STATE OF CALIFORNIA—BUSINESS, TRANSPORTATION AND HOUSING AGENCY

DEPARTMENT OF TRANSPORTATION
ENGINEERING SERVICE CENTER
Transportation Laboratory
5900 Folsom Blvd.
Sacramento, California 95819-4612

METHOD OF TEST FOR DETERMINING THE PERCENT AND GRADE OF RECYCLING AGENT TO USE FOR COLD 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 K of this method. It is the responsibility of whoever uses this method to consult and use appropriate 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 recycling asphalt concrete when the cold method of recycling is used.

B. APPARATUS

1. A jaw crusher that can be adjusted to produce material passing the 4.75 mm sieve. A sledgehammer may be used to reduce oversize particles enough to permit the material to be fed into the crusher.
2. Hot asphalt extractor, as described in California Test 310.
3. Two ovens, one capable of maintaining a temperature of 60 ± 3°C with provision for free circulation of air through the oven and another capable of maintaining a temperature of 150 ± 5°C. A microwave oven may be used in lieu of the 150°C oven.
4. Balance, 5 kg capacity, accurate to 1 g.
5. Sieves, U.S. Standard sizes:
   25.0 mm, 19.0 mm, 12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600 μm, 300 μm, 150 μm, and 75 μm.
6. Sample splitter for aggregates, 25.4 mm riffle type or equal.
7. Pans, approximately 250 mm diameter, 50 mm deep.
8. Pans standard curing, approximately 280 by 180 by 25 mm deep.
9. Trowels, small pointed.
10. Compaction equipment as described in California Test 304, Part 2.

C. MATERIALS

Emulsified recycling agents.

D. PREPARATION OF SAMPLES

1. Gradation
   a. Pavement cores or chunks.
      (1) Trim samples so that only that portion designated for recycling remains.
      (2) Prepare an 800 g representative sample of the proposed recycling mix.
         (a) Determine the asphalt content using California Test 310.
         (b) Determine aggregate grada-tion after extraction using California Test 202.
      (3) Crush the remaining material proposed for recycling to conform (approximately) to the following gradation prior to extraction:

Sieve Size	% Passing
25.0 mm	100
19.0 mm	*
9.5mm	*
4.75 mm	50 % of the amount passing the 4.75 mm sieve as determined by an after-extraction grading

*Determine by drawing a straight line between plotted points for the 25.0 mm and 4.75 mm sieves as illustrated in Figure 1.

b. Pulverized field samples.

(1) Prepare field samples repre-sentative of the material processed by the contractor (milling and/or crushing) and ready for field mixing as follows:

(a) Dry to a constant mass in an oven (maximum temperature 60°C).

(b) Remove from oven and cool to room temperature.

(c) Quarter out 2,000 ± 1 g.

(d) Determine and record the gradation (% passing) by hand sieving through the following sieves: 37.5, 25.0 (see footnote), 19.0,9.5, and 4.75 mm.

2. Viscosity of aged asphalt.

Prepare a 3.5 kg sample representative of the material to be recycled and send to TransLab in Sacramento. Request that the asphalt physical properties be determined via the Abson Recovery Test.

3. Recycling agent - amount and grade.

a. Determine approximate total bitumen requirement (ABR) using the formula:

$$ABR = \frac{4R + 7S + 12F}{100} \times 1.1$$

Where, after extraction:

R = % retained 2.36 mm

S = % passing 2.36 mm and retained 75 µm

F = % passing 75 µm

Record data on Form No. DH-TL-312.B.

b. Determine the amount of recycling agent to add by subtracting the asphalt content of the old pavement from the ABR. Divide the remainder by 0.60 to obtain the percent of *emulsified* recycling agent to add.

c. Determine the amount of recycling agent (%) in the final blend (asphalt and recycling agent) by dividing the *residual* amount of recycling agent to be added by the total binder content.

d. Using the nomograph for viscosity (Form DH-TL-314), plot the viscosity of the aged asphalt (use Pascal•second) on the left scale. Connect that point to points on the right vertical scale representing the viscosities of the residues for the various emulsified recycling agents, thereby creating a family of curves.

e. On the lower horizontal scale of the nomograph, locate the percent of recycling agent in the blend and draw a vertical line from this point.

f. At the intersection of this vertical line and the horizontal viscosity line for AR-4000, note the closest recycling agent curve. Select this grade of recycling agent to begin testing.

NOTE: Generally, this will result in a design viscosity of 4000. However, occasionally 2000 or 8000 will become the design viscosity.

4. Prepare the test specimens for the stabilometer evaluation as follows:

a. Prepare six 1200 g samples using material prepared in accordance with D.1.a or D.1.b.

b. Save one sample for determining maximum specific gravity (ASTM D-2041) and one sample for future testing if needed.

c. Dry four samples to a constant mass in a 60°C oven.

d. Remove the four samples from the oven and cool at room temperature for 2 h ± 30 min.

e. Add 2.0 % water to each sample by dry mass of the mix and thoroughly hand mix.

* When preparing the stabilometer test, always scalp so that 100 % passes the 25.0 mm sieve.

f. To one sample, add the amount of emulsion calculated in Paragraph 3b and thoroughly hand mix (aggregate, emulsion, and mixing at 25 ± 3°C).

g. Add lesser and greater amounts of emulsion in 0.8 % increments. General practice is to increase the content on one sample and decrease it on two samples. Mix each sample thoroughly after the addition of the emulsion.

E. CURING

Place in standard curing pans and cure at 60°C for 16 ± 1 h.

F. FABRICATION OF THE STABILOMETER TEST SPECIMENS

1. Prepare compaction mold and mold holder by placing in a 60°C oven for 30 min prior to use. If several samples will be compacted in succession, the mold holder may be used after the first preheating without additional heating.

2. Place mold in mold holder and this assembly into position in the mechanical spader. (If a mechanical spader is not available, proceed to F 8.) Place the metal shim, under the mold adjacent to the portion of the mold holder that extends up into the mold. Place a cardboard disk into the mold on top of the mold holder base.

3. Weigh out sufficient mix to provide a specimen between 61.0 and 66.0 mm in height for the stabilometer test.

4. Separate the coarse and fine material by screening the mix through a 12.5 mm sieve onto a flat metal scoop.

5. Arrange the separated material into two parallel rows across the width of the scoop with the finer material closest to the scoop handle.

6. Introduce the mix onto the feeder belt of the mechanical spader, exercising care so as not to disturb the size arrangement effected on the metal scoop.

7. Start the mechanical spader and operate until all of the material has been introduced into the compaction mold. Proceed to step 9.

8. In lieu of the mechanical spader described above, a specially constructed feeder trough, 100 mm wide and 400 mm long, may be used for introducing the mix into the mold. Thoroughly mix and disperse the heated material on the trough (which has also been preheated to approximately 60°C) to ensure a uniform sample when transferred to the mold. Place the mold in position in the mold holder and place a cardboard disk into the mold on top of the mold holder base.

   Use a paddle, shaped to fit the trough, to push one-half of the material into the mold. Rod the material 20 times in the center of the mass and 20 times around the edge with a bullet-nosed steel rod. Then push the remainder of the sample into the mold and repeat the rodding procedure. Perform these operations as rapidly as possible to prevent cooling of the sample. If two feeder troughs are available, the work can be expedited by preparing another sample while one is being compacted. The extra trough containing the next sample is kept in the oven until ready for compaction.

9. Place mold holder containing the mix and mold into position in the mechanical compactor.

10. Start the compactor and adjust the air pressure so 1720 kPa will be exerted by the tamper foot. Keep the tamper foot hot enough to prevent the mix from adhering to it.

11. Apply approximately 20 tamping blows at 1720 kPa pressure to accomplish a semi-compacted condition so the mix will not be unduly disturbed when the full load is applied. The exact number of blows to accomplish the semi-compaction shall be determined by observation. The number of blows may vary between 10 and 50, depending upon the type of material.

12. Remove the 6 mm shim and release the tightening screw sufficiently to allow approximately 3 mm side movement under load. Then increase the compaction pressure to 3450 kPa and apply 150 tamping blows to complete the compaction in the mechanical compactor.

13. Apply a total static leveling-off load of 5.6 kN in the testing machine at a head speed of 1.27 mm/min with the bottom of the sample in contact with the lower platen of the press. Release the applied load immediately.

14. Measure the height of the test specimen to the nearest 0.25 mm and record for later use.

15. Place mold and specimen in 60°C oven for 1.5 h ± 30 min.

G. TESTING

1. Stabilometer test.

   Test for stabilometer value at 60°C in accordance with California Test 366.

2. Specific gravity and voids.

   a. Use the stabilometer test specimen and determine the specific gravity of the briquette using Method A of California Test 308.

   b. Place a 1200 g sample (from D.4.b) of reclaimed AC pavement (RAP) in a container as required and determine the specific gravity using ASTM Test Procedure D-2041.

   c. Calculate the void content of the test specimen as follows:

$$\text{Max.Sp.Gr.} = \frac{100 + \%\ \text{Asphalt Residue}}{\dfrac{100}{\text{Salv. AC Sp. Gr.}} + \dfrac{\%\ \text{Asphalt Residue}}{\text{Sp. Gr. Asphalt}}}$$

$$\text{RelativeDensity} = \frac{\text{Sp. Gr. Briq.}}{\text{Max. Sp. Gr.}}$$

$$\text{Percent Voids} = 100 - \text{Relative Density}$$

H. RECOMMENDATION

Optimum bitumen content (OBC). Recommend the highest emulsion content that provides a specimen with the desired stabilometer value*, no evidence of surface flushing or bleeding, and a minimum of 4 % voids. Slight flushing is considered as no flushing.

* Unless other specified:
Traveled way stabilometer value = 30 min.
Shoulder stabilometer value = 25 min.

I. CORRECTION OF GRADE OF RECYCLING AGENT

Determine the residue of the OBC and divide by ABR to establish as a percent. Use this percent recycling agent and the viscosity nomograph to determine the grade of recycling agent. If the grade of recycling agent is different from the one tested, retest using the recommended amount with the newly designated grade.

J. REPORTING OF RESULTS

1. Use Form TL-302 for recording and reporting test data.

   2. Report:

      (1) Asphalt extraction

      (2) Extracted grading

      (3) Grading prior to extraction

      (4) Grade of recycling agent to use

      (5) Amount of recycling agent (OBC)

      (6) Voids at OBC

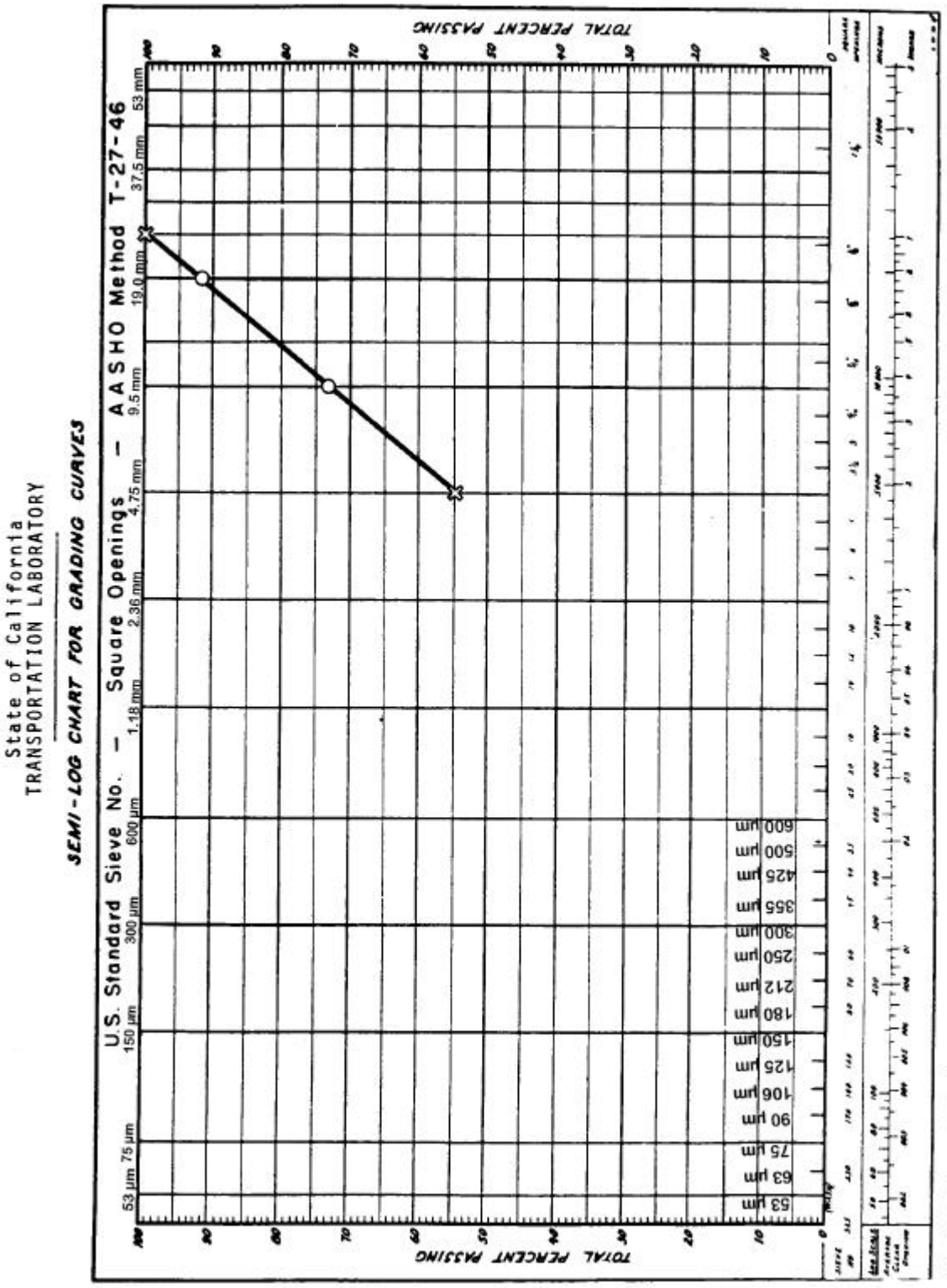
      (7) Design viscosity (2,000, 4,000, or 8,000)

K. SAFETY AND HEALTH

Prior to handling, testing or disposing of any waste materials, Caltrans 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
ASTM D2041

End of Text (California test 378 contains 7 Pages)



SEMI-LOG CHART FOR GRADING CURVES

California Department of Transportation
Engineering Service Center
Office of Materials Engineering and Testing Services
Form No. DH - TL - 312B
(Rev. 12/95)

COLD RECYCLING OF ASPHALT CONCRETE
TEST REPORT NO. _____

Location: Dist.____ Co. ____ Rte. ____ P.M. _____ CONTRACT NO. _____

COLUMN		1	2	3	4
DATA		PAV'T TO BE RECYCLED	DESIGN CALC.	DESIGN RECOMM.	RECYCLED PAVEMENT
Date:					
(A) Asphalt Content, % [RAP]			----------	----------	
(B) Penetration @ 25°C [RAP]			----------		
(C) Viscosity @ 60°C [RAP] Pa•s			----------		
(D) Asphalt Demand *	(1) ABR	----------			
	(2) D_1- A	----------			
	(3) D_2/0.60	----------			
(E) Stab. Value CT 366	Compacted & 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 2.36mm, retained 75 µm, % F, passing 75 µm, %					

*(D) Asphalt Demand

A = Binder content of RAP

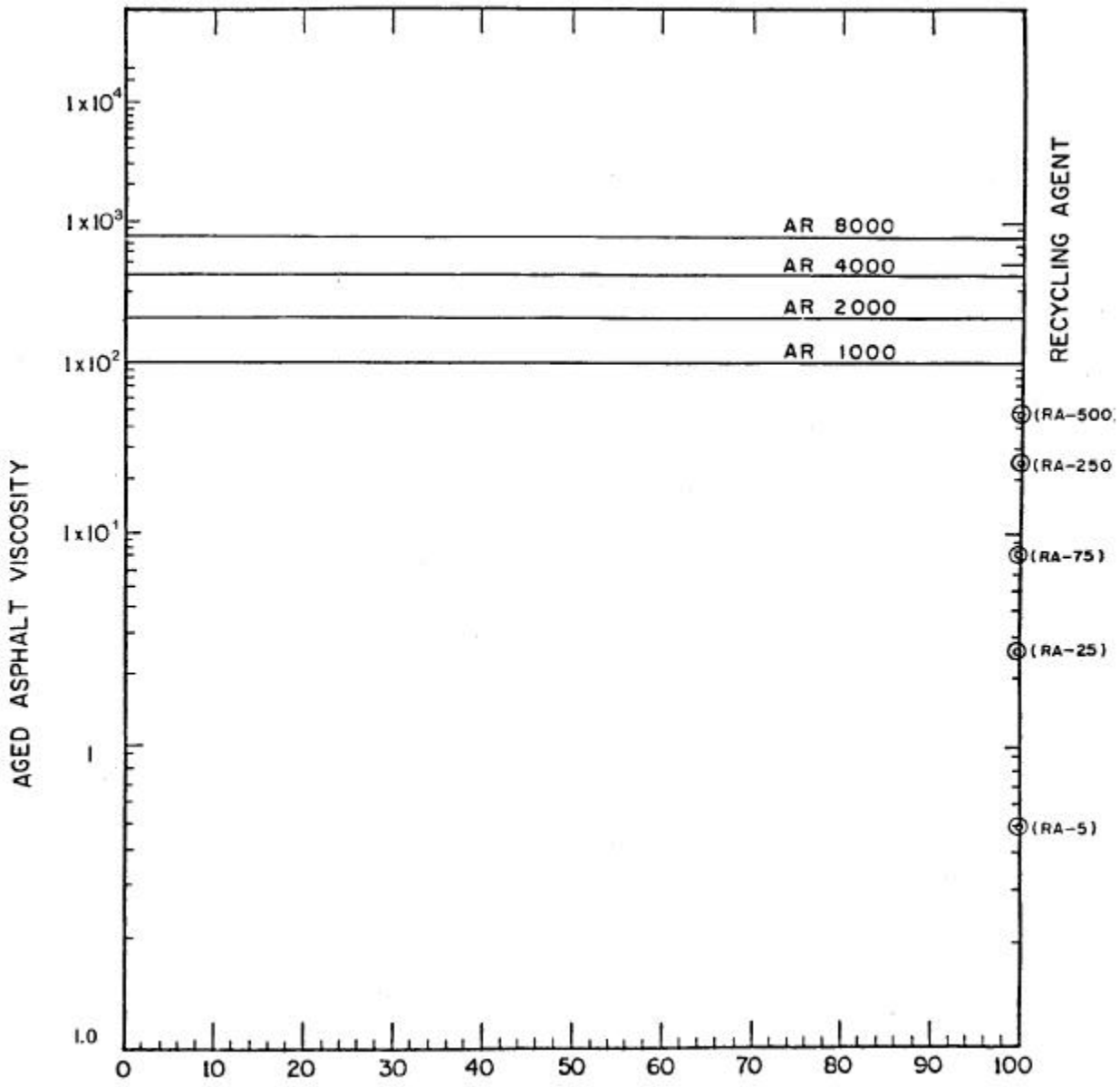
D_1 = ABR = Total binder required = $(4R + 7S + 12F)\cdot 1.1/100$ = _____

D_2 = % recycling agent to add = D_1- A

D_3 = % emulsified recycling agent to add = D_2 (0.60) = _____%

Grade of recycling agent determined _____

TEST REPORT



PERCENT RECYCLING AGENT (RESIDUE) IN BLEND

TO USE: Draw straight lines connecting viscosity of aged asphalt to each grade of recycling agent (RA). Draw a vertical line up from the percent recycling agent in blend. The RA line nearest the intersection of the vertical line and the horizontal AR-4000 line is the recommended grade of recycling agent or asphalt to use.

Form No. DH TL-314

NOMOGRAPH FOR VISCOSITY