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A Study on Effect of Polymers on the Properties of Vg-10 Grade Bitumen

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Abstract: ***The viscosity of basic paving level bitumen varies astonishingly with temperature, achieving bituminous black-top surface course vulnerable to temperature changes. In the midst of sweltering temperature the surface course ends up being soft resulting in permanent deformation and early rutting along the wheel paths of heavy vehicles. In the midst of winter season the bituminous black-top surface ends up being too stiff and brittle with the probability of early breaking/cracking under repeated wheel loads.***

Bitumen modifiers decrease temperature susceptibility of bitumen and that of bituminous mix with the subsequent change in black-top strength and stability by inducing visco elastic properties to the mix. This reduces the permanent deformation or rutting of the bituminous surface course under repeated loads. Modified bitumen offers better resistance to deformation at higher temperature and remains versatile, flexible and elastic at lower temperature. The usage of virgin polymers to change the characteristics of bituminous binder in bituminous mix is an acceptable practice in highway construction industry.

Keywords: EVA (Ethyl Vinyl Acetate), penetration, ductility, elastic recovery, viscosity, bitumen.

I. INTRODUCTION

At the point when the need of paved roads became an overall necessity, bitumen seemed as an ideal binder to build both the pavement structure and the wearing course. Increasing traffic loads and volumes, vehicle loads and tire pressures are causing accelerated degradation of the pavements. At high temperatures, bitumen remains sufficiently workable during placement and compaction due to its viscous behavior can be mixed with aggregate to manufacture asphalt concrete. At surrounding temperatures, bitumen acts as a viscoelastic material giving both strength and flexibility. Bitumen happens normally, it is for the most part gotten as a result of oil generation, and be that as it may, its thermoplastic qualities cause challenges with roads. Bitumen is a viscoelastic material and may show either elastic or viscous behavior, or a blend of these, contingent upon temperature and time over which bitumen is observed. At adequately low temperatures and high rates of strain, bitumen carries on basically as an elastic solid material.

A. Classification of modified bitumen binders

The polymer modified bitumen are classified into four types:

1) Type A- PMB(P) : Plastomeric thermoplastic based
2) Type B-PMB (E) : Elastomeric Thermoplastic based
3) Type C-NRMB : Natural rubber and SBR latex based
4) Type D-CRMB : Crumb Rubber/ treated crumb rubber based

II. LITERATURE REVIEW

Many researches have been conducted on properties of modified bitumen and a significant change was noted with the addition of polymers to the bitumen. The major studies carried out by different researchers on the use of polymers are as follows:

X.LU et al (June 26, 1998), they researched on rheological properties of SEBS, EVA and EBA polymer modified bitumen's. On the basis of the data and interpretations presented in their study they states that, polymer modification increases the elastic response and dynamic modulus of bitumen's and reduces their temperature susceptibility at intermediate (0-400C) and high (≥400C) temperatures

Panda and Mazumdar (1999) studied on EVA and found that the penetration, ductility and specific gravity decreased when compared to plain and clean bitumen whereas softening point and viscosity increases. The polymer modified bitumen does show a longer retention in properties when stored for a longer time

J.S. CHEN et al (February 21, 2002), they worked on evaluation and optimization of the engineering properties of polymer modified asphalt. In their study, SBS was shown to improve the rheological properties of the asphalt binder due to formation of a polymer network in the binder.

X.LU et al (December 2003), They performed experimental study on influence of polymer modification on low temperature behavior of bituminous binders and mixtures which gives information of low-temperature properties of bituminous binders and mixtures were greatly dependent on base bitumen, and in most cases, polymer modification did not show significant benefits as compared to the corresponding base bitumen.

N.P.KRUT'KO et al (March10,2008), They researched on thermal oxidation resistant of bitumen modified with Styrene-Butadiene-Styrene and Ethylene-Vinyl-Acetate copolymers, He was concluded that interaction of the carbonyl group of Ethylene-Vinyl-Acetate copolymer with components of bitumen asphaltenes enhances the heat resistance of the polymer.

III. EXPERIMENTAL PROGRAM

The following test were conducted to study the properties and behavior of conventional as well as modified bitumen

1) Ductility test[IS:1208-1978]
2) Elastic recovery test IRC : SP53-2002
3) Penetration test [IS: 1203-1978]
4) Softening point test [IS:1205-1978]
5) Viscosity test(IS: 1206-1978)
6) Thin film oven test (ASTM D 1754)

IV. MATERIALS

1) *Bitumen:* VG 10 Grade bitumen supplied by HP Asphalt, Mumbai.
2) *Modifiers:* Ethyl Vinyl Acetate(EVA)

Fig. 1: EVA Crystals

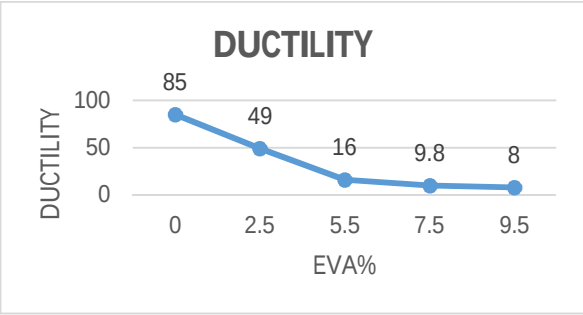
Fig.2: VG 10 grade bitumen

A. *Preparation of Modified Binders*

The VG 10 grade bitumen was heated to a temperature of 180°. As the bitumen reached a temperature of 180°, EVA was added by wt. of bitumen. (2.5%, 5.5%, 7.5%, 9.5%). The mixing was done for a period of 60-90 minutes depending upon the quantity of polymer added.

B. *Tests Conducted*

1) *Ductility Test (IS: 1208-1978):* The ductility of bitumen sample is the measured distance in centimeters up to which the elongated bitumen thread breaks in the ductilometer at 27°C at the rate of 50 +- 2.5 mm /minute. The test is conducted as per IS: 1208-1978.

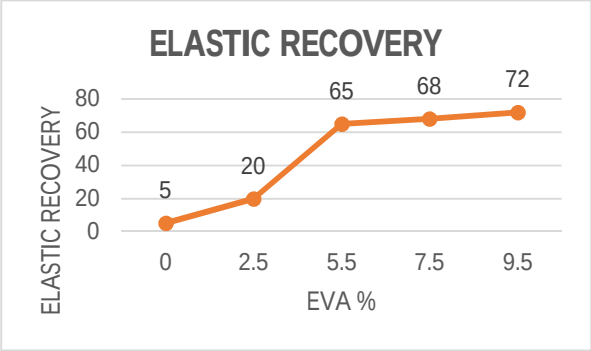


Graph 1: Variation in ductility

Fig 3: Assembly for Ductility

C. Elastic Recovery Test (SP -53 2002)

The elastic recovery is the measured distance of recovery of the bitumen thread after it is cut by Scissors at standard conditions. The elastic recovery test is carried out as per **SP -53 2002** specifications. The elastic recovery test is intended to access the degree of bitumen modification by elastomeric/ plastomeric additives. The test is conducted on a ductilometer to optimize the dosage of polymeric additives in bitumen and also helps in assessing the quality of modified bitumen in laboratory.

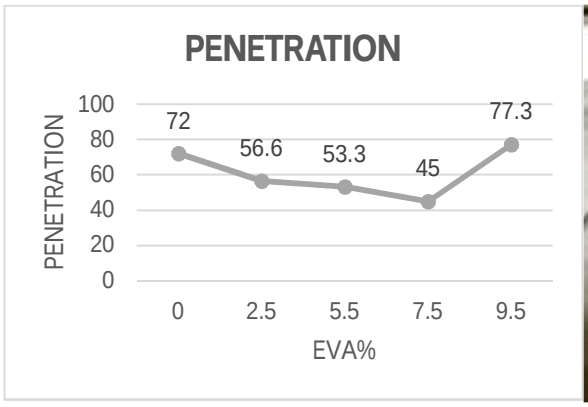


Graph. 2: variation in elastic recovery

Fig.4: Assemly for Elastic recovery

D. Penetration test (IS: 1203-1978)

The penetration of the bitumen is the distance in tenths of a millimeter that a standard needle will penetrate vertically into the sample of the material under standard condition of temperature, load and time. Penetration 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.**



Graph. 3: variation in Penetration

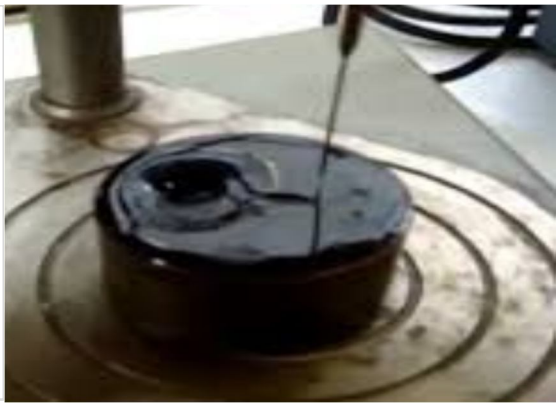
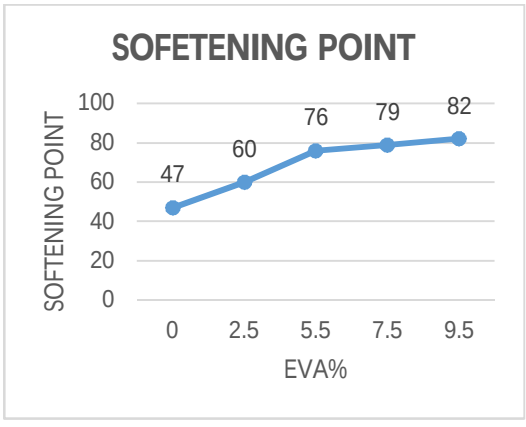


Fig. 5: Assembly for Penetration

E. Softening point test (IS -1205-1978)

The softening point is defined as the temperature at which bitumen attains a particular degree of softening under specified conditions of the test. The test is done as per **IS -1205-1978.** The softening test in laboratory is done on a ring and ball apparatus.

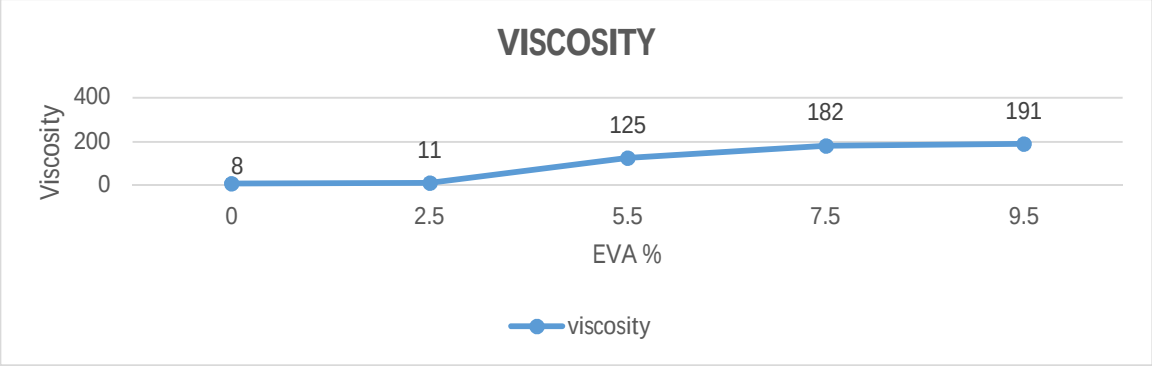


Graph. 4: variation in softening point

Fig. 6: Assembly for Softening point

F. Viscosity test (IS 1206-1978)

The property of a fluid by which it resists flow due to internal friction is called viscosity. Viscosity is the inverse of fluidity. The degree of fluidity at the application temperature greatly influences the ability of bituminous material to spread, penetrate into the voids and also coat the aggregates and hence affects strength characteristics of the resulting paving mixes.

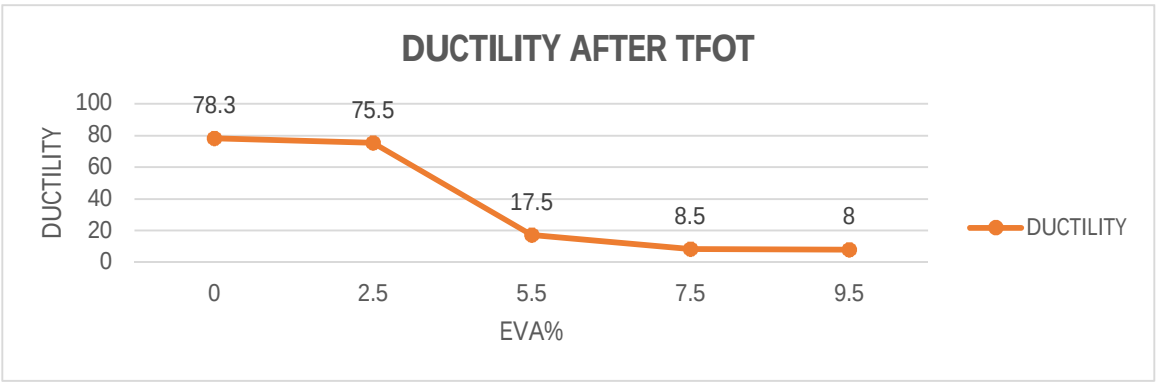


Graph. 5: Variation in viscosity

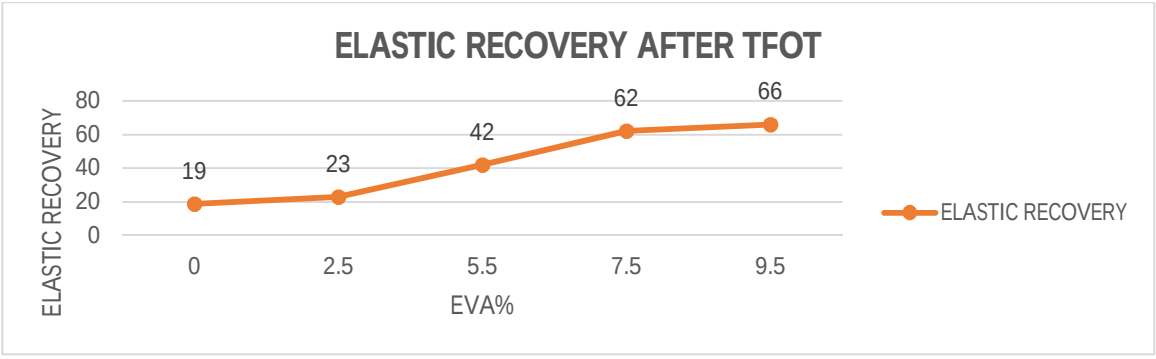
G. Thin Film Oven Test (TFOT) (ASTM D 1754)

The bituminous binders harden when exposed to atmosphere. The test specimen is subjected to accelerated aging process by thin film oven test. Under specified test conditions. The amount of hardening of the bituminous material is evaluated from the reduction in penetration test value, expressed as percentage of original penetration value. The average loss in weight is calculated. The loss in weight of the residue after the thin film oven test is expressed as percentage of the weight of the original binder. The reduction in the penetration value of the residue after TFOT wrt, the original penetration value is expressed as a percentage of the original penetration value of the binder.

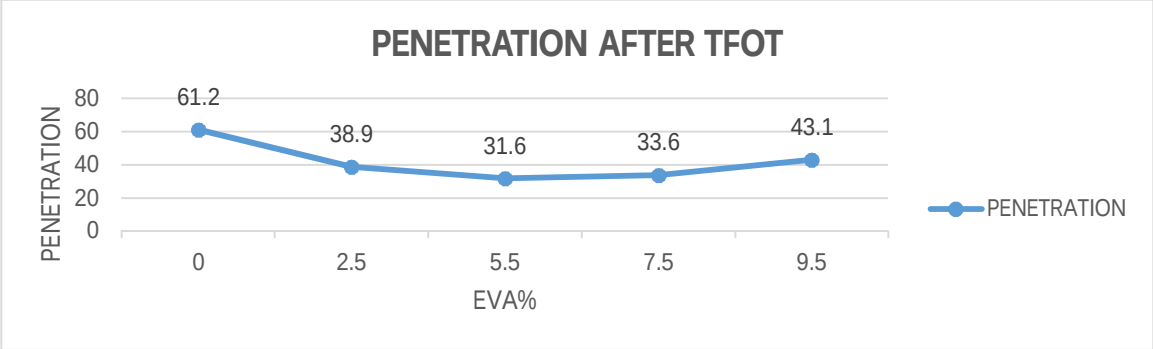
In order to evaluate the properties of the modified bitumen binder due to aging the other tests conducted on the residue after TFOT increase in softening point and elastic recovery test.



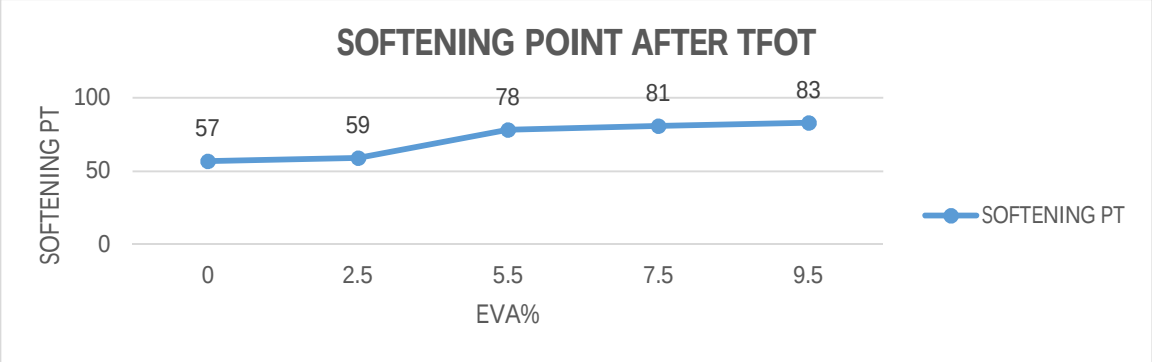
Graph.6: variation in ductility after TFOT



Graph.7: variation in elastic recovery after TFOT



Graph.8: Variation in penetration after TFOT



Graph.9: Variation in softening point after TFOT

Table I: Loss in weight% of modified bitumen after TFOT

Binder Type	Loss in weight% after TFOT	Permissible Results as per IRC: SP: 53-2002
VG 10 + 2.5%EVA	0.02%	1.0% max
VG10 + 5.5% EVA	0.068%	1.0%max
VG10 +7.5%EVA	0.03%	1.0%max
VG10 +9.5%EVA	0.054%	1.0%max

V. CONCLUSION

A. The study shows that the physical properties of virgin bitumen are increased by the modification of EVA polymer.
B. Properties like viscosity, Softening point, and elastic recovery increase.
C. Properties like Ductility, Penetration decrease.
D. The decrease in penetration value indicates that the bitumen becomes harder and due to this the quality of bitumen increases.
E. From the above study it can be conferred that with the use of polymer modified bitumen, the bitumen becomes more resistance to fatigue, thermal resistance, thermal cracking, rutting and temperature susceptibility than neat bitumen.

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