METHOD OF TEST FOR DETERMINATION OF PERFORMANCE GRADE OF PHYSICALLY AGED ASPHALT CEMENT USING EXTENDED BENDING BEAM RHEOMETER (BBR) METHOD

1. SCOPE

1.1 The extended bending beam rheometer test is carried out to determine if an asphalt cement meets the low temperature performance grade after going through a physical ageing (physical hardening) process.

1.2 Bending Beam Rheometer covered under AASHTO T 313, conditions samples for 1 h and tests at a temperature 10°C warmer than the low temperature grade to determine if the asphalt cement passes the low temperature requirement. LS-308 requires testing at two temperatures, to determine by extrapolation a limiting temperature for each conditioning time and temperature.

1.3 Low-temperature physical ageing of asphalt cement is different at different temperatures and can increase over time. LS-308 conditions at 10°C and 20°C above the low temperature performance grade (i.e. minimum design pavement temperature) for periods of 1 h, 24 h, and 72 h to simulate the effect of extended exposure to two different cold temperatures.

1.4 LS-308 has been published as a provisional test method. The test is a working document, and continuous refinement to the test method may be expected.

2. RELEVANT DOCUMENTS

AASHTO M 320	Standard Specification for Performance-Graded Asphalt Binder
AASHTO R 28	Accelerated Aging of Asphalt Binder Using a Pressure Aging Vessel (PAV)
AASHTO T 240	Effect of Heat and Air on a Moving Film of Asphalt (Rolling Thin-film Oven Test)
AASHTO T 313	Determining the Flexural Creep Stiffness of Asphalt Binder Using the Bending Beam Rheometer (BBR)

3. DEFINITIONS AND ACRONYMS

-YY = the minimum design pavement temperature, also referred to as the low temperature performance grade specified for the asphalt cement, and the –YY specified for the performance graded asphalt cement where the PGAC Grade specified is PG XX-YY.

$\mathbf{T_{HT}}$ = the higher test temperature, $\mathbf{T_{HT} = 16^{o}C\text{-}YY.}$

$\mathbf{T_{LT}}$ = the lower test temperature, $\mathbf{T_{LT} = 10^{o}C\text{-}YY.}$

4. APPARATUS

4.1 All equipment and material as noted in Section 6 of AASHTO T 313.

4.2 Two air-cooled freezers that maintain the conditioning temperature requirements to within a

temperature tolerance of ± 1.0°C.

4.3 Flat Aluminum plate of a size that will lie flat in freezer and hold five samples.

5. PREPARATION OF SAMPLES

5.1 Ten samples shall be aged according to AASHTO T 240 (RTFO) and AASHTO R 28 (PAV), and prepared following AASHTO T 313 procedures.

6. TEST PROCEDURE

6.1 Samples shall be conditioned and stabilized at prescribed temperatures prior to testing. All conditioning shall be carried out in air-cooled freezers on a flat aluminum plate.

Note: If required, a Teflon sheet can be placed between the sample and the aluminum plate to prevent the sample from sticking to the plate.

6.2 Five samples (A1, A2, B1, B2, and a spare) shall be conditioned in a freezer kept at 20°C-YY (Shown as container I in Figure 1) and the other five (C1, C2, D1, D2, and a spare) shall be conditioned in another freezer kept at 10°C-YY (Shown as container II in Figure 2).

6.3 Samples shall be conditioned for 50 + 5 min (referred to as 1 h conditioning) at the conditioning temperatures indicated in section 5.2.

6.4 Following conditioning, samples A1 and A2 from Container I, and samples C1 and C2 from Container II, shall be stabilized for 10 ± 1.0 min at T_{HT}. After stabilizing, samples A1, A2, C1, and C2 are then tested following AASHTO T 313 procedures at T_{HT}.

6.5 Following conditioning, samples B1 and B2 from Container I, and samples D1 and D2 from Container II, are stabilized for 10 ± 1.0 min at T_{LT}. After stabilizing, samples B1, B2, D1, and D2 are tested following AASHTO T 313 procedures at T_{LT}.

6.6 Immediately after testing in steps 6.4 and 6.5, samples shall be returned to their respective conditioning Container I at 20°C-YY and Container II at 10°C-YY. An example conditioning and sampling matrix is shown in Table 1 for an asphalt cement grade of PGAC XX-34 specified.

6.7 Samples shall be conditioned lying flat on their side on a flat aluminium plate in their respective air cooled freezers, Containers I and II, at 20°C-YY and 10°C-YY for an additional 23 h ± 5 min (referred to as 24 h conditioning) and then repeat steps 6.5 and 6.6.

6.8 Samples shall be conditioned lying flat on their side on a flat aluminium plate in their respective air-cooled freezers, Containers I and II, at 20°C-YY and 10°C-YY respectively for an additional 48 h ± 5 min (referred to as 72 h conditioning) and then repeat steps 6.5 and 6.6.

6.9 If during the testing sequence, sample A1, A2, B1, or B2 becomes damaged, the damaged sample shall be replaced with the spare sample in Container I. If during the testing sequence, sample C1, C2, D1, or D2 becomes damaged, the damaged sample shall be replaced with the spare sample in Container II.

Figure 1 – Samples Conditioned at Temperature 20°C-YY

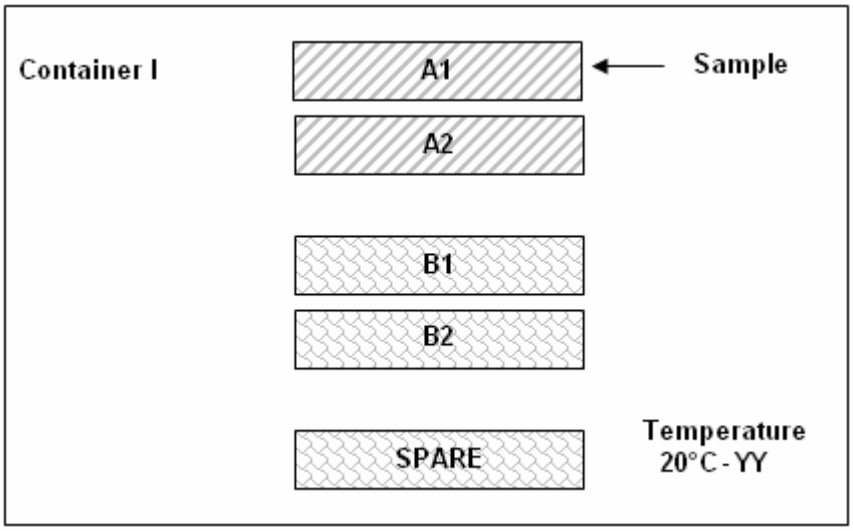

Figure 2 – Samples Conditioned at Temperature 10 °C-YY

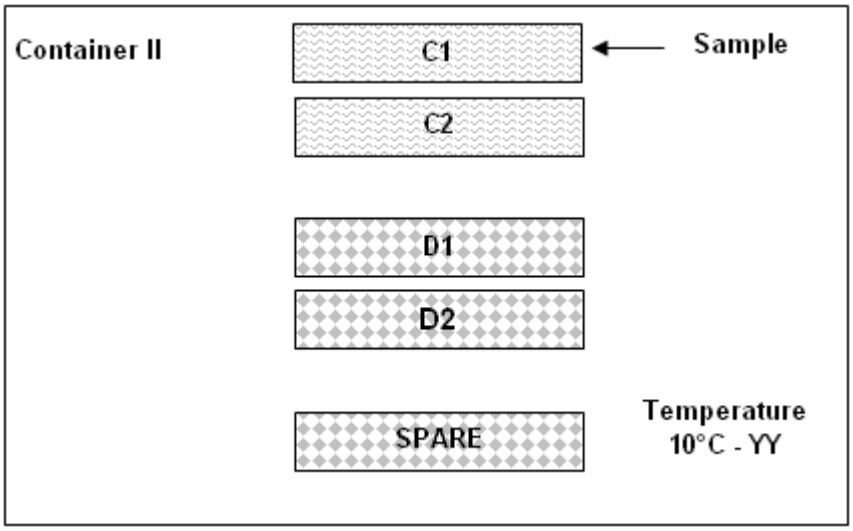

Table 1 – Example Test Matrix (see note 1)

CONDITIONING CONTAINERS AND CONDITIONING TEMPERATURE	SAMPLE NUMBER	CONDITIONING TEMPERATURE (for -YY=-34°C) (See Note 2)	TEST TEMPERATURE T_{HT}	TEST TEMPERATURE T_{LT}
I (20°C-YY)	A1	–14°C	–18°C	
	A2		–18°C	
	B1			–24°C
	B2			–24°C
	SPARE			
II (10°C-YY)	C1	–24°C	–18°C	
	C2		–18°C	
	D1			–24°C
	D2			–24°C
	SPARE			

Notes:

1. *This same test matrix is used for each of the 1 h, 24 h, and 72 h conditioning and testing periods.*
2. *An asphalt cement with a specified PG grading of XX-34 was used in this table.*

7. REPORTING OF RESULTS

7.1 Record test data on Form A, "Extended BBR Test Results". Creep Stiffness is to be recorded to the nearest 0.1 MPa and m-values to the nearest 0.001.

7.2 Calculate the average m-value and creep stiffness using the m-values and creep stiffnesses at 60 sec from Form A, "Extended BBR Test Results", and record them on Form B, "Limiting Grade Report for Extended BBR Test".

7.3 Determine by interpolation or extrapolation using a linear scale between T_{HT} T_{LT}, T_m, the continuous limiting BBR temperature where the slope of the creep stiffness at 60 seconds loading, m(60 s) equals 0.3 from the results obtained for tests conducted after conditioning samples in Container I and Container II for 1 h, 24 h, and 72 h.

7.4 Determine by interpolation or extrapolation using a log scale between T_{HT} T_{LT}, T_S, the continuous limiting BBR temperature where the stiffness at 60 seconds, S(60 s) equals 300 MPa from results obtained for tests conducted after conditioning samples in Container I and Container II for 1 h, 24 h, and 72 h.

7.5 T_m and T_S are to be recorded to within the nearest 0.1°C on Form B, "Limiting Grade for Extended BBR Test".

7.6 Determine and record limiting temperatures, limiting grades, and grade loss using Form B, "Limiting Grade for Extended BBR Test" form.

Form A: Extended BBR Test Results

AFTER 1 HOUR CONDITIONING

SAMPLE NUMBER	TEMPERATURE FOR 1 HOUR CONDITIONING	TEMPERATURE FOR 10 MINUTE CONDITIONING PRIOR TO TEST T_{HT} = 16°C-YY	TEMPERATURE FOR 10 MINUTE CONDITIONING PRIOR TO TEST T_{LT} = 10°C-YY	m-value	Creep Stiffness S (MPa)
A1	20°C-YY	A1 - tested at T_{HT}			
A2	20°C-YY	A2 - tested at T_{HT}			
B1	20°C-YY		B1 - tested at T_{LT}		
B2	20°C-YY		B2 - tested at T_{LT}		
C1	10°C-YY	C1 - tested at T_{HT}			
C2	10°C-YY	C2 - tested at T_{HT}			
D1	10°C-YY		D1 - tested at T_{LT}		
D2	10°C-YY		D2 - tested at T_{LT}		

AFTER 24 HOUR CONDITIONING

SAMPLE NUMBER	TEMPERATURE FOR 24 HOUR CONDITIONING	TEMPERATURE FOR 10 MINUTE CONDITIONING PRIOR TO TEST T_{HT}= 16°C-YY	TEMPERATURE FOR 10 MINUTE CONDITIONING PRIOR TO TEST T_{LT}= 10°C-YY	m-value	Creep Stiffness S (MPa)
A1	20°C-YY	A1 - tested at T_{HT}			
A2	20°C-YY	A2 - tested at T_{HT}			
B1	20°C-YY		B1 - tested at T_{LT}		
B2	20°C-YY		B2 - tested at T_{LT}		
C1	10°C-YY	C1 - tested at T_{HT}			
C2	10°C-YY	C2 - tested at T_{HT}			
D1	10°C-YY		D1 - tested at T_{LT}		
D2	10°C-YY		D2 - tested at T_{LT}		

AFTER 72 HOUR CONDITIONING

SAMPLE NUMBER	TEMPERATURE FOR 72 HOUR CONDITIONING	TEMPERATURE FOR 10 MINUTE CONDITIONING PRIOR TO TEST T_{HT} = 16°C-YY	TEMPERATURE FOR 10 MINUTE CONDITIONING PRIOR TO TEST T_{LT}= 10°C-YY	m-value	Creep Stiffness S (MPa)
A1	20°C-YY	A1 - tested at T_{HT}			
A2	20°C-YY	A2 - tested at T_{HT}			
B1	20°C-YY		B1 - tested at T_{LT}		
B2	20°C-YY		B2 - tested at T_{LT}		
C1	10°C-YY	C1 - tested at T_{HT}			
C2	10°C-YY	C2 - tested at T_{HT}			
D1	10°C-YY		D1 - tested at T_{LT}		
D2	10°C-YY		D2 - tested at T_{LT}		

Form B: Limiting Grade Report for Extended BBR Test

Conditioning Temperature	Conditioning Period	Average of two m-values		Average of two creep stiffnesses		T_m	T_S	Limiting Temperature at m=0.30 T_m -10 (°C)	Limiting Temperature at S=300 T_S -10 (°C)	Limiting Grade, T_L (see note 1) (°C)	Grade Loss T_{LBBR} -T_L (see note 2) (°C)
		T_{HT}	T_{LT}	T_{HT}	T_{LT}						
20°C-YY	1 hour										
	24 hours										
	72 hours										
10°C-YY	1 hour										
	24 hours										
	72 hours										

Notes:
(1) Where the Limiting Grade, T_L is the greater of T_m **–10** and T_S **–10**.
(2) Where T_{LBBR} is the Limiting Grade for **10°C-YY at 1 hour.**