STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

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METHOD OF TEST FOR DETERMINING THE PERCENT AND GRADE OF RECYCLING AGENT TO USE FOR HOT RECYCLING OF ASPHALT CONCRETE

CAUTION: Prior to handling test materials, performing equipment setups, and/or conducting this method, testers are required to read "**SAFETY AND HEALTH**" in Section J of this method. It is the responsibility of whoever uses this method to consult and use departmental safety and health practices and determine the applicability of regulatory limitations before any testing is performed. Users of this method do so at their own risk.

A. SCOPE

This procedure is used to determine the percent and grade of recycling agent to use for recycled asphalt concrete when the Hot Central Plant method of recycling is used.

B. APPARATUS

Equipment as described in California Tests 202, 304, 310, and 366.

C. MATERIALS

Recycling agents.

D. PRELIMINARY ESTIMATE OF RECYCLING AGENT GRADE AND AMOUNT

1. Reclaimed Asphalt Concrete (RAP)

Trim the samples of aged asphalt concrete so that only the portion to be recycled remains. Crush one core/slab from each sample location so that all material passes a 50-mm sieve. Quarter or split this material to obtain a representative sample for extraction. Determine the asphalt content and after-extraction aggregate gradation of this asphalt concrete in accordance with California Tests 310 and 202. Then select a gradation for the new aggregate to be added to the salvaged asphalt concrete that will provide whatever gradation adjustment is needed so that the gradation of the blend conforms to the final asphalt concrete aggregate gradation selected for the project. Crush the remaining cores/slabs so that the RAP gradation passing the 4.75-mm sieve is 60 % of the after-extraction grading.

2. Viscosity of Aged Asphalt

Provide a representative sample of the asphalt concrete to be recycled (3500 g minimum) to TransLab in Sacramento. Request that the aged asphalt physical properties be determined via the Abson Recovery Test (California Test 380) with the viscosity reported in Pascal•second.

3. Recycling Agent*

a. Amount of total binder: Using the blended (salvaged + virgin) aggregate gradation selected for the recycled mix, determine the approximate total bitumen ratio (ABR) by use of the following formula:

$$ABR = \frac{4R + 7S + 12F}{100}$$

Where:

R = % Retained on the 2.36-mm sieve

*Form TL-312A to be used as a worksheet.

S = % Passing the 2.36-mm sieve and retained on the 75 μm sieve

F = % Passing the 75-μm sieve

b. Calculate the amount of aged asphalt, D_2, present in the total combined mix as follows:

D_2 = (% Ext.) (% RAP in recycled mix)

c. Amount of recycling agent (% RA) — Subtract the amount of aged asphalt in the total mix (D_2 on the worksheet) from the ABR (D_1 on the worksheet). The remainder is the estimated amount of recycling agent required, RA (D_3 on the worksheet).

d. Grade of recycling agent: Using Chart 1,

(1) Locate the viscosity of the aged asphalt (Abson recovery data) on Scale A.

(2) Connect this point with the various paving asphalt and recycling agent viscosities on Scale C.

(3) Calculate the percent of recycling agent or new asphalt that will be in the recycled mix as follows:

$$RAB = \frac{RA}{ABR} \times 100$$

Where:

RAB = Recycling agent in blend, %

RA = Recycling agent from "c" above, %

ABR = Total binder content from "a" above, %

(4) Locate % RAB on the horizontal scale (scale "B") of Chart 1.

(5) Draw a vertical line to intersect each of the horizontal lines representing the AR grades of asphalt.

(6) Note the intersection of the vertical line and the AR-4000 grade viscosity. Select the recycling agent grade or AR grade asphalt represented by the diagonal line closest to this intersection.

E. RECYCLING AGENT GRADE AND AMOUNT RECOMMENDATION

1. Weigh out a moisture-free representative sample of RAP equivalent to the amount (based upon a 2400 g sample) proposed for the recycled mixture. For example, a 50/50 mix would require 1200 g; a 70/30 mix would require 1680 g, etc. This is the "wet" mass.

2. Determine the dry aggregate mass of the RAP per batch:

$$\text{Dry mass} = \frac{\text{wet mass}}{100 + \% \text{ Asph. ext.}}$$

3. Weigh out a moisture-free representative sample of virgin aggregate (of the gradation selected) equivalent to the amount (based on a 2400 g sample) proposed for use in the recycled mixture.

4. Combine the RAP and virgin aggregate in one large pan and heat this material in a 165°C oven for 2 to 3 h.

5. Remove the sample from the oven and immediately add the required amount of recycling agent per Section D.3.c.

6. Mix until well coated (hand or mechanical mixing).

7. After mixing, remove two 600 ± 50 g samples by quartering, using a 25.4 mm riffle splitter, and measure the binder content and aggregate gradation of each per California Tests 310 and 202. The average of the two tests must show that the binder content is ± 0.2 % of the desired amount and the gradation must be within ± 5 points on any sieve. Retain the remaining 1200 g.

8. Prepare three additional samples using 1200 g for each sample. Vary the amount of recycling agent above and below the % RA per D.3.c, using 0.5 % increments based upon dry aggregate mass (usually 1 above and 2 below).

9. Transfer the four 1200 g samples of recycled mix (one from No. 7 above and three from No. 8 above) to flat pans, 280 by 180 by 25 mm, and cure for a minimum of 15 h in a 60 ± 3°C oven.

10. Fabricate four briquettes per Part 2 of California Test 304.

11. Measure the stability of the four briquettes per California Test 366.

12. Determine the optimum % RA per California Test 367.

13. After establishing the optimum % RA, recalculate the % RAB.

14. Locate this optimum % RAB on scale "B" of Chart 1.

15. Draw a vertical line to intersect the viscosity curve for the recycling agent used in the test. This point of intersection must be within one grade of the blend viscosity selected for design. If it is not, select another grade of recycling agent and repeat the design testing. If the newly selected grade of recycling agent does not provide blend consistency within one grade of the selected viscosity, then the material should be designated as a poor risk for recycling.

F. EXTRACTION CALIBRATION CURVE

Prepare an asphalt extraction calibration curve of final recycled mix in accordance with California Test 310.

G. PRECAUTIONS

Use leather gloves when handling hot material.

H. REPORTING OF RESULTS

1. Report gradation of:
   a. RAP
   b. "New" aggregate
   c. Recycled mix
2. Report ratio used (RAP to new aggregate) such as 50/50, 60/40, 70/30. etc.
3. Report binder used:
   a. Amount recommended
   b. Grade recommended
   c. Source used
4. Report stability and specific gravity of test specimen at recommended RA content.
5. Report specific gravity of RA used.
6. Report extraction calibration curve.
7. Use Test Card, Form No. TL-302, for reporting of test data.

I. NOTE

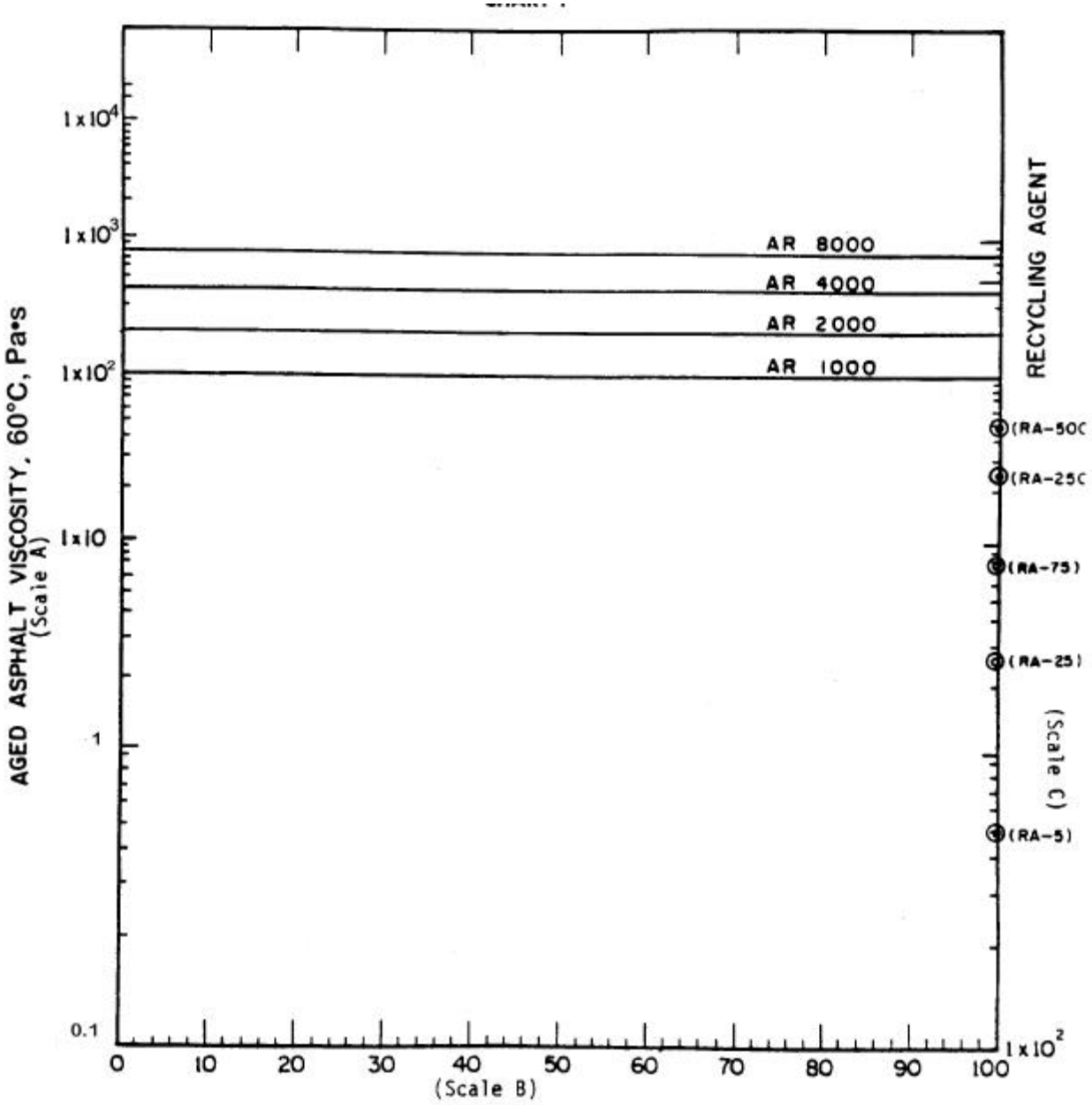
If the stabilometer values are all less than the desired 35 (or 30 for 9.5 mm max.), select the next heavier grade of recycling agent and repeat the testing.

J. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, testers are required to read: Part A (Section 5.0), Part B (Sections: 5.0, 6.0 and 10.0) and Part C (Section 1.0) of Caltrans Laboratory Safety Manual. Users of this method do so at their own risk.

REFERENCES:
California Tests 202, 304, 308, 310,366, 367, and 380

End of Text (California Test 377 contains 5 Pages)



TO USE: Draw a straight line connecting viscosity of aged asphalt with viscosity of recycling agent. Draw a vertical line up from the percent recycling agent in blend. The two lines intersect at predicted approximate viscosity of the recycled asphalt.

Form No. TL-314 (Rev 4/84) NOMOGRAPH FOR VISCOSITY

CHART 1

HOT RECYCLING OF ASPHALT CONCRETE

TEST REPORT NO. _____

Location: Dist. _____ Co. _____ Rte. _____ PM _____ Contract No. _____

DATA			COLUMN 1 Pav't to be Recycled	2 Design Calc.	3 Design Recomm.	4 Recycled Pavement
Date:						
(A) Asphalt Content, % (RAP)						
(B) Penetration @ 25°C (RAP)						
(C) Viscosity @ 60°C (RAP)						
(D) Asphalt Demand *		(1) ABR				
		(2) A x Ra				
		(3) ABR - (A x Ra)				
(E) Stab. Value CT 366		Compacted @ 110°C Tested @ 60°C				
(F) Sp. Gr.	CT 308C	(1) From specimen (E) above				
	(2) Theoretical Max. Sp. Gr. ASTM D-2041					
(G) % Voids (100 - F_1/F_2)						
(H) Aggregate Gradation: R, retained 2.36 mm, % S, passing 2.36 mm, retained 75 µm, % F, Passing 75 µm, %						

*(D) Asphalt Demand
A = Binder content of RAP
Ra = % of RAP Aggregate in Total Mix
D_1 = ABR = Total binder required = (4R+7S+12F) /100 = _____
D_2 = % asphalt in RAP = A x Ra
D_3 = RA = % recycling agent or asphalt to add = ABR - (A x Ra) = _____%

Grade of recycling agent or asphalt determined _____

Form DH-TL-312A (12/95)

FIGURE 1