Asphalt Cement properties as Binder Material

Lecture No. 6 / Part I

1-Asphalt Cement Properties

No.	Testing Methods	Engineering Significance
1	Penetration test for bituminous materials, **ASTM D5** (0.1 mm, 100 gm, 5 sec, 25 °C)	**1-** Consistency . **2-** Relative hardness. **3-**Temperature susceptibility.
2	Method for determination of softening value of bitumen, **ASTM D36**	**1-**Tendency to flow at elevated temperatures encountered in service (Higher softening point ensures that bitumen will not flow during service). **2-** To know the temperature up to which a bituminous binder should be heated for various road use applications. Max. soft heating temp. (soft point +(90-110))
3	Determination of ductility value of bitumen **ASTM D113** (25 °C, 5 cm/min)	**1-**Tensile properties. **2-**Adhesion properties.
4	Flash and fire point of bitumen **ASTM D92**	**1-**Safe mixing and heating temperature values of a particular bitumen grade (Safety on plants).

No.	Testing Methods	Engineering Significance
5.	Effects of heat and air on asphalt materials (Thin-Film Oven Test) **ASTM D 1754**	**1-**To simulate the **short-term aging** of bitumen by heating a film of asphalt binder in an oven for 5 hours at 163°C. **2-**To know the change in properties due to weathering (effective of heat and air)
6.	Kinematic viscosity at 135°C, **ASTM D2170** Dynamic (Absolute) viscosity at 60°C, **ASTM D2171**	**1-**Temperature susceptibility
7.	Solubility in trichloroethylene **ASTM D2042**	1-To determine **bitumen content or homogeneity** (to check the purity of asphalt).
8.	Specific gravity **ASTM D70**	1-It is used for **mixture calculations**.

The following table presents the requirements for penetration graded asphalt cement locally used in roads construction according to the standard specifications for roads and brides of the Iraqi state corporation for roads and bridges (SCRB, R9).

TABLE R9/2B

REQUIREMENTS FOR PENETRATION-GRADED ASPHALT CEMENT.

Property	Penetration Grade of Asphalt		
	40/50	50/60	60/70
1. Penetration at 25° C, 100gm, 5sec (1/10mm)	40-50	50-60	60-70
2. Ductility at 25°C, 5cm/min, (cm)	>100	>100	>100
3. Flash point, °C	>232	>232	>232
4. Solubility in trichloroethylene, %	>99	>99	>99
5. Residue from thin-film oven test			
- Retained penetration, % of original	>55	>53	>52
- Ductility at 25°C, 5 cm/min (cm)	>25	>40	>50

2-Temperature Susceptibility

Temperature susceptibility of an asphalt cement is defined as the rate of change of viscosity (or other measure of asphalt consistency) with temperature.

The rate of change of **viscosity or consistency** of a given bitumen **determines** its **temperature susceptibility**.

This property is of **great use** in designing satisfactory bituminous mixes (balanced mixes) for use under any given range of temperature change.

The **criterion** is that the **bitumen should exhibits as little change as possible in its viscosity** in the **given range of temperature change**.

A-Penetration Index (PI)

$$A = \frac{log\ pen\ at\ T_1\ - log\ 800}{T_1 - SP}$$

$$\mathbf{PI} = \frac{\mathbf{20(1 - 25A)}}{\mathbf{1 + 50A}}$$

The lower the penetration index, the **faster** the binder changes its consistency as the temperature changes (shows **greater** temperature sensitivity). Some literature stated that "typical" asphalts have IP values between **+2 and -2**.

Example 1:

It was found that the penetration grade of asphalt cement is 65 and the softening point is 49.8°C. Determine the PI of this asphalt binder.

$$A = \frac{log\ pen\ at\ T_1\ - log\ 800}{T_1 - SP}$$

$$A = \frac{log\ 65\ - log\ 800}{25 - 49.8}$$

$$A = 0.044$$

$$\text{PI} = \frac{20(1 - 25A)}{1 + 50A} = \frac{20(1 - 25 * 0.044\ )}{1 + 50 * 0.044}$$

$$\text{PI} = -0.619$$

It can be used as conventional paving bitumen

HW No.1

Complete the following table (you can use Excel to solve it):

Bitumen grade	Penetration	Softening point temperature (°C)	PI	Possible use for paving construction
20-30	20	63	?	?
30-45	30	60	?	?
35-50	50	50	?	?
40-60	60	48	?	?
50-70	70	46	?	?
70-100	100	43	?	?
100-150	150	41.5	?	?
160-220	200	40	?	?

B- Penetration Viscosity Number (PVN)

$$PVN = \left(\frac{4.258\text{-}0.7967 \log P - \log X}{0.7951 - 0.1858 \log P} \right) (-1.5)$$

Where:

P= Penetration at 25 ^{o}C,

X= Viscosity at 135 ^{o}C centistokes. (1 poise= 100 centistokes).

Typical values of the PVN ranges between **-2 and 0.5** and **higher PVN** indicates a **lower** temperature susceptibility while **lower PVN** indicates a **greater** temperature susceptibility.

C-Viscosity Temperature Susceptibility (VTS)

$$VTS = \frac{\log(\log \text{viscosity at } T_1) - \log(\log \text{viscosity at } T_2)}{\log T_2 - \log T_1}$$

Viscosity is measured in centistokes. (1 poise= 100 centistokes).

T_1 and T_2 temperature in degrees kelvin (absolute temperatures = ^oC+ 273)

The typical values of the VTS ranges between **3.36 and 3.98,** and the **lower the VTS**, the **lower** the temperature susceptibility or the **greater the VTS** the **greater** temperature susceptibility.

Example 2:

The following results were found from performing the penetration , viscosity, and ring and ball tests for an asphalt binder grade, AC-20

Asphalt grade	penetration	Viscosity at 135, poises	Viscosity at 60 , poises	Ring and ball softening point, ^{o}C
AC-20	58	4	2363	51

Find the PVN and VTS . It is possible to use this binder grade for paving construction?

$$PVN = \left(\frac{4.258\text{-}0.7967 \log P - \log X}{0.7951 - 0.1858 \log P} \right) (-1.5)$$

$$PVN = \left(\frac{4.258\text{-}0.7967 \log 58 - \log 400}{0.7951 - 0.1858 \log 58} \right) (-1.5)$$

PVN = -0.81 within the typical values of the PVN **(-2 and 0.5)** so it can be used for paving construction.

$$VTS = \frac{\log(\log \text{viscosity at } T_1) - \log(\log \text{viscosity at } T_2)}{\log T_2 - \log T_1}$$

$$VTS = \frac{\log(\log 236300) - \log(\log 400)}{\log(135+273) - \log(60+273)}$$

$$VTS = \frac{0.730 - 0.415}{2.6107 - 2.5224} = 3.57$$

3.57 within the typical values of the VTS (**ranges between 3.36 and 3.98**) so it can be used for paving construction

HW No.2

The following results were found from performing the penetration , viscosity, and ring and ball tests for an asphalt binder grade, AR-1000

Asphalt grade	penetration	Viscosity at 135, poises	Viscosity at 60 , poises	Ring and ball softening point, ^{o}C
AR-1000	131	1.3	556	40.6

Find the PVN and VTS . It is possible to use this binder grade for paving construction?