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Small Sample Mix Design for Full Depth Reclamation: Workshop Student Guide

Product 5-6271-03-P4

Cooperative Research Program

TEXAS A&M TRANSPORTATION INSTITUTE
COLLEGE STATION, TEXAS

in cooperation with the
Federal Highway Administration and the
Texas Department of Transportation
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Student Guide

Product 5-6271-03-P4

Small Sample Mix Design for Full Depth Reclamation: Workshop Student Guide

Published: February 2019

Texas Transportation Institute
The Texas A&M University System

SMALL SAMPLE MIX DESIGN FOR FULL DEPTH RECLAMATION: WORKSHOP STUDENT GUIDE

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Project 5-6271-03
Project Title: Using Small Sample Sizes in Full Depth Reclamation Laboratory Mix Designs

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and the
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TEXAS A&M TRANSPORTATION INSTITUTE
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College Station, Texas 77843-3135

DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The engineer in charge of the project was Tom Scullion, P.E. #62683.

ACKNOWLEDGMENTS

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SLIDE PRESENTATION

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Small Sample FDR Mixture Design

TxDOT Project 5-6271-03

July 2016

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Training Modules

- Basics of Small Sample Procedures
- Advantages of Small Sample Size Procedures
- How to Perform the Small Sample Mix Design
- Questions

Module 1: Basics of Small Sample Procedures

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Module 1

Basics of Small Sample Procedures

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Purpose

- Develop a suitable mixture design for stabilized base layers
- Initial focus of small sample procedure was on cement
- More recent focus on asphalt-based products (foamed asphalt, asphalt emulsion)

Typical pavement section that may be candidate for stabilization

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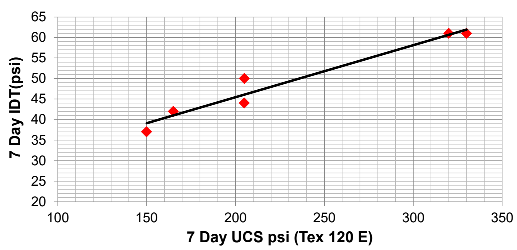
Premise of Small Sample Design



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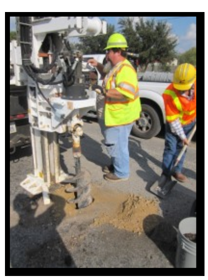
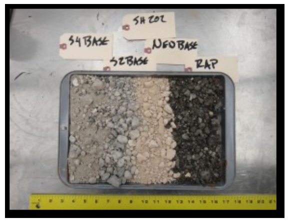
Basics of Small Sample Procedures

- Requires representative field material
- Requires add rock as appropriate
- Requires plan for FDR options
  - Mixture proportions
  - Stabilizer(s) and application rates



- Materials must be processed and recombined according to FDR options under consideration



- Make 4×2 or 6×3¾ specimens in gyratory compactor
- Cure specimens
- Perform IDT on cured, and moisture-conditioned specimens
- Determine if mix design criteria met

Example Construction Spec Mixture Design Requirement

Mixture Property	Test Method	Minimum Requirement
Indirect Tensile Strength (IDT), psi	Provided by Engineer	50
Moisture Conditioned IDT, psi	Provided by Engineer	30
Moisture Conditioned Unconfined Compressive Strength,[1] psi	Tex 117-E, Part II	120

1. Average of two test specimens. Oven dry test specimens after compaction in an oven at 104 ± 5°F for a minimum of 72 hours. After drying, allow the specimens to return to room temperature. Moisture condition the test specimens by submerging them in water for 24 ± 1 hours before strength testing.

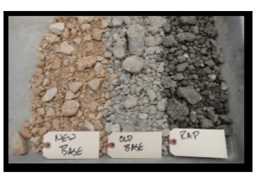
Module 2: Advantages of Small Sample Size Procedures

Module 2

Advantages of Small Sample Size Procedures

Advantages of Small Sample Procedures

- Selecting optimal FDR treatment may include several factors in testing
  - Multiple stabilizer types
  - Multiple stabilizer levels
  - Different percentages of salvage/new material
- Can easily reach ≥ 8 different designs
- Amount of material required using 6×8 sample size can become burdensome



- Smaller sample mix design allows to address numerous stabilization options and material variability under consideration

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Traditional vs. Small Sample Size

- Traditional sample sizes
  - 110 pounds per design
- Small samples
  - 15 pounds per design
- Oftentimes 4 to 8 different mixtures under consideration

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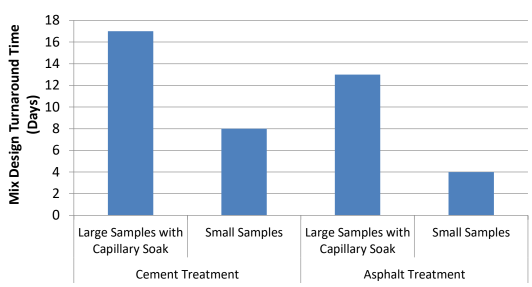
Test Turnaround Time



Module 3: Step-by-Step How to Perform Small Sample FDR Mixture Design

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Module 3

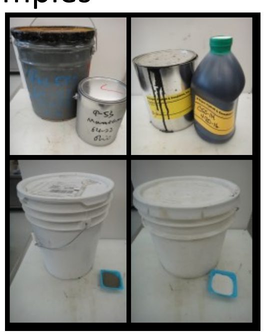
Step-by-Step How To Perform Small Sample FDR Mixture Design

Overview

- Obtain and process materials
- Perform index tests on material
  - Aggregate materials
    - Plasticity Index
    - Moisture Density Curve
  - Asphalt
    - Half-Life
    - Expansion Ratio
- Recombine Materials for Stabilization Mixture Design
- Mix Molding Water and Stabilizer
- Compact Small Mixture Design Samples
- Cure and condition design samples
- Test IDT strength of conditioned samples

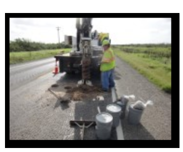
Obtain Samples

- Asphalt
  - PG 64-22
  - CSS-1H Emulsion
- Additives
  - Cement
  - Lime
  - Fly-Ash



Obtain Samples

- Salvage Materials, keep all separate
  - RAP
  - Salvage Base
  - Salvage Sub-Base
- Virgin Materials – keep separate from salvage materials
  - Flex-Base

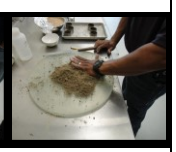


Process Aggregate Samples

- Keep RAP, salvage base, virgin base, and other aggregate samples separate
- Prepare aggregate and RAP samples in accordance with Tex 101-E Part II
  1. Air dry on floor bulk samples
  2. Oven dry bulk samples
  3. Sieve bulk samples
     - Sieve sizes:
       - 1 ¾ in.
       - 1 ¼ in.
       - ¾ in.
       - 3/8 in.
       - #4
       - #40

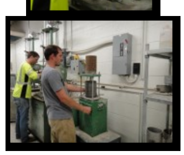
Index Tests – Aggregate Samples

- Obtain plasticity index of aggregate samples in accordance with Tex 104-106-E.
- Additive may be required to meet mixture design requirements when the aggregate PI exceeds 6. For aggregates with 6 < PI < 10, cement or lime may be needed as additive. For aggregates with PI > 10, lime with a minimum two-hour mellowing period may be required.



Index Tests – Aggregate Samples

- Obtain optimum moisture density curve of aggregate samples in accordance with Tex 113-E
  - Recombine samples in proportions expected in field
    - Example of 10 in FDR treatment
      - 4 in. virgin aggregate – 40%
      - 1 in. RAP – 10%
      - 5 in. salvage aggregate – 50%
  - Untreated material



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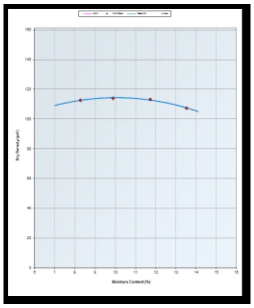

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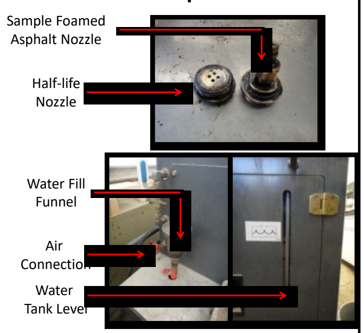
Foamed Asphalt Plant Preparation

- Before using foamed asphalt plant, check:
  - Water tank level
  - Air connection
  - Nozzle
  - Calibrate discharge rate



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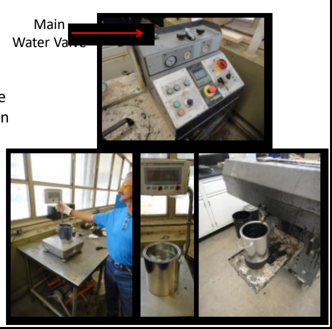
Calibrate Discharge Rate

1. Turn main water valve to off
2. Set plant to discharge 200g asphalt
3. Tare a clean gallon can on scale
4. Discharge 200g asphalt into can
5. Weigh can
6. If sample is not within ± 5g of discharge amount, adjust metering knob
7. Repeat 3 through 5 until discharged amount is ± 5g of reported discharge amount



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Lives, Time and Resources

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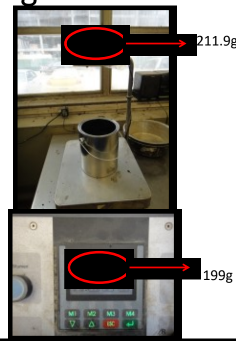

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Lives, Time and Resources

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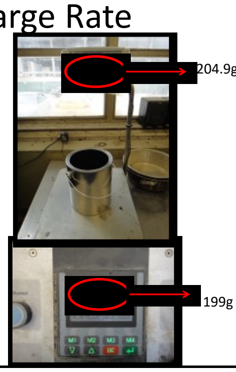

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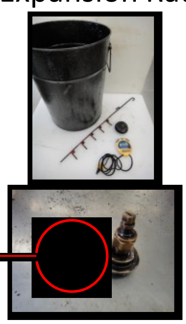
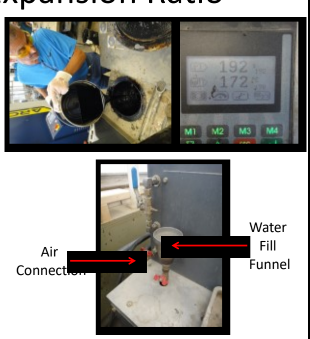
Index Test – Half-Life and Expansion Ratio

- Test is only applicable if foamed asphalt is possible stabilizer
- Run once on each batch sample of asphalt
- Test requires approximately 5 gallons of asphalt binder



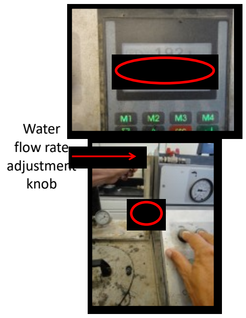
Half-Life and Expansion Ratio

- Place asphalt into laboratory foamed asphalt plant
- Allow plant to reach temperature
  - Recommended starting temperature 160°C
  - Turn asphalt pump on
- Connect air to plant
- Fill plant water tank
- Verify discharge rate of asphalt



Half-Life and Expansion Ratio

1. Ensure asphalt is at set temperature
2. Heat empty metal bucket to at least 60°C
3. Set water flow rate to desired value
   – Recommended starting point of 1.5% water addition value
4. Discharge 500g foamed asphalt into bucket
5. Measure maximum achieved height using graduated dipstick
6. Record time from maximum height to ½ maximum height as the half-life



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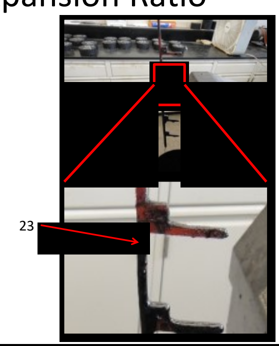

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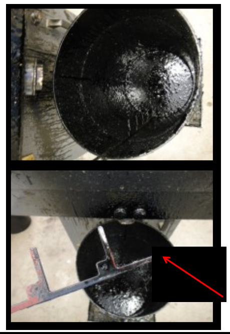
Half-Life and Expansion Ratio

7. Allow all foam to dissipate
   – Only necessary 1 time per temperature
8. Measure minimum height
9. Record expansion ratio as maximum height/minimum height
10. Repeat steps 1 through 6 at different water addition values
    – 1.5%, 2%, 3%, 4%

- Repeat process with additional temperature
  – Recommended 160 and 170°C



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Half-Life and Expansion Ratio

Half Life Video

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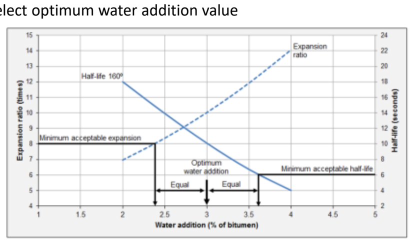
Half-Life and Expansion Ratio

- Graph
  – Half life vs. water addition value
  – Expansion ratio vs. water addition value
  – Select optimum water addition value



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Overview

- Obtain and process materials
- Perform index tests on material
  - Aggregate materials
    - Plasticity Index
    - Moisture Density Curve
  - Asphalt
    - Half-Life
    - Expansion Ratio
- Recombine Materials for Stabilization Mixture Design
- Mix Molding Water and Stabilizer
- Compact Small Mixture Design Samples
- Cure and condition design samples
- Test IDT strength of conditioned samples

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Small Sample Design

- Recombine passing ¾ in. material
  - Add % of material retained on ¾ in sieve to the 3/8 in. sieve to retain proportion of coarse aggregate
- Recombine with respect to expected roadway proportions
  - Example 8 in salvage
    - 6 in base – 75%
    - 2 in HMA/RAP – 25%

Gradation

Sieve Sizes	Materials			
	Salvage Base		Salvage RAP	
	Weight Retained	% Retained	Weight Retained	% Retained
1 3/4	0.0	0.0%	0.0	0.0%
1 1/4	2467.0	2.0%	5188.5	23.2%
3/4	5261.5	4.2%	1787.0	8.0%
3/8	16347.0	12.9%	3133.0	14.0%
#4	24288.0	19.2%	4716.5	21.1%
#40	47313.5	37.4%	5695.5	25.4%
Pan	30670.0	24.3%	1865.5	8.3%
Total	126347.0	100.0%	22386.0	100.0%

Weighout

Sieve Sizes	Materials			
	Salvage Base		Salvage RAP	
	% Portion	75.0%	% Portion	25.0%
	Full (g)	Modified (g)	Full (g)	Modified (g)
1 3/4	0.0	0.0	0.0	0.0
1 1/4	117.2	0.0	463.5	0.0
3/4	249.9	0.0	159.7	0.0
3/8	776.3	1143.3	279.9	903.1
#4	1153.4	1153.4	421.4	421.4
#40	2246.8	2246.8	508.8	508.8
Pan	1456.5	1456.5	166.7	166.7
Total	6000.0	6000.0	2000.0	2000.0

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Small Sample Design

- Add OMC
  - Account for water to be added in emulsion or lime slurry if applicable
  - If cement is being used, adjust water content in accordance with Tex 120-E
  - Cover to prevent moisture loss
  - Allow 12 hr. minimum standing time

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Small Sample Design

- If applicable, add lime slurry to recombined sample
- 40% Lime solids, 60% water
- Mix thoroughly into recombined sample
- Re-cover sample
- Allow mellow time if applicable
  - 24 hr mellow

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Small Sample Design

- Place sample into mixer
- Add cement, if applicable
- Place cover on mixer

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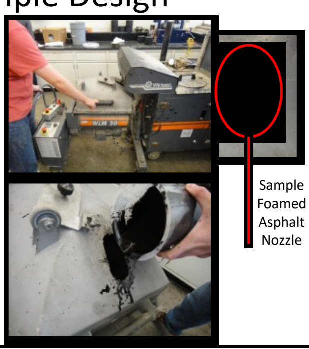
Small Sample Design

- While mixing add foamed asphalt or asphalt emulsion
- Mix thoroughly



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Small Sample Design

- After mixing, determine moisture content of sample in accordance with Tex 103-E
- Calculate the mass needed to make 4 in. × 2 in. sample at maximum density
- Weigh 6 samples
- Compact using appropriate test method
  - SGC – Tex 241-F
  - TGC – Tex 206-F


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Small Sample Design

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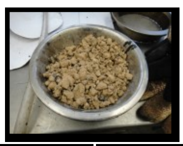
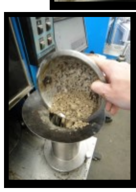


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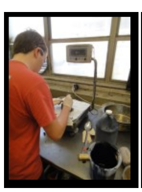
Small Sample Design

- After molding, number and weigh each compacted sample
- Dry cure all samples at 40°C for minimum 72 hr.

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Small Sample Design

- Other curing strategies:
  - Cement only samples:
    - Cure 7 days in moisture room inside unsealed plastic bag
  - Lime only samples:
    - Cure at 40°C for 72 hr. in sealed plastic bag

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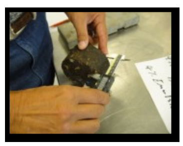
Small Sample Design

- After curing, record 4 height measurements of each sample
- Submerge 3 samples completely in water for 24 ± 1 hr.
- Store remaining 3 samples in air for 24 ± 1 hr.



Height (in)	2.013	2.035	2.003	2.014	1.997	2.019
	2.017	2.004	2.004	2.025	2.014	2.002
	1.995	2.036	2.022	2.007	1.999	2.012
	1.998	1.999	2.030	2.028	1.999	1.998
Average Height (in)	2.006	2.019	2.015	2.019	2.002	2.008

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Small Sample Design

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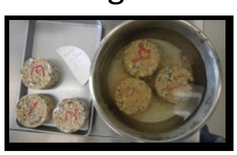
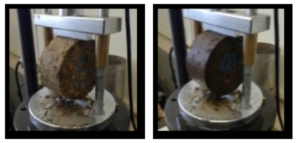


Small Sample Design

- After conditioning period, perform IDT in accordance with Tex 226-F
- Record max load (lb) and calculate IDT strength (psi)



	IDT Test Data					
	Dry			Wet		
Max Load (lb)	712.0	574.0	671.0	306.0	313.0	314.0
Strength (psi)	56.40	45.34	53.25	23.87	24.46	24.40
Average	51.66			24.25		

Small Sample Design

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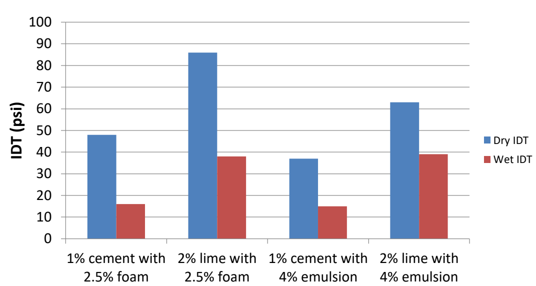
Example Results



Module 4: Questions

Module 4

Questions

Performing Agency Contacts

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  979.847.8998
  ross-taylor@tti.tamu.edu

APPENDIX: FDR DRAFT TEST PROCEDURE

Test Procedure for

INDIRECT TENSILE STRENGTH TEST FOR FULL DEPTH RECLAMATION MIXTURE USING GYRATORY COMPACTOR

TxDOT Designation: Tex-XXX

Effective Date:

1. SCOPE

1.1. This method determines the indirect tensile strength of full depth reclamation (FDR) mixtures compacted by a gyratory compactor.

1.2. This method describes the procedure for preparing 4 in. by 2 in. FDR specimens using gyratory compaction.

Note—6 in. by 3 ¾ in. specimens may be substituted for 4 in. by 2 in. specimens.

1.3. The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard

2. APPARATUS

2.1. Gyratory compactor apparatus including:

- Texas Gyrator Compactor meeting the requirements of Tex-206-F, or
- Superpave Gyratory Compactor meeting the requirements of Tex-241-F
- Molding assembly, consisting of: mold with 4 in. inside diameter, ram head, mold bottom, and wide-mouthed funnel.

2.2. Balance readable to 0.1 g and accurate to 0.5 g with a minimum capacity of 10,000 g.

2.3. Standard U.S. sieves, meeting the requirements of Tex-907-K, in the following sizes:

- 1-3/4 in. (45 mm).
- 1-1/4 in. (31.5 mm).
- 3/4 in. (19 mm).
- 3/8 in. (9.5 mm).
- No. 4 (4.75 mm).
- No. 40 (425 µm).

2.4. Laboratory foamed asphalt plant.

2.5. Mechanical mixer.

2.6. Flexible spatula, with a blade 4 in. (100 mm) long and 0.75 in. (20 mm) wide.

2.7. Micrometer dial assembly or calipers, capable of measuring a height of at least 2 ± 0.06 in. (50.8 ± 1.5 mm).

2.8. Non-porous paper gaskets, 4 in. (100 mm) in diameter.

2.9. Temperature chamber or heating oven capable of maintaining 104 ± 5°F.

2.10. Damp room maintained at a temperature of 73.4 ± 3°F and a relative humidity of not less than 96%.

2.11. Loading press capable of applying a compressive load at a controlled deformation rate of 2 in. per minute.

2.12. Loading strips, consisting of 0.5 in. by 0.5 in. square steel bars for 4-in. diameter specimens. Machine the surface that contacts the specimen to the curvature of the test specimen.

3. CALIBRATION

3.1. See Tex-241-F Section 4 for SGC calibration.

3.2. See Tex-927-K for verifying oven temperature.

3.3. Calibrate the discharge rate of the laboratory foamed asphalt plant.

3.3.1. Weigh clean bucket or gallon can.

3.3.2. Discharge 200g of asphalt from foamed asphalt plant into bucket.

3.3.3. Determine actual mass of asphalt discharged.

3.3.4. Adjust metering knob if necessary.

3.3.5. Repeat 3.3.1 to 3.3.4 until discharged amount of asphalt is 200 ± 5g.

3.4. Determine the maximum expansion ratio and half-life for use with the laboratory foamed asphalt plant each time a new asphalt source is sampled.

3.4.1. Set temperature of laboratory foamed asphalt plant, and allow the plant to maintain temperature for 5 minutes prior to testing.

Note—Normally 160°C is used as the initial starting temperature.

3.4.2. Ensure laboratory foamed asphalt plant pump is circulating prior to testing.

3.4.3. Set the water-flow meter to achieve the required injection rate, record on Form IDT_FDR as Water Addition Value.

3.4.4. Discharge 500g of foamed asphalt into a 60ºC preheated bucket. Immediately after the foam discharge stops, start a stopwatch.

3.4.5. Use a dipstick to measure the maximum height the foamed asphalt achieves in the drum. This is the maximum volume. Record on Form IDT_FDR.

3.4.6. Use a stopwatch to measure the time in seconds that the foam takes to dissipate to half of its maximum volume. This is the foamed asphalt's half-life. Record on Form IDT_FDR.

3.4.7. Let the foam dissipate completely. Use the dipstick to measure the minimum height. Record on Form IDT_FDR.

3.4.8. The expansion ratio is the ratio of the maximum height of the asphalt to the minimum height. Record on Form IDT_FDR.

3.4.9. Repeat steps 3.4.3 to 3.4.8 for a range of at least three water injection rates.

Note—Typically use water addition values of 1.5%, 2%, 3%, and 4% by mass of asphalt.

3.4.10. Repeat Steps 3.4.1 to 3.4.9 for 170°C.

3.4.11. Use form IDT_FDR to graph the expansion ratio versus half-life at the different water injection rates in the same set of axes. Choose the optimum water addition value as an average of the two water contents required to meet these minimum criteria:

- Expansion ratio: 8 times.
- Half-life: 6 seconds.

If the foamed asphalt properties do not meet the minimum requirements, reject the asphalt.

3.4.12. Figure 1 shows an example of expansion ratio versus half-life for 160°C. In Figure 1, the optimum water addition for 160°C asphalt is 3%.

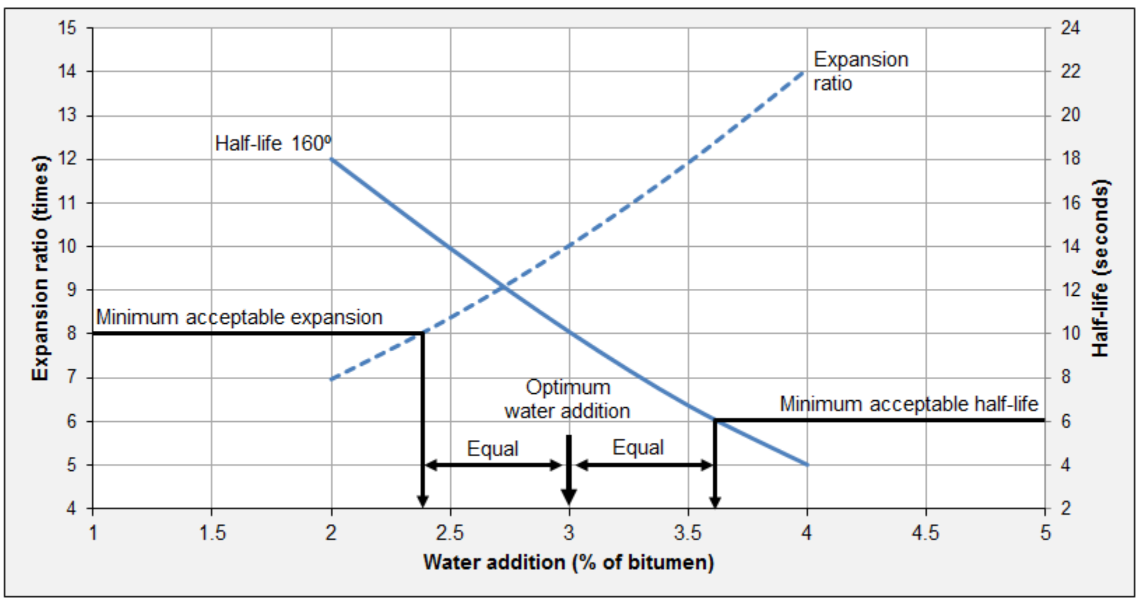

Figure 1—Example of Optimum Water Addition Value Determination

4. PROCEDURE

4.1. Obtain a representative roadway sample in accordance with Tex-100-E.

Note—A power drill rig, with auger attachments, generally results in a gradation similar to that expected from the actual FDR process.

4.2. If virgin material will be incorporated into the FDR mixture, obtain a representative sample in accordance to Tex-400-A.

4.3. Prepare all materials in accordance with Tex-101-E, Part II.

Note—Maintain reclaimed asphalt pavement (RAP), roadway aggregate, and virgin material separately for recombining according to project requirements.

4.4. Separate RAP, roadway aggregate, and virgin material by dry sieving into the following sizes:

- 1-3/4 in. (45 mm).
- 1-1/4 in. (31.5 mm).
- 3/4 in. (19 mm).
- 3/8 in. (9.5 mm).
- No. 4 (4.75 mm).
- No. 40 (425 µm).

Note—Do not overload the screens. The material passing the No. 4 and retained on the No. 40 sieve may need to be shaken separately and in several small batches to avoid overloading the screen.

4.5. Determine the liquid limit, plastic limit, and plasticity index of the roadway aggregate and virgin material in accordance with Tex-104-E, Part II, Tex-105-E, and Tex-106-E.

Note—Additive may be required to meet mixture design requirements when the aggregate PI exceeds 6. For aggregates with 6 < PI < 10, cement or lime may be needed as additive. For aggregates with PI > 10, lime with a minimum two-hour mellowing period may be required.

4.6. Determine the optimum moisture content and maximum dry density in accordance with Tex-113-E for the untreated mixture using the expected proportion of RAP, roadway aggregate, and virgin material according to the expected depth of FDR treatment.

4.7. Use the governing construction specification to group the materials into one of the following three general types of materials:

- Group A—Foamed asphalt or asphalt emulsion, with or without additives.
- Group B—Cement.

Follow the correct procedure for the specimen soil type, as shown below.

4.7.1. Group A— Foamed asphalt or asphalt emulsion, with or without additives.

4.7.1.1 Recombine the passing ¾ in. (19 mm) sieve sizes prepared in accordance with Tex-101-E, Part II, to make 8000g total sample for use in the gyratory compactor.

Note—Recombine RAP, roadway aggregate, and virgin material according to the expected depth of FDR treatment. For example, if the proposed FDR process includes 2 in. of virgin material, 2 in. of RAP, and 6 in. of roadway aggregate, the total recombined sample should consist of 20 percent virgin material, 20 percent RAP, and 60 percent roadway aggregate.

Note—Do not use particles larger than ¾ in. (19 mm) in the compacted specimens. When material contains aggregate retained on the ¾ in. (19 mm) sieve, add additional aggregate retained on the 3/8 in. (9.5mm) sieve equal to the percentage retained on the ¾ in. (19 mm) sieve.

4.7.1.2 Add the optimum moisture content to each sample. If applicable, include the amount of water in the asphalt emulsion in the calculation. Mix thoroughly.

Note—Account for water in the asphalt emulsion. For example: an 8000g sample with an OMC of 8%; 2.4% residual asphalt from emulsion; using emulsion containing 62% asphalt needs 522.3g of water.

$$Total\ water = 8000g * 0.08 = 640g$$
$$Amount\ of\ water\ in\ emulsion = \left(\frac{0.024}{0.62}\right) * 8000 * (1 - 0.62) = 117.7g$$
$$Water\ added = total\ water - amount\ of\ water\ in\ emulsion = 640 - 117.7 = 522.3g$$

Note—If using cement as an additive, vary the molding water according to Tex-120-E Section 5.3.2.

4.7.1.3 Cover the mixture to prevent loss of moisture by evaporation. Allow the wetted samples to stand for at least 12 hours before compaction. When the plasticity index (PI) is less than 12, the standing time may be reduced to not less than 3 hours.

Note—If the sample contains a lime slurry, then the water in the slurry should be included in the calculation of water needed to reach OMC.

4.7.1.4 If applicable, add additives in accordance with the appropriate test procedure:

- Cement: Tex-120-E.
- Lime: Tex-121-E.
- Lime-Fly Ash: Tex-127-E.

4.7.1.5 If applicable, mellow the mixture for the specified time.

4.7.1.6 Place the recombined sample in the mechanical mixer.

4.7.1.7 While mixing, add foamed asphalt or asphalt emulsion to the sample. Mix thoroughly.

4.7.1.8 After mixing, determine the moisture content of the sample in accordance with Tex-103-E, Part I.

4.7.1.9 Determine the mass of sample needed to fill a 4 in. × 2 in. cylindrical mold at the maximum dry density.

4.7.1.10 Weigh out six samples using the mass calculated in Section 4.7.1.9.

4.7.1.11 Compact six test specimens using the gyratory compactor.

Note—Follow Tex-206-F when using the Texas Gyratory Compactor.

Note—Follow Tex-241-F when using the Superpave Gyratory Compactor and compact according to a 2.0 in. height.

4.7.1.12 Number and weigh each specimen. Record on Form IDT_FDR.

4.7.1.13 Dry the specimens at 40°C (104 ± 5°F) for a minimum of 72 hours.

4.7.1.14 After drying, allow the specimens to return to room temperature.

4.7.1.15 Proceed to Section 4.8.

4.7.2. *Group B—Cement only.*

4.7.2.1 Recombine the passing ¾ in. (19 mm) sieve sizes prepared in accordance with Tex-101-E, Part II, to make 8000g total sample for use in the gyratory compactor.

Note—Recombine RAP, roadway aggregate, and virgin material according to the expected depth of FDR treatment. For example, if the proposed FDR process includes 2 in. of virgin material, 2 in. of RAP, and 6 in. of roadway aggregate, the total recombined sample should consist of 20% virgin material, 20% RAP, and 60% roadway aggregate.

Note— Do not use particles larger than ¾ in. (19 mm) in the compacted specimens. When material contains aggregate retained on the ¾ in. (19 mm) sieve, add additional aggregate retained on the 3/8 in. (9.5 mm) sieve equal to the percentage retained on the ¾ in. (19 mm) sieve.

4.7.2.2 Add the optimum moisture content to each sample. Mix thoroughly.

Note—If using a different amount of cement than used to generate the moisture-density curve, vary the molding water according to Tex-120-E Section 5.3.2

4.7.2.3 Cover the mixture to prevent loss of moisture by evaporation. Allow the wetted samples to stand for at least 12 hours before compaction. When the PI is less than 12, the standing time may be reduced to not less than 3 hours.

4.7.2.4 Place the recombined sample in the mechanical mixer.

4.7.2.5 Add cement in accordance with Tex-120-E.

4.7.2.6 After mixing, determine the moisture content of the sample in accordance with Tex-103-E, Part I.

4.7.2.7 Determine the mass of sample needed to fill a 4 in. × 2 in. cylindrical mold at the maximum dry density.

4.7.2.8 Weigh out six samples using the mass calculated in Section 4.7.2.7.

4.7.2.9 Compact six test specimens using the gyratory compactor.

Note—Follow Tex-206-F when using the Texas Gyratory Compactor.

Note—Follow Tex-241-F when using the Superpave Gyratory Compactor and compact according to a 2.0 in. height.

4.7.2.10 Number and weigh each specimen. Record on Form IDT_FDR.

4.7.2.11 Cure the specimens in the damp room for 7 days.

4.7.2.12 Proceed to Section 4.8.

4.8. Take four height measurements for each specimen. Record on Form IDT_FDR.

4.9. Submerge three specimens completely in water for 24±1 hours.

4.10. Store the remaining three specimens at room temperature on the countertop for 24±1 hours.

4.11. Determine the tensile strength on all specimens in accordance with Tex-226-F.

5. CALCULATIONS

5.1. Use Form IDT_FDR to calculate and record the following:

5.2. Calculate the wet density of the compacted specimens, lb/ft^3

$$D_{WET} = W_T/V_M$$

Where:
W_T = mass of the compacted sample, lb.
V_M = volume of the mold, ft.^{3}

5.3. Calculate the percent moisture:

$$\%\, Moisture = 100[(W_W - W_D)/(W_D - W_P)]$$

Where:
W_W = Wet mass of the sample and the pan, lb.
W_D = Oven dried mass of the sample and the pan, lb.
W_P = Weight of the pan, lb.

5.4. Calculate the dry density of the compacted specimens:

$$D_{DRY} = 100 \bullet D_{WET}/(100 + \%\, Moisture)$$

Where:
% Moisture = Percent moisture of the compacted specimen, % (includes hygroscopic moisture)

5.5. Calculate the tensile strength of the compacted FDR mixture:

$$S_T = \frac{2F}{3.14 \times (hd)}$$

Where:
S_T = Indirect tensile strength, psi
F = Total applied vertical load at failure, lb.
h = Height of specimen, in.
d = Diameter of specimen, in.

6. REPORT

6.1. Report the following for the FDR mixture:

- Percentage of RAP, salvage aggregate, and virgin aggregate in the mixture.
- Optimum moisture content and maximum dry density.
- Stabilizer and additive type(s) and percentage(s) used.
- Foamed asphalt temperature, if applicable.
- Water addition value, if applicable.
- Mellowing time, if applicable.

- Moisture content at time of molding for specimens.
- Compacted wet and dry density for each specimen.
- Average height for each specimen.
- Total load at failure for each specimen.
- Indirect tensile strength for each specimen.
- Average indirect tensile strength to the nearest whole number.
- Average moisture conditioned indirect tensile strength to the nearest whole number.

7. TEST RECORD FORMS

7.1. Form IDT_FDR.