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DETERMINING THE APPLICATION RATES OF FOAMED ASPHALT FOR RECLAIMED ASPHALT PAVEMENT

A. SCOPE

This test is used to determine the optimum foamed asphalt application rates for full-depth asphalt pavement reclamation using foamed asphalt.

B. REFERENCES

California Test 202 – Sieve Analysis of Fine and Coarse Aggregates
California Test 301 – Resistance "R" Value of Treated and Untreated Bases, Sub-bases, and Basement Soils (Stabilometer)
California Test 304 – Preparation of Bituminous Mixtures for Testing
California Test 371 – Resistance of Compacted bituminous Mixture to Moisture Induced Damage
AASHTO T-180 – Test for Moisture Density Relationship
AASHTO T 167 – Standard Method of Test for Compressive Strength of Hot Mix Asphalt

C. APPARATUS

1. The laboratory production method should closely simulate full-scale foamed asphalt production. Laboratory asphalt foaming equipment should be capable of producing foamed asphalt at a rate from 1.8 oz (50 g) to 7 oz (200 g) per second. The equipment should have a thermostatically controlled chamber or vessel capable of holding 8 to 25 lb of asphalt at a temperature from 300ºF to 400ºF. The equipment should have a low-pressure compressed air supply capable of delivering from 0 to 100 psi. The equipment should have a system for adding from 0 % to 4 % cold water by weight of asphalt. The equipment should be designed so that the foam can be discharged directly into the mixing bowl of an electrically driven laboratory mixer with a capacity of at least 25 lb.

2. An air cabinet capable of maintaining a temperature of 77°F ± 2°F.

3. Calipers to measure the length and diameter of test specimens to the nearest 0.02 in.

4. A thermometer capable of measuring temperatures from 32°F to 122°F.

5. Equipment for preparing and compacting asphalt concrete specimens under California Test 304.

6. A mechanical or hydraulic testing machine as specified in AASHTO T 167 to provide a range of accurately controllable rates of vertical deformation, including 2.0 in per min.

7. Lottman Breaking Head.

D. ASPHALT BINDER SELECTION AND FOAMING PARAMETERS

It is important that laboratory tests for mix design use the same asphalt binder that will be used during construction, including grade, source, and manufacturer.

1. Calibrate laboratory asphalt foaming equipment in compliance with the manufacturer's instructions.

2. Set 3 asphalt temperatures to 325°F, 350°F, and 375°F.

3. For each asphalt temperature, use 3 foaming water ratios 2.0 %, 3.0 %, and 4.0 % and determine:

   3.1 Expansion ratio: The ratio of maximum volume of foam relative to original volume of asphalt.

   3.2 Half-life: The time measured in seconds for foamed asphalt to subside to half of the maximum volume from the time the foam nozzle shuts off.

4. Select the asphalt temperature and water content with a minimum expansion ratio of 10 and half-life of 12 s.

5. If two or more asphalt temperatures and water contents meet minimum requirements of expansion ratio and half-life, select the results with highest product of multiplication between expansion ratio and half-life (expansion ratio × half-life).

E. PREPARATION OF PULVERIZED MATERIALS

1. Break down or pulverize the Asphalt Concrete (AC) into material passing the 1 in. sieve.

2. Process the pulverized AC and underlying granular materials samples under California Test 201 (Section E).

3. Split out a sufficient number of representative portions of the materials to complete the desired testing.

F. PULVERIZED MATERIALS GRADATION

1. Determine the gradation of the pulverized AC under California Test 202.

2. Determine the gradation of the underlying granular materials under California Test 202.

3. Determine the combined gradation of the proposed mixture of pulverized AC and underlying granular materials:

   3.1 Discard materials retained on 1 in. and larger sieves.

   3.2 If the fine material (passing #200 sieve) content is less than 5.0 %, extra fines can be incorporated by either blending additional underlying granular materials or adding imported granular fines.

3.3 If the fines content is greater than 20 %, reduce the fines by reducing the quantity of underlying granular materials.

G. OPTIMUM MOISTURE CONTENT

1. Thoroughly mix approximately 60 lb of prepared materials with targeted amount of active filler (e.g., 1 % to 2 % of portland cement).

2. Determine Optimum Moisture Content (OMC) and Maximum Dry Density (MDD) under AASHTO T-180 (Method D).

H. ASPHALT BINDER CONTENT

Prepare approximately 90 lb of test materials for the asphalt binder content test.

1. Thoroughly mix a sufficient amount of water without active filler to achieve 75 % of OMC.

2. Prepare18 test specimens under CT 304; 6 specimens at 2.5 %, 6 specimens at 3.0 %, and 6 specimens at 3.5 % of asphalt.

3. Cure in a forced draft oven at 105°F for 72 hr.

4. Remove 3 specimens with each asphalt content from oven and place in a water bath with a temperature from 77°F ± 2°F for 24 hr. Water level must be 4.0 in. above the specimens' surface and specimens must not be stacked.

5. Remove from the water and let stand for a minimum of 60 min.

6. Cover specimens with damp cloth to prevent excessive evaporation.

7. Determine Indirect Tensile Strength (ITS) of all specimens under CT 371.

8. Calculate average wet (ITS_w), and dry (ITS_d) of each subset.

9. Determine Tensile Strength Retained (TSR) of each subset:

$$TSR = ITS_w / ITS_d$$

10. Select asphalt content with test results of minimum $ITS_d \geq 30$ psi, $ITS_w \geq 15$ psi and $TSR \geq 0.5$.

11. If more than one asphalt content complies with the minimum test results, select the lower asphalt content.

I. DESIGN ITS

1. Thoroughly mix a sufficient amount of water with approximately 30 lb of prepared materials with active filler to achieve 75 % of OMC.

2. Mix selected asphalt content thoroughly and fabricate six test specimens.

3. Follow steps from H 1.3 through H 1.9 and determine design dry ITS, wet ITS, and TSR.

J. HEALTH AND SAFETY

Caution must be exercised in the operation of the compactor to avoid any object other than the sample itself to intercede between the compactor foot and the mold any time the ram is in motion. The clearance between the inside edge of the mold and the compactor foot is approximately 0.06 in. The applied shearing force of 1,100 lb could cause severe injury to an operator's hand if caught between the compactor foot and the mold. A clear plastic guard has been designed for the California compactor and should be used as an aid in safeguarding against this hazard.

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available online at the Caltrans website.

Users of this method do so at their own risk.

End of Text
(California Test 313 contains 5 pages)

FDR-FA Mix Design: Summary Worksheet

Project Number and Description:								
District:		**County:**			**Date:**			
Road No.:		**Post Mile:**	to					
Grading	**Sieve**		**Required**	**Actual**	**Specification Compliance**			
	50	2.0						
	37.5	1.5	85 – 100		Yes		No	
	25	1.0	-		-	-	-	-
	19	0.75	-		-		-	-
	4.75	#4	-		-	-	-	-
	0.6	#30	-		-	-	-	-
	0.075	#200	5 – 15		Yes		No	
	If P#200 < 5%, proposed action?							
	If P#200 > 15%, proposed action?							
Binder Selection	Selected binder source				OFC			
	Test		**Required**	**Actual**	**Specification Compliance**			
	Expansion ratio				Yes		No	
	Half-life				Yes		No	
	Selected foam temperature				Foam temp range			
	Selected foaming water ratio				Foaming water range			
Active filler	Active filler type			%				
OMC			OMC					
Binder content	Content			ITS @ selected content	Dry ITS			
					Wet ITS			
					TSR			
Design ITS with filler	Dry ITS		Wet ITS		TSR			
Temperature	Min recycling temp							

FIGURE 1. FDR-FA Mix Design: Summary Worksheet