LABORATORY PREPARED ASPHALT MIXTURE SPECIMENS
WAQTC TM 14

Significance

The objective of asphalt mixture design is to determine the proper combination of asphalt binder, aggregates, and additives that will provide long lasting performance as part of the pavement structure. Mix designing involves laboratory procedures developed to establish the proper proportion of materials for use in asphalt paving mixtures. Correctly designed asphalt mixtures can be expected to perform successfully for many years.

Scope

This practice covers preparing asphalt mixture samples according to an established job mix formula (JMF). The aggregate, asphalt binder, and additives are proportioned based on the JMF and mixed to produce samples for testing or verification of the JMF. These specimens can be used for determining ignition furnace asphalt binder content and aggregate correction factors, performance testing, and other Quality Assurance measures.

There are several practices for batching material in the laboratory. This procedure covers the Iterative Method of batching material and provides a process for checking the accuracy of the batched test samples by confirming the gradation of a batched test sample.

Terminology

- RAP – Recycled Asphalt Pavement
- RAS – Recycled Asphalt Shingles
- Cold feed – Term used to reference plant settings for percentages of the individual constituents.
- Iterative Method – Batching process that is repeated until the desired gradation is achieved.
- Batch Plan – A mathematical process that assists with the batching of the materials.

Apparatus

- Thermometer(s), or other temperature measuring device(s), with a temperature range of 50-500°F.
- Oven: Capable of maintaining 230 ± 9°F.
- Forced air, ventilated or convection oven: Capable of maintaining the temperature surrounding the sample at 325 ± 9ºF.
- Bins, pans, or buckets of adequate size to accommodate fractionated material for each stockpile separated size.
- Labels for each bin that note the aggregate designation and sieve size upon which the material was retained.

- Lids or plastic coverings for bins and buckets to minimize moisture absorption in the fractionated material during storage if necessary.
- Drying/batch containers: Shallow flat metal pans large enough to accommodate a batched sample.
- Balance or scale: Capacity sufficient for the sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1 g
- Sieves: meeting the requirements of the FOP for AASHTO T 27/T 11.
- Mechanical sieve shaker: meeting the requirements of the FOP for AASHTO T 27/T 11.
- Mechanical washing apparatus (optional)
- Suitable drying equipment: meeting the requirements of the FOP for AASHTO T 255.
- Containers: A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any part of the sample or water.
- Utensils: Spoons, spatulas, brushes, stirring rods, etc.
- Mixer**:** Of sufficient capacity and design to adequately combine all ingredients.

Material Sampling

1. Obtain representative samples of aggregate, from each stockpile listed on the JMF, according to the FOP for AASHTO R 90.
2. Obtain samples of asphalt binder according to the FOP for AASHTO R 66.
3. Obtain hydrated lime from the supplier listed on the JMF, if used.
4. Obtain anti-stripping agent from the supplier listed on the JMF, if used.
5. Obtain representative recycled material samples, after the material has been processed for hot mix production use, according to FOP for AASHTO R 90, if used.

Note 1: RAP is material recovered from existing roadways during milling operations or pavement removal during construction. Most RAP requires reprocessing to be useable in new asphalt mixtures. Processing may include crushing and screening of the material.

Aggregate Preparation

Obtain quality control gradation reports of the separated sizes or stockpiled materials listed on the JMF. The average gradation, expressed as a percent retained, of each stockpile will be used to verify JMF target gradation. If recycled material (RAP or RAS) is included in the JMF, verify the asphalt binder content and gradation are listed.

The virgin aggregates used in the blend may be batched unwashed or washed, according to agency requirements.

Fractionating of Virgin Aggregate

1. Dry each stockpile sample according to the FOP for AASHTO T 255.
2. After drying, cool and cover, if necessary, to minimize moisture absorption.
3. Select sieves required by the specification. Separate each stockpile sample into individual size fractions according to the FOP for AASHTO T 27/T 11.
4. Carefully empty the material retained on each sieve into a bin, pan, or bucket, and label according to size.

Note 2: To reduce the number of sizes of fractionated aggregates from which the batch is prepared, agencies may allow small amounts to be added from other stockpiles. Stockpiles should meet the criteria in Appendix A, Aggregate Batching.

5. Cover, if necessary, to prevent moisture absorption.

Wash Fractionated Aggregate

When the agency requires, the fractionated aggregate is washed and dried before batching test samples. The adherent fines that are washed out are replaced with material passing the 75 µm (No. 200) sieve during batching.

1. Wash each size of fractionated aggregate according to the FOP for AASHTO T 27/11, except for the material passing the 75 µm (No. 200) sieve or "Dust."

Note 3: Adherent fines may have different properties than sieved minus 75 µm (No. 200) material.

2. Dry according to the FOP for AASHTO T 255.
3. Store in separate bins or buckets, label according to size and cover, if necessary.

RAP

If RAP, RAS, or both, is included in the JMF:

1. Dry the processed recycled material overnight or to constant mass at 125 ± 5°F.

Note 4: Constant mass is achieved when successive mass determinations do not change more than 0.05 percent after an additional 2 hours of drying.

2. Cover and cool.

Aggregate Batch Plan

Batch plans are developed one virgin aggregate stockpile at a time starting with the coarsest stockpile and progressing through the finer stockpiles.

Determine all masses to the nearest 0.1 percent of the sample mass or to the nearest 0.1 g.

1. Calculate the required mass for each stockpile (virgin stockpile, lime, RAP, etc.) by multiplying the desired sample size by the cold feed percentage for each stockpile and record to the nearest 0.1 g. The sum of the individual masses must add up to the desired total sample mass.
2. Calculate the percent retained for each sieve of the aggregate portions using the control gradation average.

3. Calculate the mass per sieve per stockpile. Start with the coarsest virgin aggregate stockpile, multiply the individual mass for that stockpile by the percent retained on each sieve and record to the nearest 0.1 g.
4. Identify the sieve sizes that material from other stockpiles will be added. Document the mass and the contributing stockpile. See Note 2.
5. Calculate a cumulative mass total beginning with the largest sieve on the coarsest stockpile. Begin the cumulative total on subsequent finer stockpiles with the ending cumulative total from the previous stockpile.

Note 5: Cumulative masses are used so that the balance is not re-zeroed between each addition possibly causing a misrepresentation of the total mass. Repeat with each successive stockpile. If cumulative totals are not used, verify mathematically that the batch plan produces the correct mass of virgin aggregate for each stockpile and the total of all virgin stockpiles.

Verification of Aggregate Batch Plan

When the fractionated aggregate is not washed before batching, the minus 0.075 (No. 200) batch plan mass may need to be adjusted to compensate for adherent fines.

1. Batch the desired sample size according to the batch plan, excluding recycled material, if applicable.

Note 6: Refer to the FOP for AASHTO T 308 Table 1 for recommended sample size.

2. Perform washed sieve analysis according to the FOP for AASHTO T 27/T 11.
3. The batched sample percent passing must agree with the Virgin Blend Percent Passing (JMF) within the tolerances of Table 1. If the variation exceeds the allowable difference, adjust the virgin aggregate portion of the batch plan and reverify.

Table 1
Allowable Differences Between Batched and Actual Gradations

Sieves	Allowable Difference (%Passing)
Larger than No. 8	±1.5%
No. 8 to No. 50	±1.0%
Smaller than No. 50	±0.5%

Aggregate Preparation

1. Batch the number of samples at desired sample size according to the batch plan, excluding recycled material, if applicable.

Hydrated Lime

When hydrated lime is mixed with water before incorporating into the mixture, add to the test samples the night before mixing with asphalt binder (approximately 12 hours).

1. Determine the mass of hydrated lime to be added to the test sample based on the percent required in the JMF. For mixtures with RAP, the percentage is applied to the virgin aggregate only.
2. Weigh out the mass of hydrated lime required for each test sample and store in a closed tin with the test sample.
3. Add the hydrated lime to the test sample in an oven proof container.
4. Using a spoon or spatula, thoroughly stir the lime into the dry aggregate sample.
5. Add sufficient water to thoroughly wet all the aggregate and achieve a "Surface Damp Condition."
6. Stir the lime, aggregate and water for approximately five minutes to thoroughly combine. Do not lose any fine material. Spatulas and brushes may be used to clean the fine material from the implements. Do not transfer the mixed sample.
7. Place the mixed sample in the oven, set oven temperature in the mixing temperature range.
8. Dry according the FOP for AASHTO T 255.

Mixing Preparation

1. Heat the mixing equipment such as bowls, mixing paddles, spoons, etc.
2. Heat aggregate samples 20°F above the JMF mixing temperature.

Note 7: Heating aggregate above mixing temperature allows for loss of heat during the addition of the asphalt binder. Over 20 °F higher may burn the asphalt binder when it is added to the hot aggregate.

3. If RAP material is required, heat carefully in a controlled oven for approximately 2 hrs. at 230 ± 9°F.
4. Heat asphalt binder approximately 10°F above the mixing temperature range. Discard unused asphalt binder after the 3 hrs.

   Liquid anti-stripping agent

   If liquid anti-striping agent is required:

   a) Determine the mass of anti-stripping agent to be added to the asphalt binder based on the percent required in the JMF. The percentage is applied to the asphalt binder only.
   b) Follow mixing instructions from the anti-stripping agent supplier, as not all products are incorporated in the same manner.

c) Heat the anti-stripping agent to 125 ± 15 ° F or temperature range from manufacturer labeling.

d) Determine and record mass of a clean container.

e) Add asphalt binder, determine and record asphalt binder mass.

f) Calculate the mass of anti-stripping agent to be added.

g) Zero the scale and add calculated mass of anti-stripping agent. Record the measured mass of anti-stripping agent.

h) Discard material if too much anti-stripping agent is added.

Note 8: Use of a small spoon or stirring rod will assist with anti-strip addition.

i) Stir the combined sample thoroughly with a small spoon or stirring rod.

j) Loosely place a lid on the container to prevent dissipation of the additive. Do not secure the lid, expansion could cause injury or loss of material.

k) Place the combined material in an oven at the JMF mixing temperature range. During binder addition ensure product is stirred thoroughly before each use.

Note 9: Because the elastic properties of asphalt binder degrade when held at high temperatures, the asphalt binder must be used within 3 hrs. of achieving the mixing temperature.

Mixing Procedure

1. Prepare an initial specimen at the design asphalt binder content to “butter” the mixing bowl and utensils. Discard the specimen after mixing, scrape the bowl and paddle or whip with a spatula or other suitable tool.
2. Record mass of “buttered” bowl, spatula, and paddle or whip.
3. Remove the spatula and paddle or whip; zero the balance with empty bowl. Introduce the aggregate, mix thoroughly with clean, dry spatula or spoon. Record mass of aggregate, $Mass_{agg}$.
4. If RAP is required, introduce the hot RAP and mix thoroughly with the virgin aggregate. Record this mass. Determine M_{RAP} by subtracting the M_{agg} from the mass of aggregate and RAP.
5. Form a crater in the center of the material.
6. Calculate M_{binder}.
7. Zero the scale and add calculated mass of asphalt binder. Record the measured mass of asphalt binder added.

Note 10: If too much asphalt binder is added, it may be removed by dipping a corner of a paper towel in the center of the asphalt binder.

8. Thoroughly mix for a minimum of two minutes, by hand or mixer, until asphalt binder is uniformly distributed, and aggregate is completely coated.
9. Stop the mixer, if used.
10. Stir mixture with buttered spatula, scraping the center bottom of the mixing bowl.

11. If the aggregate is not thoroughly coated, continue mixing until completely coated.
12. Remove mixture from bowl.
13. Scrape bowl and paddle or whip with buttered spatula. Place all the mixture into a pan.
14. Record mass of empty bowl, spatula, and paddle or whip. Ensure the combined mass and the mass of the initial buttered bowl and utensils is within 0.10 percent of the sample mass of the mixed sample.

Note 11: For a 4700 g sample, 0.10% = 4.7 g. and for a 2100 g sample, 0.10% = 2.1 g.

15. Age the mixed specimen according to AASHTO R 30 or agency requirements.
16. Repeat steps 3 thru 15 for each specimen to be mixed.

Calculations

Trial Batch Plan

Mass of material contributed per stockpile:

$$mass\ per\ stockpile = sample\ size\ \times stockpile\%$$

Where:

mass per stockpile	=	mass of material from each stockpile in test sample
sample size	=	desired mass of test sample
stockpile%	=	percent of each stockpile in the mixture (JMF)

Mass of material contributed to each sieve per stockpile:

$$mass\ per\ stockpile\ per\ sieve = mass\ per\ stockpile\ \times \%retained\ per\ sieve$$

Where:

mass per stockpile per sieve	=	amount of fractionated aggregate from each stockpile for each sieve size
%retained per sieve	=	percent retained on each sieve (calculated from crushing records)

Anti-stripping agent mass added before heating asphalt binder:

$$M_{additive} = \%additive\ \times M_{heated\ binder}$$

$M_{additive}$	=	mass of anti-stripping agent to be added to the mass of measured asphalt binder
%additive	=	percent of anti-stripping agent, based on mass of asphalt binder, from JMF
$M_{heated\ binder}$	=	mass of asphalt binder heated for mixing

Asphalt binder mass

Asphalt binder mass is based on a percent of the mass of "hot" aggregate.

Mixes without RAP

Determine the mass of asphalt binder to be added to a mix without RAP:

$$M_{binder} = \frac{P_b \times M_{agg}}{(100 - P_b)}$$

Where:

M_{binder}	=	Mass of asphalt binder to be added to the prepared test sample
P_b	=	Required percent asphalt binder
M_{agg}	=	Mass of hot test sample

Mixes with RAP

Determine the mass of asphalt binder in the RAP:

$$M_{RAP\ binder} = M_{RAP} \times \frac{P_{bRAP}}{100}$$

Where:

$M_{RAP\ binder}$	=	Mass of asphalt binder in the RAP
M_{RAP}	=	Mass of RAP in sample
P_{bRAP}	=	Percent of asphalt binder in the RAP

Determine the amount of asphalt binder to be added to mixes with RAP:

$$M_{binder} = \left[P_b \times \frac{(M_{agg} + M_{RAP} - M_{RAP\ binder})}{(100 - P_b)}\right] - M_{RAP\ binder}$$

Asphalt Binder

Anti-stripping agent mass

$$M_{additive} = \%additive \times M_{binder}$$

$$M_{additive} = 0.25\% \times 850\ g = 2.1\ g$$

Given:

%additive	=	0.25%
M_{binder}	=	850 g.

Asphalt binder mass – mixtures without RAP

$$M_{binder} = \frac{P_b \times M_{agg}}{(100 - P_b)}$$

$$M_{binder} = \frac{6.0\% \times 4500.0\ g}{(100\% - 6.0\%)} = \frac{2700.0\ g}{94.0\%} = 287.2\ g$$

Given:

P_b = 6.0 % from JMF

M_{agg} = 4500.0 g hot aggregate

Note 13: A factor can be determined for subsequent specimens by taking P_b divided by 100-P_b. Then the hot aggregate mass is multiplied by this factor for an expedient oil add determination.

Asphalt binder mass – mixtures with RAP

Determine mass of asphalt binder in RAP:

$$M_{RAP\ binder} = M_{RAP} \times \frac{P_{bRAP}}{100}$$

$$M_{RAP\ binder} = 1125.0\ g\ x\ \frac{4.88\%}{100} = 54.9\ g$$

Given:

M_{RAP} = 1125.0 g

$P_{b\ RAP}$ = 4.88%

Determine mass of asphalt binder:

$$M_{binder} = \left[P_b \times \frac{(M_{agg} + M_{RAP} - M_{RAP\ binder})}{(100 - P_b)}\right] - M_{RAP\ binder}$$

$$Mass_{binder} = \left[6.0\% \times \frac{(4500\ g - 54.9\ g)}{(100\% - 6.0\ \%)}\right] - 54.9\ g = 228.8\ g$$

P_b = 6.0 percent from JMF

M_{agg} = 3375.0 g

$M_{agg} + M_{RAP}$ = 4500.0 g hot aggregate and RAP

Check of Calculation

$$\left[\frac{(54.9g + 228.8g)}{(4500g + 228.8g)}\right] x\ 100 = 6.0\%$$

Report

- Project name
- Date of batching
- Specimen identification
- Virgin aggregate mass
- RAP mass, if required
- Percentage of asphalt binder in specimen, nearest 0.1 percent
- Asphalt binder mass
- Anti-Strip mass, if applicable
- Conditioning process

APPENDIX—AGGREGATE BATCHING

(Non-Mandatory Information)

The following guidelines should be considered when batching virgin aggregates that have small amounts of retained material that are encountered during the separation phase and will reduce the number of containers required for material storage:

- The percent retained for the sieve to be moved is less than 10 percent. Material meeting this condition must have a retained like size on the next stockpile or batching of the separated size will be required.
- Stockpiles to be combined are from the same source and same parent material. Aggregates from different sources should not be combined.
- The particle shape and texture are essentially the same for the sieve sizes to be combined.

Stockpiles are produced using similar processes (e.g. do not mix stockpiles of crushed material with stockpiles of uncrushed material; do not mix unwashed stockpiles with washed stockpiles, etc.).

Example

Batch a gyratory sample of 4750 g. of asphalt mixture, the aggregate portion will be about *4500 g*. The mixture is to have 25 percent RAP with three virgin stockpiles of 18, 27, and 30 percent.

Batch Mass for the 12.5 to 4.75 mm (1/2 in. to No. 4) stockpile

$$Required\ mass = 4500\ g \times \frac{18\%}{100} = 810.0\ g$$

Stockpile	**12.5 to 4.75 mm (1/2 in. to No. 4)**	**4.75 to 1.18 mm (No. 4 to No. 8)**	**4.75 to 1.18 mm (No. 4 to No. 8)**	**RAP**
Cold feed %	18%	27%	30%	25%
Batch Mass	810.0 g.	1215.0 g	1350.0 g	1125.0 g

The sum of the batch masses must add up to the original aggregate target mass, in this example: 810.0 g + 1215.0 g + 1350.0 g + 1125.0 g = 4500.0 g.

Mass per sieve for 12.5 to 4.75 mm (1/2 in. to No. 4) stockpile

Sieve Size mm (in.)	%Retained	Batch Mass g	Mass Carried to Next Pile g	Cumulative Batch Mass g
25 (1)	0.0	0.0	0.0	**0.0**
19.0 (3/4)	0.0	0.0	0.0	**0.0**
12.5 (1/2)	3.3	26.7	0.0	**26.7**
9.5 (3/8)	49.4	400.1	0.0	**426.8**
6.25 (1/4)	39.8	322.4	0.0	**749.2**
4.75 (No. 4)	3.5	28.4	-28.4	
2.36 (No. 8)	1.7	13.8	-13.8	
1.18 (No. 16)	0.2	1.6	-1.6	
0.600 (No. 30)	0.0	0.0	0.0	
0.300 (No. 50)	0.1	0.8	-0.8	
0.150 (No. 100)	0.0	0.0	0.0	
0.075 (No. 200)	0.0	0.0	0.0	
Minus 0.075 (No. 200)	2.0	16.2	-16.2	
Total	**100.0**	**810.0**	**-60.8**	

The %Retained column must equal 100.0 percent. The Batch Mass Column should equal 810.0 g.

The Total Batch Mass plus the Mass Carried to Next Pile for sieves smaller than the 6.25 mm (1/4 in.) is 810.0 g + (– 60.8 g) = 749.2 g.

The minus sign shows mass is being removed from this portion of the Batch Plan. It will be added to the next (pile plus sign).

Note 12: Carrying minor amounts of material when batching as in this example reduces the number of fractionated sizes. In case, there are eight less bins from just this stockpile.

The material retained on the 12.5 mm (1/2 in) was 3.3 % and meets the less than 10 percent requirement but doesn’t have a like material in the next stockpile, so it must be batched.

Continue with the next stockpile, 4.75 to 1.18 mm (No. 4 to No. 8).

Mass per sieve for 4.75 to 1.18 mm (No. 4 to No. 8) stockpile

Sieve Size mm (in.)	%Retained	Batch Mass g	Mass Carried to Next Pile g	Cumulative Batch Mass g
25 (1)	0.0	0.0	0.0	**749.2**
19.0 (3/4)	0.0	0.0	0.0	
12.5 (1/2)	0.0	0.0	0.0	
9.5 (3/8)	1.3	15.8	0.0	**765.0**
6.25 (1/4)	29.5	358.4	0.0	**1123.4**
4.75 (No. 4)	28.4	345.1 + 28.4	0.0	**1496.9**
2.36 (No. 8)	32.4	393.7 + 13.8	0.0	**1904.4**
1.18 (No. 16)	4.1	49.8 + 1.6	-51.4	
0.600 (No. 30)	1.1	13.4 + 0.0	-13.4	
0.300 (No. 50)	0.6	7.3 + 0.8	-8.1	
0.150 (No. 100)	0.3	3.6 + 0.0	-3.6	
0.075 (No. 200)	0.0	0.0 + 0.0	0.0	
Minus 0.075 (No. 200)	2.3	27.9 + 16.2	-44.1	
Total	**100.0**	**1215.0 + 60.8**	**-120.6**	

%Retained equals 100.0, the batch mass equals the 1215.0 g. with 60.8 g. being carried from the 12.5 to 4.75 mm (1/2 in. to No. 4).

Mass per sieve for 44.75 to 1.18 mm (No. 4 to No. 8) stockpile

Sieve Size mm (in.)	Adjusted QL %Retained	Batch Mass g	Cumulative Batch Mass g
25 (1)	0.0	0.0	**1904.4**
19.0 (3/4)	0.0	0.0	
12.5 (1/2)	0.0	0.0	
9.5 (3/8)	0.0	0.0	
6.25 (1/4)	0.0	0.0	
4.75 (No. 4)	0.2	2.7	**1907.1**
2.36 (No. 8)	20.2	272.7	**2179.8**
1.18 (No. 16)	26.5	357.8 + 51.4	**2589.0**
0.600 (No. 30)	17.1	230.8 + 13.4	**2833.2**
0.300 (No. 50)	14.8	199.8 + 8.1	**3041.1**
0.150 (No. 100)	11.9	160.7 + 3.6	**3205.4**
0.075 (No. 200)	2.8	37.8 + 0.0	**3243.2**
Minus 0.075 (No. 200)	6.5	87.7 + 44.1	**3375.0**
Total	**100.0**	**1350.0 + 120.6**	

The final Cumulative Batch Mass matches the sum of the three virgin stockpiles, 810.0 + 1215.0 + 1350.0 = 3375.0.