R 30

GUIDELINES FOR LABORATORY MIXING OF HOT-MIX ASPHALT (HMA) AND MIXTURE CONDITIONING OF HOT-MIX ASPHALT (HMA)

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Significance

This FOP for laboratory mixing and short-term mixture conditioning of uncompacted hot-mix asphalt (HMA) simulates the pre-compaction phase of the construction process.

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Scope

When HMA samples are prepared in the laboratory, proportions must be accurately controlled and properly combined by mixing followed by mixture conditioning. The mixture conditioning procedure allows for asphalt binder absorption to more accurately predict the properties and performance of HMA. Conditioning in the laboratory is not necessary prior to testing of plant-produced HMA.

This FOP describes only short-term aging of laboratory-mixed HMA intended for volumetric mixture design and mechanical property testing.

Apparatus

- **Oven(s) –** Forced-draft, capable of maintaining temperature up to 350°F.
- **Balance or Scale –** Of sufficient capacity and readable to 0.1 g.
- **Thermometer(s)** – Having a range from 120°F to 500°F and readable to 1°F.
- **Mixer –** Of sufficient capacity and design to adequately combine all ingredients.
- **Miscellaneous** – Metal pans, metal spatulas or spoons, timer and gloves, etc.

Mixing Procedure

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General

Prepare a sufficient number of aggregate samples and quantity of asphalt binder to mix the required number of specimens and have one extra sample for a butter batch. Mixing temperature to be obtained from the Agency.

- Determine all masses to the nearest 0.1 g.

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- Produce a mixture that contains thoroughly coated aggregate.
- Follow the applicable steps of the procedure listed below for the initial batch to butter the bowl and paddle or whip.
- After buttering, discard the butter batch and scrape bowl and paddle or whip to remove excess material.
- Follow the procedure for each subsequent batch.

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Note 1: Aggregates may be heated to a temperature not greater than 50ºF above mixing temperature.

Note 2: Cover asphalt binder containers. When binder reaches mixing temperature stir it thoroughly. Asphalt binder may then be stored in an oven at mixing temperature for a short period of time, but must be adequately re-stirred immediately prior to use. Other heating apparatus may be used to maintain binder temperature provided it is demonstrated that uniformity in temperature is achieved without localized over-heating.

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Discard unused asphalt binder after 4 hours of achieving mixing temperature. Do not reheat asphalt binder.

Mixing Procedure Steps

1. Heat aggregate, asphalt binder, bowl, whip and utensils in an oven regulated within the mixing temperature range until temperature has stabilized. Two to four hours are required for aggregate to reach mixing temperature (See Notes 1 and 2).
2. Prepare, mix and discard a butter batch.
3. Record mass of buttered bowl and paddle or whip.
4. Remove paddle or whip and zero balance with empty bowl. Introduce the aggregate and mix thoroughly.
5. Form a crater in the center of the aggregate and determine the aggregate mass.
6. Add sufficient asphalt binder to achieve the desired asphalt binder content expressed as a percent of total mix. Record the mass of aggregate and asphalt binder actually used for each batch.
7. Thoroughly mix for a minimum of two minutes, or until complete mixing has occurred.
8. Scrape material adhering to paddle or whip into the mixed HMA.

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9. Examine the HMA for adequacy of mixing. If any aggregate has not been coated, mix by hand until HMA is properly coated.

Remove Sample From Bowl

Note 3: The tolerance for scraping the bowl to within 0.1% of mixed sample mass does not preclude cleaning to a closer tolerance. Be consistent in cleaning the apparatus from batch-to-batch to prevent influencing consecutively mixed samples.

10. Remove mix from bowl, scraping bowl clean. Place all HMA into a baking pan.
11. Record mass of empty bowl and paddle or whip. Ensure this mass agrees with the mass of the initial buttered bowl within at least 0.1% of the sample mass of the mixed HMA.

    Examples:

    4700 g HMA sample, 0.1% = 4.7 g

    2100 g HMA sample, 0.1% = 2.1 g
12. Age according to this FOP or other specified test procedure.

Procedures for Hydrated Lime and RAP

09 **Method A – Hydrated Lime Slurry Induction**

1. Prior to heating aggregate in step 1 of Mixing Procedure, add hydrated lime slurry (3:1 ratio of water to hydrated lime) to dry aggregate.
2. Mix until uniform (two minutes minimum).
3. Heat aggregate and lime to mixing temperature. Ensure aggregate has reached constant mass before mixing with asphalt binder.
4. Continue with Step 1 of mixing process.

10 **Method B – Lime Marination**

1. Prior to heating aggregate in step 1 of Mixing Procedure, add hydrated lime slurry (3:1 ratio of water to hydrated lime) to dry aggregate.
2. Mix until uniform (two minutes minimum).
3. Hold for 24 hours.
4. Heat aggregate and lime to mixing temperature. Ensure aggregate has reached constant mass before mixing with asphalt binder.
5. Continue with Step 1 of mixing process.

11 **Incorporation of Reclaimed Asphalt Pavement (RAP)**

Thirty minutes prior to mixing dry aggregates with asphalt binder (step 6 of Mixing Procedure), add RAP (at room temperature) to dry aggregate in step 1 of Mixing Procedure. Return to oven for remaining 30 minutes. Continue with mixing as above.

Mixture Conditioning Procedures

12 **Conditioning for Volumetric Mixture Design**

Short-term mixture conditioning for volumetric mixture design is conducted at compaction temperature (the middle range of temperature at which the asphalt binder's kinematic viscosity is 0.28 ± 0.03 Pa·s).

Spread Sample 1 – 2 in Thick

Forced Draft Oven

13 1. Place the mixture into a metal baking pan.

14 2. Spread the mixture in the baking pan evenly at 1 – 2 inch thick.

15 3. Place the mixture and pan in the forced-draft oven at compaction temperature for 2 hours ± 5 minutes. (If using modified asphalt, consult the supplier for the proper compaction temperature).

4. Stir the mixture after 60 ± 5 minutes to maintain uniform conditioning.

16 5. After 2 hours ± 5 minutes, remove the mixture from the oven.

6. The conditioned mixture is now ready for compaction or other required testing. Conduct required testing without delay.

17 **Conditioning for Mechanical Property Testing**

Pre-heat the mixture-conditioning oven to 275 ± 5ºF.

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1. Place the mix in a pan of sufficient size for the volume of HMA required for the mechanical property testing.
2. Spread the mixture in the pan evenly at 1 – 2 inch thick.
3. Place the mixture and pan in the forced-draft oven at 275 ± 5ºF for 4 hours ± 5 minutes.

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4. Stir the mixture every 60 ± 5 minutes to maintain uniform conditioning.
5. After 4 hours ± 5 minutes, remove the mixture from the oven.
6. The conditioned mixture is now ready for required mechanical test specimen preparation. Conduct required procedures without delay.

20 **Tips!**

- Be sure that all materials and mixing tools are heated within the mixing temperature range
- Remember to first mix and discard a butter batch
- Check that bowl is cleaned to within acceptable tolerance of initial buttered mass (0.1% of mass of HMA sample mixed)
- Record mass of aggregate and asphalt binder actually used for each sample to 0.1 g
- Plan mixing and conditioning so that HMA is used without delay

REVIEW QUESTIONS

1. Describe the procedure leading up to but prior to mixing a sample in the laboratory.

2. For laboratory mixing, how long may binder be left at mixing temperature? May binder be reheated and used for laboratory mixed specimens?

3. Describe the required laboratory mixing procedure.

4. How thick is the layer of HMA placed in the baking pan for mixture conditioning?

5. During mixture conditioning, how frequently is the sample stirred?

6. What is the duration of mixture conditioning for laboratory specimens; for plant mixed specimens?

7. For laboratory mixed specimens, what is the required mixture conditioning temperature?