Homework 4 PG Grading System Solutions

Question 1:

a) For at least 50% minimum reliability, the resulting PG grading is PG 58-22.

b) For 98% reliability, consider mean plus two standard deviation,

High temperature: $56 + 2 \times 2 = 60$
Low temperature: $-17 + (2 \times (-4)) = -25$
Therefore, a PG 64-28 grade is needed.

c) In cases of slower loading rates an asphalt binder must exhibit a higher stiffness to minimize rutting. To meet these situations, the high temperature grade should be increased by one grade for slow moving loads. Therefore, in this example, a PG 70-28 grade should be used.

Question 2:

a) Binder A: PG64-28; Binder B: PG58-16

b) Latitude for Spokane, WA: 47.658N
Pavement seven-day average maximum temperature at 20mm depth:
T_{20} = (Tair – 0.00618Lat^2 + 0.2289 Lat + 42.2)*0.9545-17.78
= 53 °C

98% reliability: $\mu + 2\sigma$
High temperature: 53+2*2.5=58
Low temperature: -21+2*(-3)=-27
Therefore, binder A PG64-28 will give at least 98% reliability.

c) Binder A PG64-28
(64-53)/2.5=4.4
Check normal distribution table given in the statistics book,
$\mu + 4.4\sigma$ will give a reliability of 100%.

Similarly, (28-21)/3 = 2.33
Check normal distribution table given in the statistics book,
$\mu + 2.33\sigma$ will give a reliability of 99.01% reliability.

The actual reliability for binder A will be:
100% reliability for high temperature, and 99.01% for low temperature.

Properties	Asphalt A	Asphalt B
Original Properties		
Flash Point temp. C	257 ✓	267 ✓
Viscosity at 135C poise	2.2 ✓	6.8 ✓
Dynamic shear		
G*/Sin δ at 58C	1.9 ✓	1.88 ✓
G*/Sin δ at 64C	1.05 ✓ 64	1.08 ✓
G*/Sin δ at 70C	0.74 ✗	0.51 ✗
Rolling Thin Film Oven Aged Binder		
Dynamic shear		
G*/Sin δ at 58C	3.98 ✓	2.25 ✓
G*/Sin δ at 64C	2.34 ✓ 64	1.34 ✗
G*/Sin δ at 70C	1.96 ✗	0.96 ✗
Rolling Thin Film Oven and PAV Aged Binder		
Dynamic shear		
G*Sin δ at 19C	4879 ✓ -34	7879 ✗
G*Sin δ at 22C	3987 ✓ -28	5982 ✗
G*Sin δ at 25C	2258 ✓ -22	4252 ✓
Creep stiffness		
S(t) (Mpa) / m-value at -12C	225/0.359 ✓ -22	125/0.459 ✓
S(t) (Mpa) / m-value at -18C	359/0.310 ✓ -28	259/0.320 ✓
S(t) (Mpa) / m-value at -24C	489/0.287 ✗	389/0.287 ✗
Direct Tension test		
failure strain at -12C (%)	2.5	2.1
failure strain at -18C (%)	1.6	1.8
failure strain at -24C (%)	1.1	0.9

0.22pa·s / 0.68pa·s

64 64

58

-16

PG64-28 PG58-16