

Special Specification 3089

Full Depth Reclamation Using Asphalt Emulsion (Road-Mixed)



1. DESCRIPTION

Perform full depth reclamation (FDR) using an in-place mixing process to obtain a homogenous mixture of the existing surface and the underlying base material (with or without new material and additive added) using an emulsified asphalt.

2. MATERIALS

Furnish uncontaminated materials of uniform quality in accordance with the plans and specifications. Notify the Engineer of the proposed material sources and, when necessary, changes to material sources. The Engineer will verify the specification requirements are met before approving the sources for use. The Engineer may sample and test project materials at any time during the project to verify specification compliance in accordance with Item 6, "Control of Materials."

- 2.1. **Emulsion.** Furnish standard or high yield emulsion in accordance Table 1, unless otherwise shown on the plans. Provide emulsified asphalt that is homogenous, does not separate after thorough mixing.

Table 1
Emulsified Asphalt Properties

Property	Test Procedure	Standard Emulsion		High Yield Emulsion	
		Min	Max	Min	Max
Residue from distillation, %	AASHTO T 59	60	-	63	-
Oil distillate by distillation, %	AASHTO T 59	-	0.5	-	0.5
Sieve Test, %	AASHTO T 59	-	0.1	-	0.1
Penetration, 25°C, dmm	AASHTO T 49	55	95	120	-
Viscosity SFS @ 25°C, sec	AASHTO T 59	20	100	20	100
<i>Tests on rejuvenating agent:</i>					
BWOA, % ¹	***	-	-	2	-
Viscosity 140 °F, cSt	AASHTO T201	-	-	50	175
Flash Point, COC, °F	AASHTO T48	-	-	380	-
Solubility in n-pentane, % by weight	D2007	-	-	99	-
Polyphosphoric Acid (PPA), % BWOA	MTD ²	-	0.5%	-	0.5%
Re-Refined Engine Oil Bottoms (REOBS), % BWOA	MTD ²	-	5.0%	-	5.0%

1. BWOA = By Weight of Asphalt. Provide a manufacturer's certificate of analysis with the percent of rejuvenator added.

2. When required, this material property will be determined by the Materials & Tests Division (MTD).

- 2.2. **Additional Material.** When shown on the plans, required by the mixture design, or as directed, furnish base or reclaimed asphalt pavement (RAP) material meeting the requirements of Item 247, "Flexible Base" for the type and grade required.
- 2.3. **Additive.** When shown on the plans, required by the mixture design, or as directed, use the type and amount of additive required. Do not exceed 1.5% by weight of material, unless otherwise shown on the plans.

- 2.3.1. **Lime.** When shown on the plans, required by the mixture design, or as directed, furnish lime in accordance with DMS-6350, "Lime and Lime Slurry," and DMS-6330, "Pre-Qualification of Lime Sources." Use hydrated lime or commercial lime slurry as required.
- 2.3.2. **Cement.** When shown on the plans, required by the mixture design, or as directed, furnish hydraulic cement in accordance with DMS-4600, "Hydraulic Cement," and the Department's Hydraulic Cement Quality Monitoring Program (HCQMP). Sources not on the HCQMP will require testing and approval before use.
- 2.3.3. **Fly Ash.** When shown on the plans, required by the mixture design, or as directed, furnish fly ash in accordance with DMS-4615, "Fly Ash for Soil Treatment." Use Class CS or FS as shown on the plans.
- 2.4. **Mixture Design.** The Engineer will provide an approved mixture design, unless otherwise directed, generated using the Materials & Tests Division (MTD) mixture design procedure before the start of any work pertinent to this item. Provide the Engineer with samples of standard or high yield emulsified asphalt. The mixture design must meet the requirements listed in Tables 1 and 2 and report the optimum moisture content, maximum dry density, percent additive when applicable, percent of additional material when applicable, percent of existing material, type of emulsified asphalt, percent residue by distillation, and the optimum percent emulsion content.
- 2.5. **Mixture Design Verification.** When directed, provide the Engineer with representative samples of all materials that will be included in the treatment process before the start of production. The Engineer will verify the target emulsion content and when applicable, the target additive content that produces a mixture to meet the requirements listed in Tables 1 and 2. When the mixture fails to meet the material requirements listed in Tables 1 and 2, the Engineer may provide a new mixture design.
- 2.6. **Water.** Furnish water free of industrial waste and other objectionable material.

Table 2
Laboratory Mixture Design Properties

Mixture Property ¹	Test Method	Minimum Requirement
Indirect Tensile Strength (IDT) psi	Provided by MTD	50
Moisture Conditioned ² IDT, psi		30
Moisture Conditioned ² Unconfined Compressive Strength (UCS) ³ , psi		120

1. Oven dry test specimens at 104 ± 5°F for a minimum of 72 hr. after compaction.
2. MTD will provide the procedure for moisture conditioning test specimens. Moisture conditioning will be performed by submerging test specimens in water for 24 ± 1 hr. before IDT and UCS strength testing.
3. Average of a minimum of two test specimens.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work.

- 3.1. **Storage Facility.** Store cement, quicklime, dry hydrated lime, and fly ash in closed, weatherproof containers.
- 3.2. **Slurry Equipment.** Use slurry tanks equipped with agitation devices to slurry cement, hydrated lime, or quicklime at the project or at another approved location. The Engineer may approve other slurry methods. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with a sampling device in accordance with Tex-600-J, Part I.
- 3.3. **Dry Distribution Equipment.** Provide equipment to spread the cement or lime or fly ash evenly across the area to be treated. Provide equipment with a rotary vane feeder to spread the cement or lime, when shown on the plans.
- 3.4. **Rollers.** Provide rollers in accordance with Item 210, "Rolling."

- 3.5. **Proof Rollers.** Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.
- 3.6. **Reclaimer for Emulsion Treatment.** Use a reclaimer with the following equipment and capabilities:
- self-propelled mixer capable of fully mixing the existing road to the depth shown on the plans with emulsion, water, and when applicable, additives and additional material to produce a homogeneous material;
 - minimum power capability of 400 horsepower;
 - ability to mix the roadway with the additive and additional materials, when applicable, in a single pass for the width and depth specified by the plans;
 - ability to add emulsion with a full width spray bar consisting of a positive displacement pump interlocked to the machine speed such that the amount of emulsion added is automatically adjusted with changes of machine speed;
 - equipped with an emulsion injection system capable of accurately adding up to 8 gallons per square yard of emulsified asphalt; and
 - emulsion injection system spray bar equipped with individual valves that can be turned off to minimize emulsion overlap on subsequent passes.

4. STAFFING REQUIREMENTS

Provide staff onsite for a minimum of 3 days from the start of the FDR process or as deemed necessary by the Engineer. This staff must have a minimum experience of 2 years supervising FDR projects using emulsion.

Provide Soils & Base 102 (SB102) Field Specialists certified by the Department-approved Soils and Base Certification Program to conduct all sampling and testing for the duration of the project. Supply the Engineer with a list of certified personnel and copies of their current certifications, either hardcopy or electronic files, before beginning production and when personnel changes are made.

5. CONTROL SECTION

Construct a control section at a location approved by the Engineer using the equipment specified in Section 3. Process material in the control section for a lane width, minimum 300 ft. in length, and to the depth shown on the plans. Meet the process control requirements of Section 7 with the Engineer witnessing the sampling and testing; and provide test results and any pertinent information to the Engineer upon completion of the control section.

The Engineer will use Tex-103-E to determine the moisture content of the reclaimed and treated material. The Engineer will use this moisture content to determine a correction factor for Section 6.6.2, Density and Moisture Content.

When directed, proof-roll the control section in accordance with Item 216, "Proof Rolling." Proceed to full construction when approved by the Engineer.

6. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the materials, density, and moisture content as required by the approved mixture design (Section 2.4). Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans, or as directed.

- 6.1. **Reporting and Responsibilities.** Use Department-provided templates to record and calculate all test data and pertinent information for the mixture design and process control testing. Obtain the current version of the templates at <http://www.txdot.gov/inside-txdot/forms-publications/consultants-contractors/forms/site-manager.html> or from the Engineer. The Engineer and the Contractor will provide any available test results to

the other party when requested. Record and electronically submit all test results and pertinent information on Department-provided templates.

- 6.2. **Preparation of Existing Pavement for Treatment.** Before treating, remove existing asphalt pavement in accordance with Item 105, "Removing Treated and Untreated Base and Asphalt Pavement," when shown on the plans or as directed. Shape existing material in accordance with applicable bid items to conform to typical sections shown on the plans and as directed.
- 6.3. **Application of Additive.** Apply the required additive uniformly across the roadway in advance of the mixer, when required. Minimize dust and scattering of additives by wind. Do not apply additives when, in the opinion of the Engineer, wind conditions cause blowing additive to become dangerous to traffic or objectionable to adjacent property owners.
- 6.3.1. **Lime.** Uniformly apply lime using dry or slurry placement as shown on the plans or as directed. Add lime at the percentage determined in the mixture design. Apply lime only to the area to be reclaimed during the same working day.
- 6.3.1.1. **Dry Placement.** When necessary, sprinkle in accordance with Item 204, "Sprinkling." Distribute the required quantity of hydrated lime with approved equipment. Do not use a motor grader to spread hydrated lime.
- 6.3.1.2. **Slurry Placement.** Provide slurry free of objectionable materials, at or above the approved minimum dry solids content, and with a uniform consistency that will allow ease of handling and uniform application. Inject slurry directly into mixing chamber via an independent metered spray system. Alternatively, distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached.
- Deliver commercial lime slurry to the jobsite or prepare lime slurry at the jobsite or other approved location by using hydrated lime, as specified.
- 6.3.2. **Cement.** Uniformly apply cement using dry or slurry placement as shown on the plans or as directed. Add cement at the percentage determined in the mixture design. Apply cement only on an area where mixing, compacting, and finishing can be completed during the same working day.
- 6.3.2.1. **Dry Placement.** Distribute the required quantity of dry cement with approved equipment. Minimize dust and scattering of cement by wind.
- 6.3.2.2. **Slurry Placement.** Mix the required quantity of cement with water, as approved. Provide slurry free of objectionable materials and with a uniform consistency that can be easily applied. Agitate the slurry continuously. Apply slurry within 2 hr. of adding water and when the roadway is at a moisture content drier than optimum. Distribute slurry uniformly by making successive passes over a measured section of the roadway until the specified cement content is reached.
- 6.3.3. **Fly Ash.** Uniformly apply fly ash using dry or slurry placement as shown on the plans or as directed. Add fly ash at the percentage determined in the mixture design. Apply fly ash only on an area where mixing, compacting, and finishing can be completed during the same working day. Distribute the required quantity of fly ash with approved equipment.
- 6.4. **Weather Restrictions.** Suspend additive and emulsion application for any of the following:
- the surface temperature is below 50°F, or
 - the weather forecast calls for freezing temperatures within 3 days after incorporation of the emulsion, or
 - the moisture condition of the roadway is unsuitable, or
 - the Engineer determines the weather condition is unsuitable.
- 6.5. **Mixing.** Thoroughly mix the material using approved equipment. Mix until a homogenous mixture is obtained.

- 6.5.1. **Moisture.** Do not start mixing the material being treated if the moisture content is greater than 70% of the optimum moisture content from the mixture design, unless otherwise directed; aerate if too wet and add water if too dry.
- 6.5.2. **Lime.** When applicable, begin mixing within 6 hr. of application of lime. Hydrated lime exposed to the open air for 6 hr. or more between application and mixing, or that experiences excessive loss due to washing or blowing, will not be accepted for payment. Thoroughly mix the material and lime using approved equipment. Allow the mixture to mellow for a minimum of 24 hr., or as directed, before mixing with emulsion.
- 6.5.3. **Emulsion.** Apply the emulsion to obtain the optimum emulsion content determined in Section 2.4. Apply emulsion only to areas where mixing and compaction can be completed during the same working day. Do not dilute the emulsion at the jobsite. Monitor the required depth of mixing and meet the gradation requirements listed in Table 3.

Complete the entire operation of mixing the existing road and incorporating additional flexible base, cement, lime, or fly ash when applicable, water, and emulsion in one pass. Overlap each adjacent pass of the mixer with the previous pass by a minimum of 6 in. Use multiple passes if the process control requirements specified in Section 7 are not met.

After mixing, the Engineer will sample the mixture at roadway moisture for a minimum of 1 per 3,000 CY or 1 per lift at roadway moisture and test in accordance with Tex-101-E, Part III, to determine compliance with the gradation requirements in Table 3. When test results fail to meet the requirement of Table 3, modify operations until the Engineer's test results meet the gradation requirements.

Table 3
Gradation Requirements

Sieve Size	Min Percent Passing
1-3/4 in.	100
3/4 in.	85

- 6.5.4. **Irregularities.** Avoid spilling water or emulsion onto the surface of the existing or reclaimed surface when connecting or disconnecting transports from the reclaimer or when filling water trucks. When excess water is spilled onto the existing or reclaimed surface, identify the location and rework material that fails to meet or loses the required density, stability, or finish within 24 hr. of completion of compaction. Reworking includes loosening, adding material, or removing unacceptable material if necessary; mixing; compacting; and finishing as directed. Continue work until specification requirements are met. Perform the work at no additional expense to the Department.
- 6.6. **Compaction.** Compact the mixture in one lift using density control, unless otherwise shown on the plans.

Perform initial compaction using a heavy tamping roller applying high amplitude and low frequency. Continue rolling until the heavy tamping roller "walks out" of the material. Walking out for the heavy tamping roller is defined as light being evident between all of the pads at the material-heavy tamping roller drum interface.

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least half the width of the roller unit. On super-elevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph, as directed.

After the completion of tamping rolling, remove remaining tamping marks. Cut slightly below the depth of the tamping marks and ensure material being cut is kept moist at all times. Achieve the desired slope and shape to the lines and grades as shown on the plans. Perform final surface shaping on the same day emulsion is incorporated. Clip, skin, or tight-blade the surface to remove and waste accumulated fines. Do not use fines to fill surface irregularities.

Use a vibratory roller and pneumatic roller to compact the bladed material. Do not finish-roll in vibratory mode. If necessary, use a light spray of water to aid in final compaction density and appearance.

Rework material that fails to meet or loses the required density, stability, or finish within 24 hrs. of completion of compaction. Add additional emulsified asphalt and additives as directed. Reworking includes loosening, adding material, or removing unacceptable material if necessary; mixing; compacting; and finishing as directed. Continue work until specification requirements are met. Perform the work at no additional expense to the Department.

When an area fails to meet or loses required density, stability, or finish more than 24 hr. after completion of compaction and before the next course is placed or the project is accepted, remove the unacceptable material and replace with treated flexible base in accordance with Item 247 or as directed that meets the mix design requirements. Compact and finish until specification requirements are met. Perform the work at no additional expense to the Department.

Suspend field operations when significant changes of materials being treated occur. Provide the Engineer with recommendations to modify operations based on the changes of materials. This may include changes in additives or percentages of emulsion or verification of the maximum dry density and optimum moisture content. Provide the Engineer with an emulsion treatment proposal for all areas requiring full depth repair.

Notify the Engineer when significant changes of materials being treated occur. The Engineer may suspend field operations and investigate the areas of concern.

Before final acceptance, the Engineer will select the locations of tests and measure the depth of the emulsion treatment in accordance with Tex-140-E at a minimum of 1 per 3,000 CY or 1 per lift. Correct areas deficient by more than ½ in. in thickness by reshaping, re-compacting, and refinishing at the Contractor's expense, unless otherwise directed.

- 6.6.1. **Ordinary Compaction.** Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.
- 6.6.2. **Density and Moisture Control.** The Engineer will determine the roadway density and moisture content of completed sections in accordance with Tex-115-E using the correction factor from Section 5. The Engineer will perform testing for each day of production at a minimum of 1 per 3,000 CY or 1 per lift. The full depth of the layer must be compacted to a minimum of 97.0% of the maximum density and within 2.0 percentage points below the optimum moisture content and no more than 0.5 percentage points above the optimum moisture content determined from the mixture design in Section 2.4. Unless otherwise directed:
- Perform additional compaction or rework with the reclaimer unless otherwise directed, and recompact when the material does not meet the density but meets the moisture content,
 - Aerate and recompact when the moisture content is more than 0.5 percentage points above the optimum moisture content, and
 - Rework, add moisture, and recompact when the moisture content is more than 2.0 percentage points below the optimum moisture content.
- 6.7. **Curing.** Cure the finished section until the moisture content is a minimum of 2 % below the optimum moisture content, or as directed, before applying the next successive course or prime coat. The Engineer may allow traffic on the finished section during curing when proof rolling indicates adequate stability.

Proof-roll the roadbed in accordance with Item 216, "Proof Rolling." If deformation occurs, do not allow traffic to return to the finished section until the mixed material is firm enough to accommodate traffic without deformation. Apply prime coat and seal coat or additional courses within 14 calendar days of final compaction.

When no specific detour is required, provide one-way traffic control until proof rolling permits the return of normal traffic to the compacted material.

7. PROCESS CONTROL

Perform process control testing during the treatment process and for the completed base in accordance with Table 4 at locations independent from the Engineer's testing locations, unless otherwise directed. Test results from process control will not be used for acceptance. Contractor may perform additional testing as they deem necessary for process control. Report test results and all pertinent information in accordance with Section 6.1., "Reporting and Responsibilities." When test results do not meet specification requirements, modify operations and perform the test methods required in Table 4. Suspend operations when any of the test results performed after the modifications do not meet specification requirements.

Table 4
Minimum Testing Frequency

Description	Test Method	Minimum Frequency
Depth of Pulverization	Tex-140-E	1 per day of production
Gradation	Tex-101-E, Part III	1 per day of production
Emulsion Content	Meter Readings or Truck Weight Tickets	1 per day of production
Moisture Content ¹	Tex-103-E	3 per day of production

1. Measure the moisture content in accordance with Tex-103-E before adding the emulsion.

- 7.1. **Depth of Pulverization.** Determine the depth of pulverization in accordance with Tex-140-E.
- 7.2. **Gradation.** Sample the roadway mixture after mixing with the moisture and measure the gradation in accordance with Tex-101-E, Part III.
- 7.3. **Emulsion Content.** Verify the percentage of emulsion added to the pulverized material using meter readings or truck weight tickets as approved; the quantity of material treated (depth, width, and length); and estimated in-place density. Changes in the emulsion content, type, or supplier must be approved before the start of production. Notify the Engineer when adjustments to the emulsion content are made during any day's production.
- 7.4. **Moisture Content.** Measure the moisture content in accordance with Tex-103-E before adding the emulsion. Verify the moisture content when precipitation occurs after testing and before the emulsion is added.

8. MEASUREMENT

- 8.1. **Emulsion.** Emulsified asphalt material will be measured by one of the following methods.
- 8.1.1. **Weight.** Emulsion will be measured in tons using certified scales meeting the requirements of Item 520, "Weighing and Measuring Equipment," unless otherwise approved. The transporting truck must have a seal attached to the draining device and other openings. Random checking on public scales at the Contractor's expense may be required to verify weight accuracy.
- Upon work completion or temporary suspension, any remaining asphalt material will be weighed by a certified public weigher. The quantity to be measured will be the number of tons received minus the number of tons remaining after all directed work is complete.
- 8.1.2. **Volume.** Emulsion will be measured by the gallon of emulsified asphalt used in the emulsified asphalt and water mixture.
- 8.2. **Additive.**
- 8.2.1. **Lime.** When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."

- 8.2.1.1. **Hydrated Lime.**
- 8.2.1.1.1. **Dry.** Lime will be measured by the ton (dry weight).
- 8.2.1.1.2. **Slurry.** Lime will be measured by the ton (dry weight) of the hydrated lime used to prepare the lime slurry at the jobsite.
- 8.2.1.1.3. **Commercial Lime Slurry.** Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
- 8.2.2. **Cement.** Cement will be measured by the ton (dry weight). When cement is furnished in trucks, the weight of cement will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."
- Cement slurry will be measured by the ton (dry weight) of the cement used to prepare the slurry at the jobsite or from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
- 8.2.3. **Fly Ash.** Fly ash will be measured by the ton (dry weight). When fly ash is furnished in trucks, the weight of fly ash will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."
- Fly ash slurry will be measured by the ton (dry weight) of the fly ash used to prepare the slurry at the jobsite or from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.
- 8.3. **Emulsion Treatment.** Emulsion treatment will be measured by the square yard of surface area. The dimensions for determining the surface area is established by the widths shown on the plans and lengths measured at placement.

9. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid in accordance with Section 8.1, "Standard Emulsion" or "High Yield Emulsion"; Section 8.2.1, "Lime"; Section 8.2.2, "Cement"; Section 8.2.3, "Fly Ash"; and Section 8.3, "Emulsion Treatment."

Furnishing and delivering new base will be paid for in accordance with Item 247, "Flexible Base," unless otherwise shown on the plans.

Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items or Section 4.4, "Changes in the Work."

Additives and emulsion used for reworking a section will not be paid for directly but will be subsidiary to this Item.

Sprinkling and rolling, including proof rolling, will not be paid for directly but will be subsidiary to this Item unless otherwise shown on the plans.

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be in accordance with pertinent Items or Section 4.4, "Changes in the Work."

When an additional additive is required by the mixture design or required by the Engineer and not shown on the plans, it will be paid for in accordance with Section 4.4, "Changes in the Work."

- 9.1. **Emulsion.** Emulsion will be paid for at the unit price bid. This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.
- 9.2. **Lime.** Lime will be paid for at the unit price bid for one of the following types: Hydrated (Dry), Hydrated (Slurry), or Commercial Lime Slurry. This price is full compensation for furnishing lime.
- 9.3. **Cement.** Cement will be paid for at the unit price bid. This price is full compensation for furnishing cement.
- 9.4. **Fly Ash.** Fly Ash will be paid for at the unit price bid for the type specified. This price is full compensation for furnishing fly ash.
- 9.5. **Emulsion Treatment.** Emulsion treatment will be paid for at the unit price bid for the depth specified. No payment will be made for thickness or width exceeding that shown on the plans.

This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying additives and Emulsified Asphalt, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.