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A Study on aging Behavior of paving Grade Bitumen using Filler Material

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Abstract - Age hardening of bitumen has long been professed as one of the main factors that can significantly affect the durability of bituminous paving materials. When the bitumen is age hardened, the asphalt mixture will become brittle and its ability to support traffic-induced stresses and strains may significantly decrease. Deterioration of the pavement by readily-induced cracking may follow. In addition, excessive hardening can also weaken the adhesion between the bitumen and aggregate, resulting in loss of materials at the surface layer and generate weakening of the asphalt mixture. It is generally agreed that ageing is primarily associated with bitumen oxidation and the loss of volatile/oily components from the bitumen to the air and/or aggregates during asphalt mixture production (short-term ageing) and in-place service period (long-term ageing). Both factors cause an increase in viscosity (or stiffness) of the bitumen and consequential stiffening of the asphalt mixture.

In the present research work, study on different research papers is carried out to examine the effect of aging on bitumen binder using different filler materials. In terms of effect of filler materials on bitumen aging, studies have shown that the modified bitumen binder has less effect of aging than the neat bitumen.

I. INTRODUCTION

Bitumen is manufactured from crude oil. Bitumen is extractive as the last residue from fractional distillation of crude petroleum. Crude petroleum is different molecular weights. In the petroleum refineries the individual components like LPG, naphtha, Kerosene, Diesel etc. are separated through the process of fractional distillation. The heaviest material Obtained from the fractional distillation process is further treated and blended to make different grades of paving grade bitumen. The selection of the appropriate crude is cannot control actual bitumen outputit also required adopting varying processes in the refinery. The choice of process would depend on the availability of suitable crude, demand of the end products and total commercial viability of the complete refining process (H.P. Bitumen Handbook).

The function of asphalt pavements on any given road can be defined as:

1. The roof of the road construction, preventing moisture from penetrating into the construction.

2. A riding surface for the traffic and the users of the road.

3. A structural layer in the construction.

The functional quality of an asphalt pavement will vary, depending on traffic volume. In case of high volume roads, rutting resistance will be very much important, especially to withstand wear from studded tires. These roads have to be resurfaced after few years due to rutting. Pavements where traffic volume is very low will serve for many years before resurfacing, and important properties for these pavements are flexibility and low temperature capacity. The overall long term pavement performance is important for low volume roads.

The binder has a great influence on pavement performance,In spite of binder content in asphalt pavement is about 5-7 percent by weight. There are arguments in favor and against using hard or soft binders, and modified or unmodified binders. The selection is complicated due to the fact that binder properties are altered during production and with time in the pavement. This change is called ageing.To be able to choose the right binder and asphalt mix, it is necessary to know how binder properties change under production and over time under real condition (traffic load, climate, temperatures, etc.) and over time under real condition (traffic load, climate, temperatures, etc.).

Table:1 Viscosity Grade (Vg Bitumen Specification As Per IS 73:2006

Characteristics	VG-10	VG-20	VG-30	VG-40
Absolute Viscosity, 60°C, poises .min	800	1600	2400	3200
Kinematic Viscosity, 135°C, CST, min	250	300	350	400
Flash point, C, min	220	220	220	220
Solubility in trichloroethylene, %, min	99.0	99.0	99.0	99.0
Penetration at 25°C	80-100	60-80	50-70	40-60
Softening point, C, min	40	45	47	50
Tests on residue from thin film over test / RTFOT:				
i. Viscosity ratio at 60°C, max	4.0	4.0	4.0	4.0
ii. Ductility at 25°C , cm, min, after thin film over test	75	50	40	25

II. OBJECTIVES

Following are the objectives of study:-

1. To workout effect of aging on softening point of neat bitumen and modified bitumen samples.
2. To workout effect of aging on viscosity of neat bitumen and modified bitumen samples.
3. To workout effect of aging on Penetration value of neat bitumen and modified bitumen samples.
4. To workout effect of aging on Rheological properties of neat bitumen and modified bitumen samples.
5. To workout effect of aging on neat bitumen and modified bitumen samples.

III.Aging of Bitumen

As any organic matter, is affected by factors like presence of oxygen, ultraviolet rays and changes in temperature, as is also with the Bitumen because it last product. These factors are responsible for hardening of bitumen. Hardening results in decrease in penetration increase in softening point and increase in penetration index (PI).For increased life of bituminous pavement it is essential that excessive hardness does not take place(H.P. Bitumen Handbook).

III. EXPERIMENTAL METHOD

a) Material

i. Bitumen of VG 30 grade
ii. Ordinary Portland Cement 53 grade (UltratechCement).

For this study, Bitumen of VG 30 grade (equivalent to penetration grade 60/70) is used for the study. Locally available cement is used as the filler material for the study.The neat bitumen of viscosity grade 30 (equivalent to penetration grade 60/70) is used for this research study. Cement is used as filler material for this study. Cement is added at different percentages like 1%, 1.5% and 2. The penetration test is conducted to measure the penetration value at 25ºC. Softening point test is conducted to get softening point value of different binders. Cannon-Manning vacuums viscometer is used to obtain viscosity values of different bitumen binders. Thin Film Oven test is conducted to obtain aging characteristics of mixers and in which way such pavements can be rapidly aged and evaluated in the laboratory. The comparison of aged and unaged modified bitumen samples are carried out.

a) Sample Preparation

In preparing the modified binders about 500g of bitumen is heated to fluid condition in 2 liter capacity metal container. The mixing is performed in the laboratory using an oven fitted with mechanical stirrer and rotated at 70 rpm for mixing bitumen and filler. A filler sample is placed in an oven at 110±5◦C for drying to a constant weight. After preheating the bitumen and filler samples, each are removed from its respective oven. The correct quantities of the dried filler sample and the heated bitumen are placed into a sample container and heated it to approximately 160◦C

.The blend is mixed manually for about 3-4 minutes. The mixture is then stirred using a mechanical stirrer for about 10 minutes. The mortar is heated until the air bubbles escape and stirred to mix the filler particles, which would otherwise settle at the bottom of the container. When the mortar appears visually homogeneous, the mortar would be ready for pouring into the testing mould. The modified bitumen is cooled to room temperature and suitably stored for testing. Four samples of modified bitumen containing cement (0%,1%, 1.5% and 2%) are prepared.

b) Stripping Value Test

Bitumen and tar adhere well to all normal types of aggregates provided they are dry and are not exceptionally dusty. This problem of stripping is experienced only with bituminous mixtures, which are permeable to water. This test gives the procedure for determination of the stripping value of aggregates by static immersion method, when bitumen and tar binders are used.

Some types of aggregates have a lesser affinity with bitumen in comparison with water and hence stripping value of the bituminous binder is done when the mix is immersed in water. The problem of stripping in coated aggregate is not so amenable to theoretical treatment. Thus an adhesion test such as the simple stripping test would be suitable to assess whether the binder would adhere to the aggregate when immersed in water. Several anti-stripping agents are available, which when used with the bituminous mix reduce the stripping.

Indian Road Congress (IRC) has specified the maximum stripping value as 25 percent for aggregates to be used in bituminous construction like surface dressing penetration macadam, bituminous macadam and carpet.

c) Penetration Test

The penetration values of different sample is evaluated at laboratory before and after aging in accordance with IS:1203-1978.

d) Softening Point Test

The softening point of the various test samples is obtained using the ring and ball test in accordance to IS: 1205-1978, before and after aging.

e) Viscosity Test

The viscosity of samples is determined using Cannon-Manning vacuums viscometer before and after aging. The test was conducted at the temperature of 60ºC as per IS:1206(part-2)-1978.

V. RESULTS

1. BeforeAging:

The results shows that before aging softening point, viscosity increases and penetration decreases with increasing percentage of filler material, as presented in Table-2

Table-2

Binder Type	Penetration, (1/10th mm)	Softening, Point, (◦C)	Viscosity, (Poises)
0% Cement	**35**	**54**	**1805**
1% Cement	**36**	**55**	**1842**
1.5% Cement	**43**	**54**	**2367**
2% Cement	**47**	**53**	**2700**

2.After Aging:

obtain aging of modified bitumen samples, Thin Film Oven Test was carried out; the values after aging are shown in below Table-3.

In order to **Table- 3**

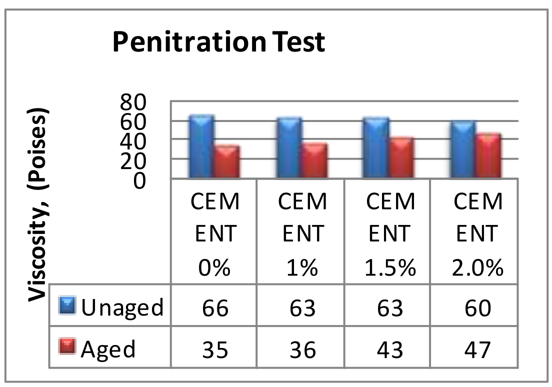
Binder Type	Penetration,(1/10th mm)	Softening Point,(◦C)	Viscosity, (Poises)
0% Cement	**66**	**49**	**1636**
1% Cement	**63**	**49.5**	**1730**
1.5% Cement	**63**	**51**	**1986**
2% Cement	**60**	**52**	**2058**

VI. COMPARISON OF AGED AND UNAGED BITUMEN SAMPLES

Comparison of aged and unaged bitumen samples containing different percentages of cement is carried out before and after aging.

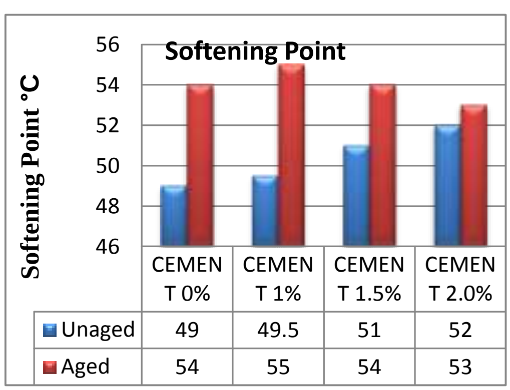
1) Penetration Value

The Comparison of Penetration values of aged and unaged Samples are shown in below Fig. 7.For binder containing 0% cement, the difference in penetration value before and after aging are more compare to other binders of varying percentages of cement. It is less for binder containing 2% cement than other binders Fig. 7: Comparison of Penetration values of aged and unaged Samples.



2) Softening Point

The Comparison of Softening Point values of aged and unaged Samples are shown in below Fig. 8. For binder containing 0% cement, the difference in Softening Point value before and after aging is more compare to other binders of varying percentages of cement. It is less for binder containing 2% cement than other binders.



3) Viscosity

The Comparison of Softening Point values of aged and unaged Samples are shown in below Fig. 9.For binder containing 2% cement, the difference in Viscosity value before and after aging are more compare to other binders of varying percentages of cement. The difference in Viscosity value is less for binder containing 1% cement than other binders.

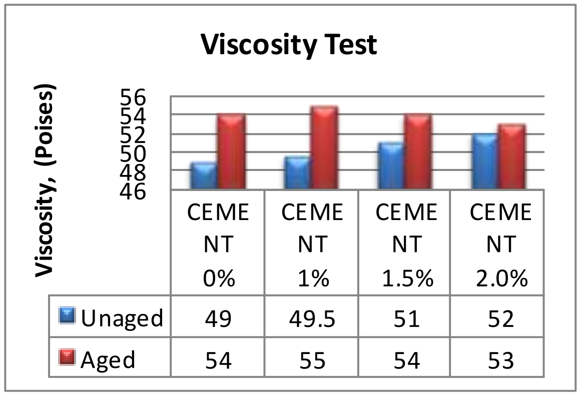


Fig. 9: Comparison of Viscosity values of aged and unagedSamples

V. CONCLUSIONS

The bitumen modified using different material like SBS, CR, Hydrated lime, Calcium carbonate; EVA etc. resist the effect of aging. Mahrez et al. concluded that the use of CR reduced the aging effect on rheological properties of the bitumen binder. Aging index was considered for evaluating and characterizing the aging properties of rubberised bitumen. It was found that in all binders the aging index is observed to be greater than one, which indicate hardening of this binders. Recasens et al. concluded that the hydrated lime tends to stiffen the mixture less and make it less brittle than does calcium carbonate. The filler content proposed must be 20% or 30% less than the content recommended to minimize the effect of aging on bitumen in conditions where there is no aging. Bianchetto et al. concluded that the use of hydrated lime and calcium carbonate as filler reduced the aging effect on rheological properties of the bitumen binder. Pilat et al. concluded that Viscoelastic properties of road bitumen are improved by means of SBS elastomers modification. It is good to replace a part of the elastomer with a linear particle for modifying road bitumen with a branched particle elastomer. It can be seen that Binders with a branched particle show increased resistance to the ageing processes. They have lower temperature sensitivity and lose the properties slower in comparison to bitumen modified with a linear particle polymer only.

Mohamed et al. concluded that the use of CR30 reduced the aging effect on rheological properties of the bitumen binder than neat bitumen. Yero et al. Concluded that Modified bitumen with SBS show greater resistance to aging than neat bitumen. Seyed Abbas Tabatabaei concluded that the use of SBS bitumen binder reduced the aging effect on physical properties of the bitumen binder. FTIR result shows aging causes oxidation of bitumen and forms the carbonyl and oxide sulphate structures in bitumen. Aging in modified bitumen by SBS has been less than base bitumen. Manindarsingh et al. concluded that the use of EVA, SBS and CR binder reduced the aging effect on rheological and physical properties of the bitumen binder.

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