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Comparative Study on Short Term Ageing of Bitumen VG 10 and VG 30 by using Epoxy Resin as a Modifier

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ABSTRACT

The deterioration of the flexible pavements are also due to extreme climatic conditions prevailing in the country in addition to the heavy traffic. The Epoxy Resin modification of the bitumen can improve the quality of binders and enhance the properties of binders used for the construction of pavements. Ageing of bitumen is one of the principal factors causing the failure of bituminous pavement components due to the prolonged exposure to air and environmental conditions. Ageing are of two types i.e. short term and long term. Short-term ageing occurs when binder is mixed with aggregates in a mixing plant. Long-term ageing occurs after pavement construction and is generally due to environmental exposure and loading. The properties of bitumen mainly depend on the age of bitumen. Therefore there is a need to study the properties of modified bitumen before and after ageing. In this paper the physical properties of Epoxy Resin modified bitumen is discussed, optimum dose is determined and the effect of ageing on the binder prepared using the optimum dose is evaluated.

Keywords: Short Term Ageing, Epoxy Resin, Physical Properties, Engineering and Technology

I. INTRODUCTION

The ability of modified bituminous binders to reduce rutting at high temperatures and thermal cracking/fracture at low temperatures has made them popular in the recent past. The quality of bituminous road surfacing and its performance depends upon the properties of bitumen and these are controlled by composition of bitumen. Hence, properties of bitumen may be modified by certain binders such as polymer, crumb rubber, sulphur, Epoxy Resin etc. Addition of Epoxy Resin in bitumen increases the life span of the road pavement considerably. The purpose of bitumen modification using Epoxy Resin is to achieve desired engineering. This modification results in improvement of one or more properties of binder and (hence the mix) viz. fatigue resistance, stiffness modulus, rutting resistance, stripping potential, temperature susceptibility, oxidation potential etc. The beneficial effects include decreased thermal susceptibility and permanent deformation under load and increased resistance to low temperature cracking. Binder modification is aiming to produce new binders with better rheological and mechanical properties. The improvement in the modified binders can be linked to the chemical change due to the interaction between the molecular structure of the bitumen and modifier added.

In Section 2 (Methods and Material), I'll give detail of any modifications to equipment or equipment constructed specifically for the study and, if pertinent, provide illustrations of the modifications. In Section 3 (Result and Discussion), Discussed in Section 4(Conclusion).

II. METHODS AND MATERIAL

Materials

The materials which are used in this work are as follows

1) Bitumen

The 60/70 and 80/100 grade bitumen supplied by the Aashapura Tar, Baroda.

Used in this study.

2) Modifiers

Epoxy Resin is used to modify the conventional 60/70 and 80/100 bitumen.

Preparation of Modified Binders

For preparation of Epoxy Resin blends Epoxy resin was added to the hot bitumen at ratios varying between 1% and 6% and mixed for 1 h. This sample was then maintained at 150^{o}C in an oven for 1 h and at room temperature for 1 day. When the binder appears visually homogeneous, it will be ready for pouring into the testing mould. The modified bitumen is cooled to room temperature and suitably stored for testing.

Tests Conducted

The following conventional tests were conducted on the Modified and unmodified binders.

Penetration Test

The penetration of a bituminous material is the distance in tenths of millimeter that a standard needle will penetrate vertically into a sample of the material under standard condition of temperature, load and time. Penetration test is the most commonly adopted test on bitumen to grade the material in terms of its hardness. The test is conducted as per IS: 1203- 1978.

Softening point Test

The softening point is the temperature at which the substance attains a particular degree of softening under specified condition of test. The softening point of bitumen is determined as per IS: 1205-1978.

Ductility Test

The ductility of bitumen is expressed as the distance in centimeters to which the bitumen filled in a standard briquette elongates before the breaking of the thread of bitumen formed due to elongation under specified conditions. The ductility test is conducted as per IS: 1208-1978.

Elastic Recovery

The elastic recovery of the binder is evaluated by measuring the recovery of the binder thread formed by the elongation of binder specimen when it is cut down by a scissor at standard conditions. The elastic recovery test is carried out as per IRC: SP 53-2002 specifications.

Viscosity Test

The ratio between the applied shear stress and the rate of shear is called the coefficient of viscosity. This coefficient is a measure of the resistance to flow of the liquid. It is commonly called the viscosity. The viscosity of a fluid is highly dependent on the temperature. It gets reduced with the increase in temperature. To determine the influence of temperature on the viscosity of bituminous binders we have to determine the viscosity at different temperatures. Brookfield viscometer is used for the purpose and the test is conducted as per ASTM D 4402- 2006.

Thin-Film Oven Test (TFOT)

Ageing or hardening of bituminous binder occurs during the mixing and during service. Short term ageing of the binders is performed by two methods, Thin Film Oven test (TFOT) and Rolling Thin Film Oven Test (RTFOT). Once the bitumen is found to be meeting the viscosity criteria the next step of aging the sample in the laboratory is undertaken. TFOT simulates the ageing occurring in bitumen during mixing, transportation and laying. The different binder samples are artificially aged at 163 ºC for 5 hours using Thin Film Oven Test (TFOT) in accordance with IS: 9382-1979.

III. RESULTS AND DISCUSSION

The physical properties of the bitumen modified with the Epoxy Resin and the effect of aging on these properties are discussed ahead.

Penetration Value

The penetration values of the unmodified and modified binders are tabulated in the figure given below.

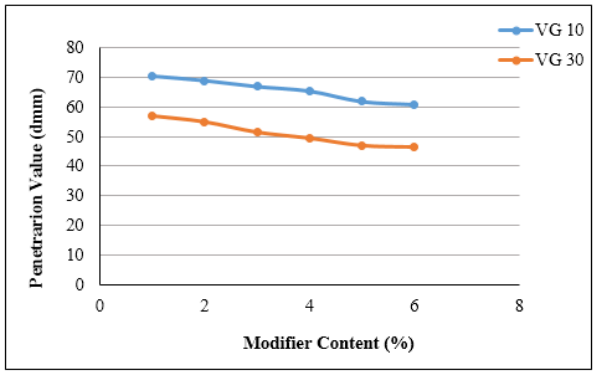

Fig. 1 Variation in Penetration Value of Aged VG10 and VG 30

Softening Point

The softening point values of the unmodified and modified binders are tabulated in the figure given below.

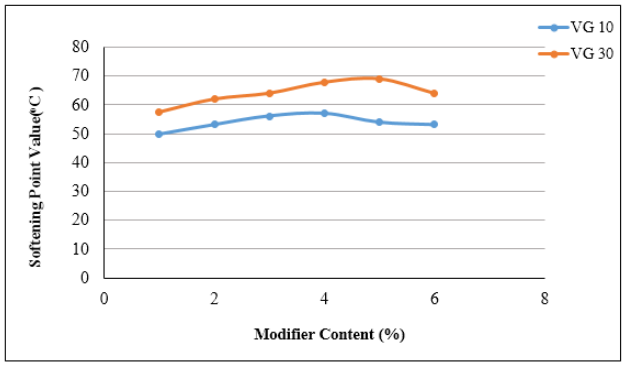

Fig. 2 Variation in Softening Point Value of Aged VG10

Viscosity

The Viscosity values of the unmodified and modified binders are tabulated in the figure given below.

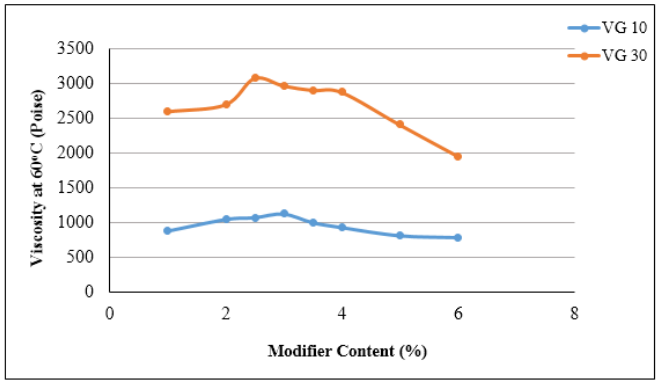

Fig. 3 Variation in Viscosity Value of aged VG10

Ductility

The Ductility values of the unmodified and modified binders, are tabulated in the figure given below.

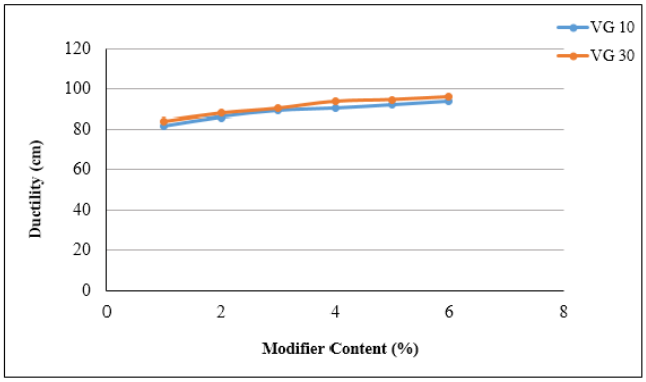

Fig.4 Variation in Ductility Value of VG10

Elastic Recovery

The Elastic Recovery values of the unmodified and modified binders, are tabulated in the figure given below

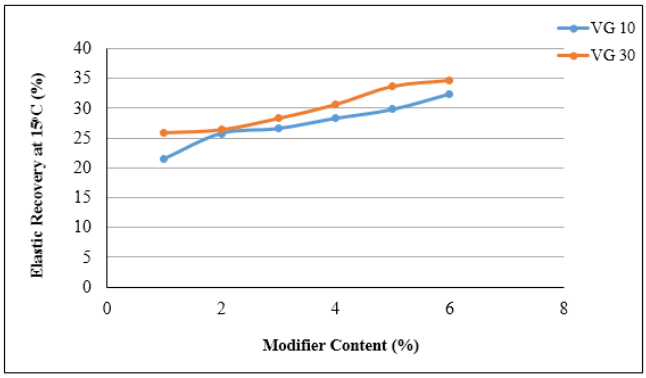

Fig. 5 Variation in Elastic Recovery Value of Aged VG10

Determination of Optimum Dose

The requirement of penetration, softening point, viscosity and ductility is satisfied at 3% of Epoxy resin at VG 10 & 2% of Epoxy Resin at VG 30 as per IRC: SP: 53-2002, IS 15462-2004 & IS 73-2006.

Effect of Ageing

The effect of ageing is depicted by the changes in the physical properties of the different modified binders after TFOT. The changes in physical properties are shown in Table 1.

Table 1 Optimum Dose Modifier of VG 10 and VG 30

Designation	VG 10	VG 10 + 3% of ER	Permissible Limit (min.)	VG 30	VG 30 + 2% of ER	Permissible Limit (min.)
Penetration (dmm)	75	67	30	59	55	30
Softening Point (°C)	49	56.1	47	56	62	47
Viscosity (Poise)	823	1121.6	800	2411	3078	2400
Ductility (cm)	80	89	50	85	87.8	50
Elastic Recovery (%)	22	26.6	35	23.5	26.4	35

IV. CONCLUSION

The following conclusions are drawn based on the results obtained in the present study:

1. The physical properties of bitumen such as penetration and softening point are improved with addition of polymers.
2. Epoxy Resin modified binder gives lower Penetration value as compared to neat bitumen
3. Epoxy Resin modified binder gives Higher Softening point value as compared to neat bitumen
4. Epoxy Resin modified binder gives Higher Viscosity as compared to neat bitumen.
5. Effect of Aging on Epoxy Resin modified binder is with in permissible limits.

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