer's established target dosage rate, the acceptable for production, and documentation showing the impact of excessive production variation.**
5. **Fiber technology material safety data sheets (MSDS).**
6. **Documentation of past Fiber technology field applications including project type, project owner, tonnage, location, mix design, mixture volumetrics, field density, and performance; or documentation of Fiber technology listing on [*Agency specified*] approved products list.**
7. **Temperature range for mixing.**
8. **Temperature range for compacting.**
   Asphalt binder performance grade test data and asphalt binder viscosity-temperature relationships.
9. **Fiber mixture performance test results [*as required by the Contracting Agency*].**

Laboratory test data, samples and sources of all mixture components

Comply with the manufacturer's recommendations for incorporating the fiber technologies into the mix. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of fibers (Keep fibers dry).

Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference while producing FRAC.

C. *Sampling*. Perform sampling according to the following standards:

1. *Aggregate*. AASHTO T 2 or [*Agency specified procedure*].
2. *Asphalt Binder*. AASHTO T 40 or [*Agency specified procedure*].
3. *Asphalt Mixes (HMA/WMA), Plant Mix*. AASHTO T 168 or [*Agency specified procedure*].

D. *Weather Limitations*.
1. Place FRAC mixtures only on dry surfaces and only when weather conditions allow for proper production, placement, handling, and compacting. 2. Meet [*agency specified*] placement temperatures.
(Note to Contracting Agency: The minimum HMA delivery, placement, and compaction temperatures should be reviewed to accommodate the FRAC and achieve workability and density requirements. Some FRAC technologies may serve as a compaction aid by providing lateral

confinement during rolling, the mix compacts instead of displacing under the compaction equipment.)

E. *Equipment*. Use equipment and fiber technologies capable of producing an asphalt mixture that meet specification requirements and is workable at the time of placement and compaction, regardless of storage or haul distance considerations.

1. *Asphalt Mixing Plant*. Meet AASHTO M 156 or [*as further modified by the Agency*].
Modify the asphalt mixing plant as required by the manufacturer to introduce the Fiber technology.

Generally no plant modifications or additional plant instrumentation are required. The use of a fiber feeder system should be inter-locked with the asphalt plant. Fiber may be introduced manually if approved by the Manufacturers Representative (MR) via pre-weighed bags of fiber at the correct dosage rate.

(Note: Implementation of best management practices in the control of aggregate and/or RAP moisture content prior to introduction to the drying or mixing drum is highly recommended in order to achieve the maximum distribution of the fibers in the mix.)

All metering devices will meet the current [*Agency specified*] requirement for liquid or mineral additives. Document the integration of plant controls and interlocks when using fiber feeder metering devices.

2. *Hauling Equipment*. Furnish equipment with tight, clean, smooth metal beds to haul FRAC mixture. Keep beds free of petroleum oils, solvents, or other materials that would adversely affect the mixture. Apply a thin coat of approved release agent to beds as necessary to prevent mixture sticking. Do not use petroleum derivatives or other coating material that contaminates or alters the characteristics of the mix.

Be prepared to cover and insulate hauling beds. Equip each truck with a waterproof and windproof cover of suitable material and sufficient size to protect the mix from the weather. Securely fasten covers when necessary to maintain temperature. Ensure that covers do not allow water to enter the bed, paver, or mix transfer device during mix unloading. Use insulated truck beds when necessary to maintain temperature.

3. *Asphalt Pavers*. Provide self-propelled asphalt pavers with activated, heated, adjustable, vibratory screed assemblies to spread and finish to the specified section widths and thicknesses. Provide full width screw augers and provide auger extensions to ensure the paver's distribution system places the mixture uniformly, maintaining a consistent head of material in front of the screed. Screed or strike-off the surface without segregating, tearing, shoving, or gouging the mixture.

Operate the paver at consistent speeds and in a manner that results in an even, continuous layer. Avoid and minimize stop and start operation or allowing the paver to remain stationary during operation.

Equip pavers with automatic screed controls with sensors capable of continuously sensing grade, sensing the transverse slope of the screed, and providing the automatic signals that operate the screed to maintain grade and transverse slope. Control the screed to maintain the grade and transverse slope according to plan.

The Contractor may operate equipment manually in irregularly shaped, narrow, and minor areas.

If automatic controls fail, operate equipment manually only for the remainder of the work day and only if specified results are obtained.

Suspend paving if the specified surface tolerances are not met. Resume only after correcting the situation.

4. *Rollers*. Use rollers as required to achieve [*Agency specified*] pavement density and capable of reversing direction without shoving or tearing the mixture.

Operate rollers according to manufacturer's recommendations. Only use vibratory rollers equipped with separate energy and propulsion controls. Select equipment that will not crush the aggregate or displace the mixture.

F. *Mixing and Holding*. Heat the asphalt binder within the specified temperature range. Ensure a continuous supply of heated asphalt binder to the mixer.

Heat and dry aggregates to the required temperature. Avoid damaging or contaminating the aggregate.

Combine and mix the dried aggregates and asphalt binder to meet the job mix formula. Ensure a minimum of 95 percent uniform coating of aggregates according to AASHTO T 195 or [*Agency specified procedure*].

Correct procedures if storing or holding causes segregation, excessive heat loss, or a reduced quality mixture. Properly dispose of mixture which does not meet specifications.

G. *Preparing Base or Existing Surface*. Clear surface of debris and deleterious material. Apply and cure tack coat before placing the FRAC. Apply a tack coat on all surfaces, curbs, gutters, manholes, or other structure surfaces, that will be in contact with the FRAC mix.

Repair damaged areas of the base or existing surface. Restore the existing surface or base to a uniform grade and cross section before placing the mix. Correct any drainage issues which may have contributed to base failures.

H. *Pre-paving Requirements*. If required by the Materials Engineer, prior to placing FRAC mixed at greater than 1 lb per ton of mix dosage, produce a sufficient amount of FRAC mix to properly calibrate the plant using the mix design approved for mainline construction. The Engineer will sample and test the FRAC mix thus produced for the following:

1. Voids in Mineral Aggregate (VMA);
2. Asphalt binder content;
3. Gradation;
4. Air voids; and
5. Tensile Strength Ratio (or Hamburg wheel tracking test for moisture damage)
6. Other Agency laboratory performance tests.

Heat FRAC field samples, transported to the laboratory, to the field production temperature, when reheating is required for FRAC mixture testing.

If required by Materials engineer, construct a control strip or initial production lot with production materials and equipment. Select compacting methods to meet the specified density. The Engineer will take random loose mix and core samples to verify compliance with job mix and specification requirements. Reconstruct the test strip or initial production lot if the job mix formula, the compacting method, or compacting equipment changes, or if results do not meet specifications.

I. *Spreading and Finishing*. Spread and finish the mixture with asphalt pavers to specified grade and thickness.

Hand place material in areas inaccessible to mechanical spreading and finishing equipment. Maintain a consistent supply of mixture to ensure uninterrupted paving.

Minimize inconvenience to traffic and protect existing and finished surfaces. Leave only short lane sections, normally less than [26 ft (8 m)], where the abutting lane is not placed the same day, or according to [*Agency specified*] traffic safety requirements.

J. *Compacting*. Compact immediately after spreading and before the FRAC mixture falls below the minimum job mix design compaction temperature. [*Agency specified*]

Provide the number, weight, type, and sequence of rollers necessary to compact the mixture without displacing, cracking, or shoving. Roll the FRAC mixture parallel to the centerline. Begin rolling superelevated curves at the low side and continue to the high side, overlapping longitudinal passes parallel to the centerline.

Maintain a uniform roller speed with the drive wheels nearest the paver. Operate vibratory rollers uniformly at the manufacturer's recommended speed and frequency.

Continue rolling to eliminate all roller marks and to achieve the minimum [*Agency specified*] percent of theoretical maximum density or the recommended [*Agency specified*] percent of laboratory density as determined according to [*Agency-specified method*].

(Note to Contracting Agency: Air void and density requirements are important to provide long-term performance of asphalt pavements. Due to the potential for FRAC to act as a compaction aid by providing lateral confinement of the mixtures and therefore increased density, it is important to monitor rolling operations to ensure excessive compaction does not occur and minimum air void requirements and/or the upper limit on percent of maximum density are not exceeded.)

Maintain the line and grade of the edge during rolling.

Prevent the mixture from adhering to the rollers by using very small quantities of detergent or other approved release material.

Hand compact areas inaccessible to rollers.

The Engineer will take random tests of the compacted pavement to verify specification compliance. At no cost to the Agency, remove and replace mixture that does not meet specification requirements or that becomes contaminated with foreign materials. Remove defective materials for the full thickness of the course by saw cutting the sides perpendicular and parallel to the direction of traffic. Coat saw cut edges with bituminous materials and replace the defective material with specification materials.

K. *Joints*. Protect ends of a freshly laid mixture from damage by rollers. Form transverse joints to expose the full depth of the course. Apply a tack coat on transverse and longitudinal joint contact surfaces immediately before paving. Construct all longitudinal joints within 12 in. (300 mm) of the lane lines. Offset longitudinal and transverse joints on succeeding lifts 6 inches (150 mm) to 12 inches (300 mm) from the

joint in the layer immediately below. Create the longitudinal joint in the top layer along the centerline of two-lane highways or at the lane lines of roadways with more than two lanes.

L. *Surface Tests*. The Engineer will test pavement surfaces to verify compliance with [*Agency specified*] smoothness and texture requirements.

Correct pavement surfaces that do not meet specification requirements by cold milling, diamond grinding, overlaying, or removing and replacing according to the following:

a. *Diamond Grinding.* Diamond grind final pavement surfaces exposed to vehicle traffic to the required surface tolerance and cross section. Remove and dispose of all waste material.

b. Cold Milling. Cold mill intermediate pavement surfaces to the required surface tolerance and cross section. Remove and dispose of all waste materials.

c. *Overlaying*. Use specification materials for overlays. Overlay the full width of the underlying pavement surface. Place a minimum recommended overlay thickness of [1.6 in. (40 mm)]. Use only one overlay.

d. *Removing and Replacing*. Replace rejected areas with pavement materials that meet specification requirements. Test the corrected surface area. Complete all corrections before determining pavement thickness.

4XX.04 Measurement

The Engineer will measure work acceptably completed as specified in Subsection XXX and as follows:

A. The Engineer will base quantities of asphalt binder on the theoretical mass incorporated into accepted product as verified by samples taken according to Subsection XXX.

4XX.05 Payment

Include costs of plant startup operations, considering both labor and materials, in the price bid for the mixture in place. The Agency will pay for accepted quantities at the contract unit price as follows:

Pay Item Pay Unit
(A)Asphalt Binder ton (Mg), gal (L)

(B) HMA Plant Mix—Type _____ ton (Mg), yd2 (m2)

Such payment is full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.