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Rubber Pavements Association Draft Guide Asphalt-Rubber Plant Equipment Certification Program



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The Rubber Pavements Association

Asphalt-Rubber Plant Equipment, Quality Control, and Certification Program

Introduction

Vulcanized tire rubber is a unique engineered material. It has many valuable properties that are advantageous in asphalt paving materials. It is able to resist thermal changes and permanent deformation better than most materials used in civil engineering applications. However, the primary value to asphalt pavement engineers is the ability of tire rubber to resist cracking. After forty years of use in asphalt paving systems in the southwestern United States, the technology has been fine tuned to provide a well established pathway to success

In order to capture tire rubber properties in asphalt, the tire material must be granulated to a size that is small enough to fit into a pavement system. In hot mix asphalt materials 1 mm sizing and less are suitable. Rubber is highly absorptive of the light fractions in asphalt and will continuously soak up the oils until it is completely saturated. It has been shown that the interaction between tire rubber and the aromatic oils in asphalt is temperature dependent. Tire rubber that is too finely graded loses the ability to inhibit cracking. Finely ground tire rubber will dissolve or de-polymerized in asphalt, even at ambient temperatures. Additionally, the fine particles in asphalt will substantially affect viscosity, making the liquid very thick and difficult to handle.

Rubber particles that are too large require more space within an asphalt mixture and can create challenges with mix design. Large particles can interfere with the stone on stone contact and density of the mix. When the material is compacted the rubber particles go into compression. The material can become un-compacted as the rollers move away and the rubber decompresses. Large rubber particles will absorb the light fractions in the mix even after it is placed reducing the effective asphalt content over time.

Through years of trial and error, the ideal gradation provides enough mass and volume of particles to interfere with crack propagation and enough fine material to increase the viscosity and film thickness of the liquid.

A standard gradation suitable for stone matrix or friction course mixtures is provided below:

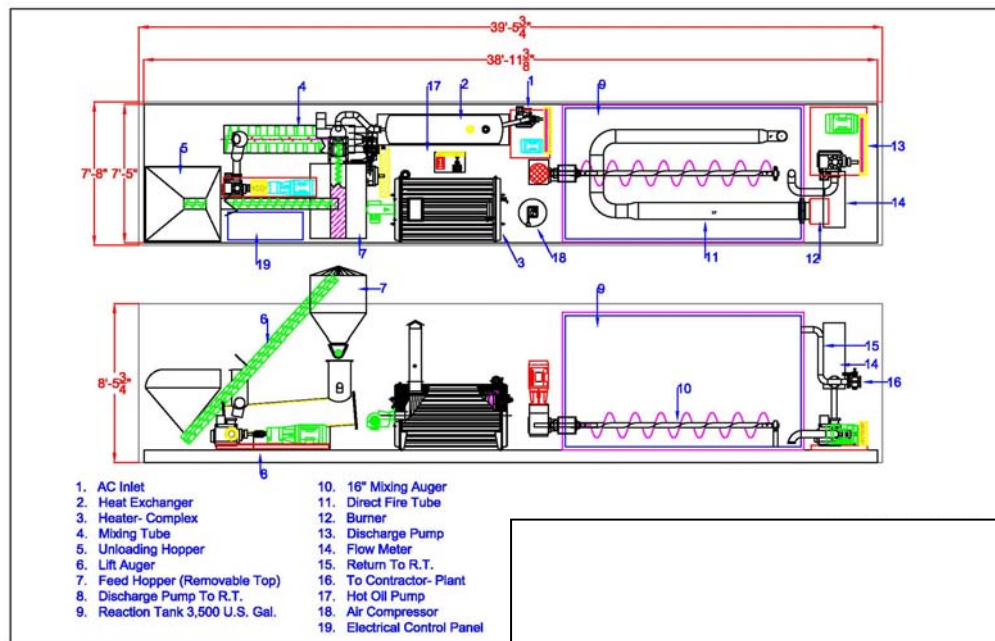
Sieve Size	Percent Passing
#10	100%
#16	75% - 100%
#30	25% - 60%
#50	12% - 20%
#100	6% - 12%
#200	2% - 5%

Recommended Crumb Rubber Gradation



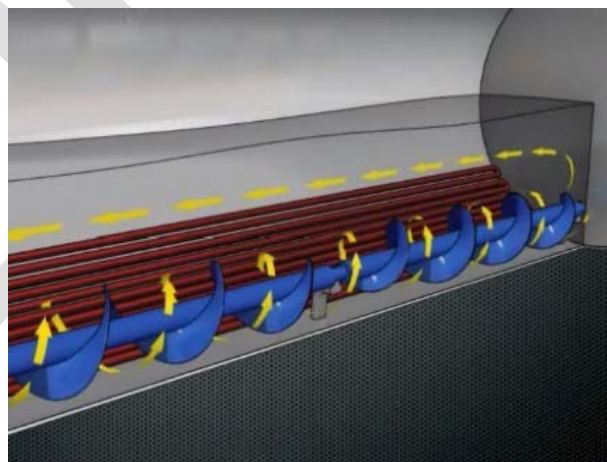
Crumb Rubber for use in Asphalt

The most efficient and economical method of combining granulated tire rubber and asphalt involves on-site blending equipment that is designed to meter the solid and liquid components in high volumes and in precise amounts to accommodate the needs of hot mix asphalt facilities.



Schematic of a small scale A-R Blending Unit

The material is made on demand. Some preparation time is required to allow the rubber particles to become fully saturated with the oils in the asphalt. Blending tanks with heating elements and agitation are used to keep the rubber and asphalt homogenized until the material is pumped into the hot plant. Depending upon the specific gravity of the rubber and asphalt, the rubber can float to the top of the tank, or settle to the bottom. Horizontal blend tanks provide the greatest surface area of material and screw augers provide an efficient and effective source of agitation to keep the asphalt and rubber homogenized or blended until it is used in a hot mix material.



Example of complete A-R material flow in a Blending Tank before it is supplied to a HMA facility or chip seal.

The following text describes the equipment design that will produce material capable of meeting asphalt-rubber specifications.

I. Asphalt Rubber Blending Plant Equipment Requirements

- A. General
- B. Ingredient Indicators
- C. Liquid Measurement and Proportioning
- D. Crumb Rubber Measurement and Proportioning
- E. Asphalt Rubber Binder Blending Equipment
- F. Asphalt Rubber Binder Storage, Temperature Control and Metering

A. General

This document describes the requirements for asphalt rubber (A-R) binder blending plants. The equipment must be capable of combining particulate scrap tire rubber, liquid asphalt and asphalt modifiers and additives as needed with precise proportioning controls to produce A-R materials in accordance with the American Society for Testing and Materials specification D 6114 “Standard Specification for Asphalt-Rubber Binder”. A minimum of 15 % rubber is needed to achieve beneficial material properties in the asphalt measured by resilience, softening point, penetration, and viscosity that will allow the paving material to perform more like tire rubber under traffic loading and expanded environmental temperature ranges. Tire rubber is extremely absorptive of the oils in asphalt. Saturation of the crumb rubber particles with the oils in the asphalt is critical before the rubber and asphalt are added to the aggregate at the HMA plant. Saturation is defined as a stabilized viscosity in samples taken from the A-R Binder Storage Tank. The A-R binder is manufactured in a batched process. Equipment that meets these requirements will be able to manufacture high quality A-R binders for use in hotmix applications.

B. Ingredient Indicators

The A-R blending indicators must be grouped and readable from where the proportion operations are controlled. The method and equipment for combining asphalt, asphalt modifier, and crumb rubber shall be so designed and accessible that the Engineer can readily determine the percentages by weight for each material in the mixture. The indication for the mass-flow, Coriolis effect type meter must be in weight. Volume is not acceptable as a unit of measurement for these meters. Multiple indicators for the same ingredient must agree to within 0.1 percent when compared directly. It is recommended to group the material proportioning displays or indicators in a control house or enclosure to prevent environmental interference when they are read by the Engineer.

C. Liquid Measurement and Proportioning

A meter is an electromechanical device designed to measure liquid ingredients. Asphalt shall be introduced into the mixer through meters conforming to the provisions in Section II-D “Device Testing and Calibration”. If needed, asphalt modifier shall be introduced into the asphalt or mixer through a meter that has been calibrated using the “small draft option” provided in Section II-D-3. The blending system shall be capable of varying the rate of delivery of asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of asphalt and the asphalt modifier shall be maintained and controlled within 25°F of the specified temperature.

When the asphalt and asphalt modifier are pre-blended, an asphalt heating tank equipped to heat and maintain the blended ingredients at the necessary temperature before blending with the CRM is required. This unit shall be equipped with a thermostatic heat control device. This unit shall be equipped with a temperature reading device that is accurate to within $\pm 5^{\circ}\text{F}$ and shall have a chart recording device. Do not use pre-blended A-R binder until 20 minutes of continuous re-circulating or agitation has elapsed within the specified temperature.

D. Crumb Rubber Measurement and Proportioning

The CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Scales and meters used for proportioning the CRM ingredients shall be equipped with rate-of-flow indicators to show the rates of delivery so that the total amounts of CRM ingredients introduced into the mixture can be determined. Weigh hoppers with load cells shall be calibrated before use. Delivery of the CRM in enclosed conveyors or augers is recommended to prevent material loss due to wind or other environmental conditions.

E. Asphalt Rubber Binder Blending Equipment

An asphalt rubber binder blender is a mechanical mixer that will provide for the complete, homogeneous blending of asphalt, asphalt modifier, and CRM in a controlled fashion. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced.

F. Asphalt Rubber Binder Storage, Temperature Control and Metering

An asphalt rubber binder storage tank shall be equipped with a heating system to maintain the proper temperature of the asphalt-rubber binder, an internal temperature reading device and an internal mixing unit capable of maintaining a homogeneous mixture of asphalt, asphalt modifier, and CRM. The storage tanks shall provide agitation and material flow over and around heating tubes or coils. Heating must be effective and controlled. Storage tanks shall be equipped with low binder level indicators to safeguard against accidental loss of binder flow or exposure of the heating tubes or coils.

The asphalt rubber binder storage tanks must be equipped with a recirculation line or system that allows a mass flow meter to draw the desired proportions of binder.

The Contractor shall provide a safe sampling device capable of delivering a representative sample of the completed asphalt-rubber binder. The device shall deliver a sufficient quantity of binder for the required test.

When remote or off site blending is used the AR binder transport tanks shall be equipped with an agitation system compliant with this section. The receiving tank shall have heating and agitation compliant with this section.

If metering tests and calibration methods are not established or available for Hot Mix Asphalt facilities the following is provided as a guide.

II. Guide Procedures for Liquid Metering

- A. General
 - 1. Meter by Weight
 - 2. Meter by Volume
- B. Inspection
- C. Testing Equipment and Provisions
 - 1. General
 - 2. Tank Scales
 - 3. Provers
- D. Device Testing and Calibration
 - 1. General
 - 2. Large Draft Option
 - 3. Small Draft Option

A. General

If the liquid meter system includes a separate, stand-alone controller, this controller must be the only controller used for liquid meter testing and calibration. The calibration procedure must be separate from the main plant controller's calibration procedure. After the successful testing of the separate, stand-alone controller, the main plant controller must be adjusted to exactly track the calibrated, stand-alone controller.

If the meter does not self-calibrate, the main plant controller must be used for the liquid meter testing and calibration.

The meter manufacturer's name and model number must be on the device identification plates. For multiple part meters, this identification must be on the meter proper and the meter transmitter.

1. Meter by Weight

A mass-flow meter is a device that measures the flow of liquids by weight. This device records and indicates the weight of liquid passing through it without input of the liquid's temperature or specific gravity.

2. Meter by Volume

A volume meter is a device that measures liquid volumetrically. The device records and indicates the volume of liquid throughput. This measurement must be manually converted to weight and may require the input of the liquid's temperature and specific gravity.

B. Inspection

Meter installations must be inspected visually for proper connections and conditions before tests for accuracy are performed. The meter installation must comply with the meter manufacturer's instructions.

C. Testing Equipment and Provisions

1. General

Test the liquid meter at the material-production site under normal operating and environmental conditions. Reschedule the testing if weather conditions cause the witness scale indicator to fluctuate more than three graduations.

The metering systems at HMA plants must be operated in the circulate mode for at least 15 minutes just before testing and calibration to heat and fill the system.

Test drafts must be weighed on a witness scale at the proportioning plant. Witness scale error testing must be performed with test weights and must produce a witness scale within two graduations of the test weight load.

For the calibration procedure, the producer must provide a suitable container capable of receiving the full flow of material delivered from the meter for the size of the required test draft. Meter installation must be plumbed to facilitate the diversion of the test draft to the container. The meter system must not leak calibration liquid or air. If testing material is lost during the calibration run between the liquid storage and test weight determination on the witness scale, cancel the testing until it is corrected. Any physical change of the meter system requires a restart of the calibration procedures.

Product flow rates used during device testing must be commensurate with anticipated production flow rates. Specifications for minimum test draft size, witness scale capacity, and witness scale graduations must comply with Table A, "Meter Testing Extremes" in the appendix.

The device plumbing must allow the resident engineer to clearly ascertain that none of the liquid passing through the meter during calibration is diverted before entering the test draft container.

2. Tank Scales

Some plant configurations include a scale-mounted tank for calibration. This tank may be used as the witness scale if it meets the specifications in Table A "Meter Testing Extremes" in the appendix, and other specifications for witness scales and calibration containers in this Plant Equipment Certification Program.

3. Provers

A "prover" is a calibrated vessel with test draft capacity as specified in Table A "Meter Testing Extremes" in the appendix. The prover must be maintained in a level position throughout the test run.

D. Device Testing and Calibration

1. General

A rate meter is a digital display of the speed of the operation in units such as tons-per-hour or gallons-per-minute. A totalizer is a digital display of the amount in units such as tons or gallons delivered at any time. Check the rate indicator against the totalizer's indicator for an interval of at least one minute. Time the interval with a stopwatch. The indicated rate must track the rate determined from the totalizer.

Before starting the meter calibration, send calibration liquid through the system to bring the calibration path to an as-used condition. Leave the system at the same degree of "empty" for all test runs. This exercise will ensure the meter system is in the same condition for all of the test runs, including the first one. Reset the totalizer to zero and re-tare the calibration container before the start of each calibration test run.

Hoses, ropes, and other paraphernalia on or hanging from the calibration container may affect the weighing accuracy of the test draft. If fill hoses are left attached to the calibration container during the weighing process, the witness scale may require error testing again after the hoses have been softened by the hot asphalt.

Record the meter's span number (calibration constant) for each test in the series. Each series of tests consists of at least three runs. Each calibration run size must comply with Table A, "Meter Testing Extremes" in the appendix, or the "large draft option" provided in Section II-D-2. Calibration flow rates must be commensurate with flow rates anticipated during production.

If the liquid is used in an HMA mixture, apply the asphalt binder content from the proposed job-mix formula to the aggregates flow rate to determine asphalt binder flow rate. In the case of lime slurry treatment of HMA aggregates, apply the ratio of lime slurry to aggregate.

Read the meter totalizer with the indicator at rest. Totalizer readings must not be made on the fly. The meter totalizer indicator must start from zero, return to zero, or both and must not advance its indications before material delivery.

At the individual test run's end, as indicated by the process controller, log the amount measured by the meter, the value from the meter totalizer, or the weight delivered. Compare the meter indication for the measured liquid for any individual test run with the weight determined by weighing the measured liquid on the witness scale. Make determinations of accuracy by comparing metered results with actual results from the witness scale.

Calculate error with the formula $E = A - M$, where E = error for the run, A = the actual weight of the liquid as determined on the witness scale, and M = the weight of the liquid as determined by the meter.

Determine the percentage error with the formula $\%E = (E/A) \times 100$

Average error for the device is the combined percent error for three sequential runs divided by three. If the metering device is adjusted before completion of the three calibration runs, the test is aborted, and a new series must be initiated. Error limits must comply with Table A “Meter Testing Extremes” in the appendix.

2. *Large Draft Option*

At the option of the producer, a large draft calibration test may be used. The minimum test draft must be 1,000 gallons. The large draft option requires a vehicle scale located at the proportioning plant as the calibration witness scale. Error-test the vehicle scale with test weights. The minimum graduation of the vehicle scale’s indicator must not be greater than 0.01 tons.

3. *Small Draft Option*

If the witness scale has a maximum capacity of 5,000 pounds and a maximum graduation of one pound, the material producer may choose to use a 300-gallon test draft instead of the required 1,000-gallon test.

III. Guide Procedure for Hopper Scales

- A. General
- B. Inspection
- C. Testing Equipment
- D. Device Testing and Calibration
 - 1. General Check Indication Oscillations
 - 2. Buildup Test

A. General

The maximum allowable error for hopper and tank scale testing is two scale graduations. Refer to Table B “Dry Ingredients Testing Extremes” in appendix, for calibrating scales used for dry ingredients.

B. Inspection

Inspect the weigh system load cells. In multiple load-cell applications, the load cells must be of the same value on the same device. Load-cell values must be appropriate for their intended use.

C. Testing Equipment

Supply at least 25% of the scale capacity.

If automatic batch controllers are used, the producer must provide an electronic load-cell simulator to facilitate controller interlock testing. The load-cell simulator must have a range and sensitivity compatible with the device being tested.

D. Device Testing and Calibration

1. General Check Indication Oscillations

The maximum oscillation is two scale graduations.

Set the zero-load balance after the scale testing equipment is installed. For dial mechanical indicators:

- a. Lock the dial and release the locking mechanism. The indicator must return to zero, even if the action is repeated.
- b. Lock the dial and shake the hopper or tank. After releasing the locking mechanism, the indicator must return to the starting point.

2. Buildup Test

If there are not enough test weights available or the means to hang the required test weights to achieve full capacity, the contractor must provide an acceptable means of building up or substituting other weight.

For hopper scales, the buildup method replaces a portion of the test weight with aggregate or another product used during production:

- a. Hang available test weights to at least one-fourth of the scale's operational capacity, and calibrate the scale system to this known weight.
- b. Remove the known weight, and replace it with a weight of material in the hopper equal to but not in excess of test load of known weight.
- c. Add the known weight again to the built-up weight. Repeat as necessary to attain capacity. The total buildup weight may not exceed three times the known weight.

Following the completion of all testing and calibration in accordance with this certification program, the equipment shall be approved by the Engineer prior to use.

References:

Binder Specifications

- A. American Society for Testing and Materials (ASTM) Standard Specification for Asphalt-Rubber Binder D-6114-97
- B. AR Binder Section 1009 – Arizona Department of Transportation (DOT)
- C. Section 300 Oils – Texas DOT

Hot Mix Specifications

- A. Arizona DOT
 - i. AR ACFC Sec 414
 - ii. AR Gap Grade Sec 413
- B. California DOT
 - i. RHMA Type G
 - ii. RHMA Type O
- C. Texas DOT
 - i. Section 346 SMA-R
 - ii. Section 342 AR PFC
 - iii. Texas Flexpave Guide

Chip Seal Specifications

- A. ADOT Section 410 Asphalt
- B. Caltrans AR Chip Seal 37-030_A11-18-05
- C. Texas Item 318 Hot AR Surface Treatments

Appendix

Calibration and Production Error Limits

Table A - Meter Testing Extremes

Meter Size	Size Designation	Minimum Test Draft	Witness Scale Maximums Capacity Graduation		Maximum Individual Error* Asphalt, LAS, Lime Slurry, Epoxy HMA Admixtures Water	
< 0.50"	Very Small	50 lb.	100 lb.	0.1 lb.	±0.5%	±1.5%
0.51" - 0.99"	Small	200 lb.	500 lb.	0.5 lb.	±0.5%	±1.5%
1.00" - 1.49"	Medium	2,500 lb.	5,000 lb.	1.0 lb.	±0.5%	±1.5%
> 1.50"	Large**	8,500 lb.	80,000 lb.	20.0 lb.	±0.5%	±1.5%

* Meters used for proportioning at continuous mixing HMA plants and lime slurry treatment plants must be accurate to within 0.5% of the test load for an average of three test runs and no individual test run error may exceed 1.0% of the test load.

**Refer to Section I-D, 2-3 "Device Testing and Calibration, Large Draft Option and Small Draft Option."

Table B – Dry Ingredients Testing Extremes

Product		Maximum Error Average Individual		Test Size Minimum	Witness Scale Maximums Capacity Graduation		Approximate y Operational Testing Range
Agg, HMA	agg	1.00%	2.00%	3 min.*	40 tons	20 lb	***
	dust	1.00%	2.00%	15 min.	5,000 lbs.**	1.0 lb	***
Lime, Marinate	agg	1.00%	2.00%	3 min.*	40 tons	20 lb	***
	lime	1.00%	2.00%	1,000 lbs.	5,000 lbs.**	1.0 lb	***
Lime, Dry	agg	1.00%	2.00%	3 min.*	40 tons	20 lb	***
	lime	1.00%	2.00%	1,000 lbs.	5,000 lbs.**	1.0 lb	***
All Other	> 100 tph	1.00%	2.00%	3 min.*	40 tons	20 lb	***
	11-100 tph	1.00%	2.00%	1,000 lbs.	5,000 lbs.**	1.0 lb	***
	< 10 tph	1.00%	2.00%	100 lbs.	250 lbs.**	0.1 lb	***

* Use a three-minute or longer calibration run unless the calibration rate exceeds 400 GPH.

** The witness scale size for baghouse dust will depend on the amount of material delivered during the 15-minute test run.

*** Producer designates the maximum and minimum rate per Chapter 3, V-C, "Test Equipment and Provisions." The low rate must be ≤ 30% of the maximum rate. The mid rate must be approximately 60% of the maximum rate.

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