SAVE MY ROAD

Full Depth Reclamation

Sample Construction Specification Guideline

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1. Scope

The scope of this sample construction specification guideline is limited and intended to provide general information regarding the design, component material specification, application, inspection, measurement, and payment of Full Depth Reclamation (FDR) using asphalt emulsion.

2. Description

Asphalt emulsion FDR consists of reclaiming the existing road with a reclaimer to the width and depth specified in the plans. Asphalt emulsion will be injected to the reclaimed materials through the reclaimer; water will be added if needed. Then the materials will be spread and compacted, resulting in a finished bituminous base in accordance with the plans and specifications. This specification applies to a road that has had a site selection and material evaluation performed by the agency or its representative.

3. Training and Education

Attending a two-hour minimum Just-in-Time Training (JITT) shall be mandatory and consist of a formal joint training class on FDR materials, equipment, placement, and quality control. Construction operations for FDR shall not begin until the contractor's and the engineer's personnel have completed the mandatory JITT. The contractor's personnel involved in FDR mix design and quality control, as well as equipment operators and crew involved in the recycling and recycled paving operations, plus the engineer's representative, including inspectors and testers, shall attend JITT. JITT shall be in addition to the pre-paving conference.

The JITT class shall be completed not more than eight working days prior to the start of the project. The class shall be held during normal working hours. The JITT shall be conducted at a project field location convenient for both contractor and engineer.

The JITT instructor shall be provided by the contractor unless otherwise specified in the project documents. The instructor shall be experienced in the construction methods, materials, and test methods associated with construction of FDR projects. A copy of the course syllabus, handouts, and presentation material shall be submitted to the engineer at least five days prior to training. The contractor and the engineer shall mutually agree to the course instructor, course content, and training site.

JITT shall not relieve the contractor of responsibility under the contract for the successful completion of work in conformance with the requirements of the plans and specifications.

4. Materials

4.1 Asphalt Emulsion

The asphalt emulsion shall be designated FDR-EE and shall meet the requirements shown in Table 1. Asphalt emulsion delivered to the project shall be accompanied by a laboratory Certificate of Analysis and any other certifications as deemed necessary or advisable.

The properties of the asphalt emulsion to be used shall be determined by the mix design in order to meet the requirements in Table 1.

Table 1

Property	Test Procedure	Minimum	Maximum
Emulsion Properties			
Residue from Distillation, %	**ASTM D244[1]**	**63**	**-**
Oil Distillate, %	**ASTM D244[1]**	**-**	**0.5**
Sieve Test, %	**ASTM D244[1]**	**-**	**0.1**
Penetration (TBD[2]), 25°C, dmm	**ASTM D5**	**40**	**160**

1. Modified ASTM D244 procedure – Distillation temperature of 177°C with a 20-minute hold. The ASTM D244 vacuum distillation procedure may be substituted once the maximum oil distillate is satisfied.
2. TBD – To be determined from the mix design prior to emulsion manufacture for project. Penetration range will be reported on the submitted mix design and should be +/- 25 pen points from design. Climate in which the project is located will affect the penetration value selected.

4.2 Aggregate

The amount and type of added aggregate or reclaimed asphalt pavement (RAP) (“add rock”), if any, will be determined by the mix design in order to meet the requirements of the mix design listed in Table 2.

4.3 Other Additives

If necessary, additives may be used to meet the requirements in Table 2. In the case that an additive is used, the type, and allowable usage percentage must be described in the submitted design recommendation.

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5. Mix Design

The contractor shall submit the mix design to the engineer for approval prior to the start of the project. Reclaimed Material – Refer to Appendix 1. The reclaimed material at the recommended emulsion content shall meet the properties in Table 1. Based on road variability, more than one design may be required. The properties and quantity of asphalt emulsion, add rock, and water shall be determined by the mix design.

Table 2	
Property	**Criteria**
Superpave Gyratory Compaction, 1.25° angle, 600 kPa, gyrations	30
Short-term strength test, 1 hour – modified cohesiometer, ASTM D1560-92 (Part 13), g/25mm of width (see Appendix 1 for modifications)	175 min
Indirect tensile strength (ITS), ASTM D4867 Part 8.11.1, 25°C, psi	40 min
Conditioned ITS, ASTM D4867 (see Note 1), psi	25 min
Resilient modulus, ASTM D4123, 25°C, psi x 1000	150 min
Thermal cracking (IDT), AASHTO T322 (Based on LTPPBind for climate)*	See note in Appendix 4
Note 1: FDR Type 1 – For mixtures containing <8% passing No. 200 150 mm diameter specimens shall be prepared in a gyratory compactor *Optional if project is in -20°C or warmer climate (98% reliability)	
Property	**Criteria**
Superpave Gyratory Compaction, 1.25° angle, 600 kPa, gyrations	30
Short-term strength test, 1 hour – modified cohesiometer, ASTM D1560-92 (Part 13), g/25mm of width (see Appendix 1 for modifications)	150 min
Indirect tensile strength (ITS), ASTM D4867 Part 8.11.1, 25°C, psi	35 min
Conditioned ITS, ASTM D4867 (see Note 2), psi	20 min
Resilient modulus, ASTM D4123, 25°C, psi x 1000	120 min
Thermal cracking (IDT), AASHTO T322 (Based on LTPPBind for climate)*	See note in Appendix 4
Note 2: FDR Type 2 – For mixtures containing ≥8 percent passing No. 200 or for all granular mixtures 150 mm diameter specimens shall be prepared in a gyratory compactor *Optional if project is in -20°C or warmer climate (98% reliability)	

6. Equipment

All equipment for asphalt emulsion FDR described below used on the project shall be in proper working condition and approved by the engineer.

6.1 Reclaimer

The reclaimer shall be self-propelled and capable of fully reclaiming the existing road to the depth required. Incorporate the asphalt emulsion and water, and mix the materials to produce a homogeneous material. The recommended minimum power of the reclaimer is 400 hp. The machine shall be capable of reclaiming not less than eight feet (2.4 m) wide and up to 12 inches deep in each pass. The reclaimer shall have a computerized rate-controlled system for adding asphalt emulsion with a full-width spray bar consisting of a positive displacement pump interlocked to the machine speed so that the amount of emulsion being added is automatically adjusted with changes in machine speed. The additive system shall be capable of incorporating up to seven gallons per square yard of emulsion. Individual valves on the spray bar shall be capable of being turned off as necessary to minimize emulsion overlap on subsequent passes.

6.2 Motor Grader

The motor grader used for pre-shaping, aerating, spreading, and final shaping of the material shall have a cross slope indicator.

6.3 Vibratory Pad Foot Roller

A vibratory pad foot roller with an 84-inch wide drum and 10-ton minimum weight is required. If the FDR section is deeper than eight inches, then a segmented Rex Compactor roller with a width of 114 inches and a 27-ton minimum weight shall be used. Once the vibratory pad foot roller or segmented roller has walked out of the FDR area, back-dragging shall be done with a motor grader. Additionally, a pneumatic tire roller with 20-ton minimum weight and a double-drum vibratory steel roller with 10-ton minimum weight. Booth pneumatic and double drum rollers are required to have a working water spray system to prevent pick-up.

If the reclamation depth is five inches or less, then a pad foot roller is optional. If no pad foot roller is used, then the pneumatic roller shall be 20-ton minimum weight with water spray system.

6.4 Water Truck

A water truck to supply potable water to the reclaimer for addition of moisture, as required, during the FDR operation shall be used. The water truck shall be capable and set up for a controlled spray on the road before compaction.

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7. Construction Methods

FDR work shall not proceed in the rain. The weather forecast shall not call for freezing temperatures for seven days. The historical weather database shall not call for freezing temperatures within seven days of the end of the project; this shall be based on 50% reliability. Any deviation from these requirements requires the written authorization of the engineer.

7.1 Pre-Shaping

The road shall be shaped by the reclaimer and/or motor grader to correct for profile, crown, and contour, according to the plans, before the addition of emulsion. Water and add rock can be added during this operation. The material shall then be compacted to support equipment and/or traffic and to provide depth control during reclaiming. Compaction with a steel roller should be sufficient unless otherwise determined by the engineer.

7.2 Reclaiming

Moisture content before emulsion addition shall be within 1% from the mix design recommendation and as measured in Section 5.4; aerate if too wet, and add water if too dry. The amount of asphalt emulsion used shall be as recommended from the mix design. The required depth of reclamation shall be monitored regularly. Prior to spreading and compacting, the material shall have a gradation meeting the requirement of Section 8.3.

7.2.1

If the entire operation cannot be completed in one pass, then the existing road shall be reclaimed to the depth on the plans. During this first pass, water and add rock shall be added; pre-shaping can also be accomplished at this time. After completion of the first pass, the road shall be shaped with a motor grader and compacted with a steel roller to provide better depth control. A second pass of a reclaimer shall be completed with the required amount of asphalt emulsion added. Each base shall be overlapped no more than 3.5 inches and no less than one inch.

If an additional pass of the reclaimer significantly improves dispersion of the emulsion, then this additional pass shall be required for the entire project.

7.3 Initial Compaction

The breakdown roller (pad foot, segmented, or pneumatic) shall not be behind the reclaimer by more than 500 feet. The pad foot roller, applying high amplitude and low frequency, or the pneumatic roller, shall perform initial compaction at enough passes until it walks out of the material. Walking out for the pad foot or segmented roller is defined as light being clearly evident between all of the pads at the material pad foot drum interface. Walking out for the pneumatic roller is defined as no significant wheel impressions being left on the surface.

7.4 Shaping

After the completion of pad foot rolling, any remaining pad foot marks shall be removed, and the material spread using a motor grader cut no deeper than necessary to remove the pad foot marks. Desired slope and shape shall be achieved. Compaction will be aided if the steel roller (high frequency/low amplitude) and/or pneumatic roller follow the motor grader; this is required if there are no compaction measurement requirements. After the first day of emulsion addition, the reclaimed base shall not be shaped or significant chunking will result.

7.5 Intermediate and Final Compaction

The vibratory double drum steel roller and pneumatic roller shall compact the bladed material. The best combination of number of passes and order of rollers shall be used to meet compaction requirements. Do not finish roll in vibratory mode. A light spray of water may aid in final compaction density and appearance.

7.6 Proof Rolling

Proof roll the compacted material according to engineer's approval. It is recommended that proof rolling represent the type of traffic expected on the road. If deformation does not occur, moving truck traffic can be allowed on the reclaimed base. If deformation occurs, truck traffic should be kept off until the reclaimed material is firm enough. It is expected that the reclaimed base can support moving car traffic after finish rolling has occurred.

7.7 Surface Sealing

Before opening to traffic, the surface will be fog sealed. The fog seal shall be SS-1H, CSS-1H, ePrime, FDR-EE, or CQS-1H, meeting the appropriate specification and diluted 50/50 with potable water. The fog seal shall be applied at range of 0.08 +/- 0.002 gallons per square yard following the application of the fog seal. Sand will be spread over the fog sealed area at a rate of 2lbs +/- 0.25 lbs per square yard.

7.8 Curing of FDR Treatment

Before placing any surfacing, the reclaimed base shall be allowed to cure until the moisture content in the material is reduced to 2.5% or less, or at the discretion of the engineer. The reclaimed base shall be surfaced before seasonal (winter) weather that is detrimental to maintaining the surface condition.

8. Quality Control

Supervisory personnel of the contractor, crew, and testing laboratory shall meet a representative(s) of the agency at a mutually agreed time prior to the start of the project to discuss methods of accomplishing all phases of the project. If needed, a representative of the asphalt emulsion supplier shall be present to discuss handling of emulsions and delivery issues.

The contractor shall be responsible for quality control (QC) of the FDR process and the completed reclaimed base. QC shall include the following activities, and the results of the QC reported daily in writing to the engineer. See Appendix 2 for data sheets.

8.1 Asphalt Emulsion

A representative from the asphalt emulsion supplier will check the mixing and setting properties as needed and will make adjustments to the asphalt emulsion formulation if necessary. Changes shall comply with Table 1. The sampling frequency shall be in accordance with the engineer's requirements and be established prior to the start of the project. The testing shall meet the requirements in Table 1.

8.2 Add Rock

The spread rate of the add rock shall be checked and conform to the quantity required by the mix design. The type of add rock shall conform to the type used in the mix design. Rates shall be checked by yield at a frequency to be decided by the engineer.

8.3 Maximum Material Size

Samples of the reclaimed material shall be obtained before beginning compaction and sieved over the sieves to determine compliance with the following maximum particle size requirements:

Sieve Sizes	Percent Passing
2.0 in. (50 mm)	100
1.75 in. (44 mm)	97-100

Sample size shall be 40 pounds. Sampling frequency shall be at the engineer's discretion.

8.4 Moisture Content

Prior to emulsion addition, moisture content shall be checked by microwave oven according to ASTM D4643 or equivalent procedure. Other suitable methods are acceptable, such as a nuclear gauge, direct heating, or infrared. Minimum sample size recommended is 700 grams for the microwave procedure after screening through a 3/4-inch sieve. Check the moisture content on the same day that emulsion will be added. If rain has occurred after testing and before emulsion addition, recheck the moisture content. If the average moisture content is not within 1% of the mix design recommendation, then it shall be adjusted by moisture addition (water truck) or by aeration. If the moisture content has been manipulated, it shall be rechecked. The sample shall be to the depth of reclamation by any suitable method; make sure the sides of the sample hole are perpendicular to the road surface. Keep samples sealed until they are ready for testing. The moisture content shall be checked on at each of three reclaimer passes on the first day of FDR. Moisture content sampling frequency shall be at the engineer's discretion after the first day.

8.5 Emulsion Content

The amount of asphalt emulsion used shall be as recommended from the mix design. Any changes in asphalt emulsion content must be approved by the engineer. The percentage of emulsion added shall be checked by determining the amount used by meter readings or truck weight tickets and by estimating the quantity of road reclaimed — depth, width, length, and estimated in-place density by Proctor density (mix design or field check) or nuclear density. On the first day of FDR, emulsion content shall be determined at a minimum on the first emulsion transport. Adjustments in equipment calibration shall be made if necessary. If adjustments are made, emulsion content shall be checked again. Thereafter, emulsion content shall be determined at a sampling frequency at the engineer's discretion.

8.6 Depth Control

The reclaiming depth during all operations shall be monitored regularly to determine compliance with the plans. The depth shall be determined on each side of the reclaimer pass and shall be adjusted immediately as necessary.

8.7 Compaction

Density measurements are required. There are two options for reference density — a test strip or Modified Proctor density. The moisture and emulsion contents will be checked and established before determination of reference density.

Test Strip Option — If the sand cone method is used for test strip reference density, then it shall be used for acceptance testing. If the nuclear density gauge is for test strip reference density, then it shall be used for acceptance testing. The test strip shall be at least 1000 feet long. The final roller pattern shall result in the maximum achievable density with the rollers specified. This roller pattern shall be used throughout the rest of the project. However, any significant changes with the road, such as materials, moisture content, or emulsion content, shall require a new test strip for roller pattern determination and new reference density determination. A reference density shall be determined on the test strip at a recommended three to five locations after finish rolling and measured by sand cone (ASTM D1556) or nuclear gauge (ASTM D2950, direct transmission). If measured, all subsequent material shall be compacted to a minimum of 97% reference density of the test strip average reference density at a sampling frequency to be determined by the engineer. If accurate dry (nuclear) density results cannot be obtained, then wet density shall be the reference. Correction to dry density shall be by direct moisture measurement, as described in Section 5.4.

Modified Proctor Density Option — Refer to ASTM D1557, Method C or equivalent; the six-inch diameter mold is required. Only the nuclear gauge shall be used for acceptance testing when Modified Proctor is used as the reference density, and it shall be measured at the same location as the nuclear gauge reading. Samples shall be obtained to the full depth of reclamation before rolling and stored in a sealed container for no longer than one hour before Proctor compaction. Material shall be compacted to a minimum of 97% reference density of the Modified Proctor average reference density. Moisture contents on the material shall be obtained in accordance with Section 5.4 for reference. The mold shall be placed on a firm surface during compaction. If accurate dry (nuclear) density results cannot be obtained, then wet density shall be the reference. Correction to dry density shall be by direct moisture measurement, as described in Section 8.4.

8.8 Reclaimed Base Contour and Profile

The contour and profile and their methods and tolerances shall be as indicated on the plans or as required by the engineer.

9. Measurement

Mobilization shall be a lump sum.

Traffic control shall be a lump sum.

FDR work as described for this item will be measured by the square yard of the completed sections for the depth specified. It includes the reclaiming of the existing road, including furnishing, preparing, hauling, and placing new materials, such as water and aggregate; all freight involved; all manipulations, including blading and rolling; all labor, tools, equipment, and incidentals necessary to complete the work; and quality control.

Asphalt emulsion will be measured by the ton.

10. Payment

Mobilization will be paid for as a lump sum at the price bid.

Traffic control will be paid for as a lump sum at the price bid.

FDR will be paid for by the square yard processed and the unit price bid. It shall include all items described under “Measurement.”

Asphalt emulsion shall be paid for separately at the unit price in the “Asphalt Emulsion Full Depth Reclamation” bid. An emulsion content of X% (X = 5% for FDR) by weight of the material shall be used for bidding purposes prior to the completed design. The actual emulsion content will be adjusted based on the quantity necessary to meet the design requirements in Table 1.

Fog Seal emulsion shall be paid for separately at the unit price by the ton and shall include the application of the cover sand.

APPENDIX 1

Mix Design Procedure

1. Sampling and Processing

Based on data from auger borings (ASTM D1452), cores, and/or other determinations (i.e., pavement records, FWD deflection data, etc.), determine if more than one design shall be performed. In addition, FDR projects with more than a two-inch difference in bituminous surface between sections shall have separate designs performed. A minimum sample size of 350 pounds is required for each mix design.

If cores or slabs are received, determine the individual and average thickness values. Also, measure the density of four cores or two slabs (if possible) if the bituminous materials are the primary component of the mix design (for emulsion rate calculations later).

Crush bituminous materials to the gradation below before blending with the aggregate. If bituminous materials consist of a chip seal only, then the only requirement is that it is crushed to 100% passing the one-inch sieve.

Sieve Sizes	Gradation
1.25 in. (31.25 mm)	100
1 in. (25 mm)	90-100
3/4 (19 mm)	80-97
No. 4 (4.75 mm)	30-55
No. 30 (0.6 mm)	5-15

Specimens prepared for mix design shall have a maximum size passing the 1.25 in (31.25 mm) screen for all material components.

2. Material Evaluation

The base rock shall have a washed gradation (ASTM C117 and C136) and sand equivalent (ASTM D2419, Method B) performed and reported. RAP shall have a dry or washed gradation and sand equivalent performed. Report the washed gradation and sand equivalent on the blend.

Perform Modified Proctor compaction according to ASTM D1557, Method C to determine optimum moisture content (OMC) at peak dry density. OMC shall be defined by a best-fit curve from a minimum of four points. Material containing 20% or more passing No. 200 shall be mixed with target moisture, sealed, and set aside a minimum of 12 hours. All other material shall be set aside a minimum of three hours. If a material contains less than 4% passing No. 200, then this testing is not required.

3. Selection of Water Content for Design

Water content of specimens, not including water in the emulsion, shall be:

- 50% to 75% of OMC if SE ≤ 30
- 40% to 65% of OMC if SE > 30

Sand equivalent value (SE) is from the combined materials.

If a material contains less than 4% passing No. 200 or if no peak develops with the OMC curve, then fix the moisture content between 2% and 3%.

Specimens shall be mixed with the required amount of water before the addition of emulsion. Specimens shall be mixed with the appropriate amount of water and allowed to sit sealed according to the same guidelines as used for Modified Proctor specimens.

4. Number of Specimens/Mixing

Samples shall have a weight before addition of water and emulsion to produce 70 to 80 mm tall compacted specimens (except for IDT testing).

Choose four emulsion contents that will bracket the design emulsion content.

A minimum of two specimens at each of four emulsion contents shall be produced for short-term strength testing.

Four specimens at each of four emulsion contents shall be produced for the strength and retained strength tests.

Two specimens shall be produced for maximum specific gravity.

Four specimens at 120 to 140 mm tall at the design emulsion content shall be produced for thermal cracking testing (IDT).

A mechanical mixer shall be used that has a bowl of 10 to 12 inches in diameter. It shall rotate on its axis at 50 to 75 revolutions per minute. A mixing paddle that makes contact with the bottom and side of the bowl shall rotate on its axis at twice the bowl rotation rate and in the opposite rotation direction as the bowl.

Aggregate material and emulsion shall be mixed at a temperature of 20°C to 26°C.

Water shall be mixed for 60 seconds.

Emulsion shall be mixed for 60 seconds.

If other materials are added, such as lime or cement, then they shall be introduced in a similar manner, as they will be on the project. For example, if lime is incorporated a day or more before emulsion addition, then it shall be added to the wet aggregate a day or more before mixing with emulsion. If lime is incorporated as slurry, then it shall be incorporated as slurry in the laboratory.

5. Curing Before Compaction

Loose specimens shall be cured individually in plastic containers of four to seven inches (100 to 180 mm) height and six inches (150 mm) diameter. Specimens shall be cured at 40°C for 30 to 45 (+/- 3) minutes. No further mixing or aeration shall occur during this time.

6. Compaction

Specimens shall be compacted in a gyratory compactor at a vertical pressure of 600 kPa, an angle of 1.25 degrees, and a mold of 150 mm diameter for 30 gyrations. After the last gyration, 600 kPa pressures shall be applied for 10 seconds. The mold shall not be heated.

7. Short-Term Strength (STS) Test

A modified Hveem cohesiometer apparatus shall be used to test early strength (one hour). This apparatus and procedure generally conforms to ASTM D1560 Section 10 with the following exceptions:

- It shall have the capability of testing 150 mm diameter specimens.
- It shall have a shot flow rate of 2700 +/- 50 g/minute.
- Specimens shall be cured before compaction according to Section 5, and cure each specimen at each emulsion content for 60 +/- 5 minutes at 25°C and 10% to 70% humidity after compaction and before testing.
- See Appendix 3 for further details of the equipment and operation.

8. Curing After Compaction

Specimens (except STS specimens) shall be cured for 72 hours at 40°C. The bottom of the specimens shall rest on racks with slots or holes for air circulation. After curing, specimens for moisture conditioning shall be cooled at ambient temperature a maximum of 24 hours; specimens for dry strength shall cool at ambient temperature or 25°C and be tested at the same time as moisture-conditioned specimens.

Specimens for maximum specific gravity shall be cured at the same conditions as the compacted specimens, except they can be tested after cooling a maximum of 24 hours.

9. Volumetric Measurements

Perform bulk specific gravity of the specimens according to ASTM D6752. Keep specimens in bags until testing or vacuum saturation is performed. ASTM D2726 (one-minute soak) can be performed if absorption is less than 2%.

Perform maximum specific gravity measurements according to ASTM D2041 with the supplemental dry-back procedure. Determine maximum specific gravity at the other emulsion contents corrected for the residue of the emulsion.

Determine air voids at each emulsion content.

10. Mechanical Measurements

Perform resilient modulus testing in accordance with ASTM D4123 on at least two specimens at each emulsion content after conditioning for at least two hours at 25°C. Test at a frequency of 1 Hz and use a Poisson's ratio of 0.30 to 0.40 for analysis. This can be performed before the ITS test on the same (dry) specimens.

Perform strength testing according to ASTM D4867. Specimens shall be conditioned at 25°C for two hours before testing. Soak half the specimens at each emulsion content for 24 hours at 25°C before retained strength testing.

11. Thermal Cracking

See Appendix 4.

12. Emulsion Content Selection

The emulsion content selected shall result in the mixture meeting the requirements of Table 1.

13. Report

The mix design report shall have the following information:

- The name of the road and other pertinent project information.
- Penetration of the emulsion residue used in the mix design.
- A general description of the materials received, their locations, and how samples were obtained.
- Average thickness of bituminous materials. Report density if Proctor testing was not performed.
- Thickness to be reclaimed.
- Washed gradation of the separate and blended material(s). If RAP was crushed in the laboratory, then the gradation of the RAP shall be reported, and the combined washed gradation of the blend shall be reported.
- Sand equivalent value of the separate and blended materials.
- Density and OMC from Proctor compaction.
- The moisture content used in mix design.
- Range of emulsion contents.
- Short-term strength at each emulsion content (average values).
- Density, Gmm, and air voids at each emulsion content (average values).
- Resilient modulus and indirect tensile strength at each emulsion content (average values).
- Level of saturation and conditioned indirect tensile strength at each emulsion content (average values).
- Critical thermal cracking temperature from IDT at the design emulsion content, if performed
- Design emulsion content as a percent, in gallons per square yard, and in gallons per foot (with assumed width reported).

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APPENDIX 2

Quality Control (QC) Data Sheet (Use one or more data sheets per day)

Information

Date: _____ Project/Location: _____

QC Personnel: _____ Phone: _____

Temperature at start of day: _____ Temperature at end of day: _____

Climate conditions: _____

Other notes: _____

Results of Mix Design

Optimum moisture content (OMC) from Modified Proctor: _____

Density at OMC: _____

Recommended field moisture range _____

Recommended emulsion content _____

Add Rock

Station/Location						
Type and Source						
Length, ft						
Width, ft						
Weight, lb						
Rate, lb/SY						

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Test Strip for Sand Cone or Nuclear Density

Location	Station	Wet Density, pcf	Moisture, %	Dry density, pcf	Notes

Average (Reference Density)					
Operator					
Gauge Model					
Gauge Serial Number					

Final roller pattern: _____

Material Tests

Reported by: _____

Station/Location						
Max Size (Section 5.3) – 2”						
Size (Section 5.3) – 1.75”						
Moisture Content, % (Section 5.4)						
Emulsion Content, % (Section 5.5)						
Wet Density, pcf (Section 5.7)						
Dry Density, pcf (Section 5.7)						
Proctor Dry Density, pcf (Section 5.7)						
Percent of Reference Density						

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APPENDIX 3

Additional Instructions for the Short-Term Strength Test

Ensure that the following calibrations are made:

1. The counter balance should be positioned exactly so that the hinged plate just barely remains horizontal when the top brackets and empty bucket are in place. This ensures that there is no force on the sample until shot begins to flow into the bucket.
2. The gap between the bars of the switch that turns off the flow of shot should have a gap of 3/4 inch when there is 3000 g of shot in the bucket. During this adjustment, the locking bolt that prevents the plate from moving is in place.

To test cohesion:

1. Tare the balance with the empty bucket weight.
2. Center the specimen on the unit.
3. Place plates on top of sample and press down while adjusting the outer lower nuts up until they just contact the bottom of the plate.
4. Use a torque wrench or torque-meter to tighten the nuts on the specimen to 20-inch pounds (maximum).
5. Gently support the bar so the unit does not move when the pin is pulled, releasing the hinged plate.
6. Pull pin and push open valve to start the flow of shot.
7. After the unit shuts off the flow of shot, immediately put the locking pin in place and then record the weight of shot.
8. Loosen top nuts to remove plates and rotate specimen 90 degrees.
9. Repeat procedure on the other axis of the specimen.
10. Calculate short-term strength as follows:
    - shot weight / (15 * (0.031*height + 0.0027*height^2))
    - where shot weight is in grams and height is in cm
11. A total of two results will be obtained for each specimen at each emulsion content, and a total of four results will be obtained at each emulsion content.

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APPENDIX 4

Procedures for Performing AASHTO T322 for FDR Design Specimens

NOTE: Procedure for critical cold temperature selection

Specification temperature shall be chosen using FHWA LTPPBind software (Version 2.1) using the weather station closest to the project. The required temperature for the specification is the coldest temperature at the top of the FDR layer in the pavement structure. Use 98% reliability.

Perform the indirect tensile testing (IDT) according to AASHTO T322 with the following exceptions:

1. Specimens shall be 150 mm in diameter and at least 115 mm in height and cured and compacted as described in the testing procedures. After curing, two specimens shall be cut from each compacted specimen to 50 mm in height. Perform bulk specific gravity after cutting.
2. Two to three specimens are required at each of three temperatures.
3. Select two temperatures at 10°C intervals that bracket the required specification. For example, if the required specification temperature is -25°C, then select testing temperatures of -20°C and -30°C. A temperature of -10°C or -40°C should then be selected to complete the third required temperature.
4. The tensile strength test shall be carried out on each specimen directly after the tensile creep test at the same temperature as the creep test.
5. The environmental chamber must be capable of temperatures down to -40°C.
6. The critical cracking temperature is defined as the intersection of the calculated pavement thermal stress curve (derived from the creep data) and the tensile strength line (the line connecting the results of the average tensile strength at the two temperatures).