

COMPARATIVE STUDY OF SBS AND EVA POLYMER MODIFIED BITUMEN

Vaishali Gupta¹, Tarushi singh¹, Abhishek Verma², Amit Kumar², Ashish Choudhary², Hardik Anand²

¹ Assistant Professor, Department of Civil Engineering,

Dr. Akhilesh Das Gupta Institute of Technology Management, Shastrri Park, New Delhi-110053

² UG Students (Civil Engineering), Department of Civil Engineering,

Dr. Akhilesh Das Gupta Institute of Technology and Management,

Affiliated to IP University, Shastrri Park, New Delhi-110053

Abstract - Polymer modified bitumen is to provide extra life to pavement, roads and construction designs. The polymer that is added is to modify the properties of bitumen are styrene butadiene styrene (SBS) and Ethylene vinyl acetate (EVA) both of these polymers acts as a binder modification agent. The aim of this study to find those economical ways through which we can alter properties of bitumen to make it much more durable as well as resilient to the temperature changes that occurs in the external environment. In this study we have used to use SBS and EVA polymer at different percentages to modify the properties of bitumen and compare the economical factor that is associated with both these polymers to modify the properties of bitumen through various type of testing.

Key Words: Styrene butadiene Styrene, Ethyl Vinyl Acetate, Binder Modification agent, Economical Factor

1. INTRODUCTION

Bitumen is a by-product of the fractional distillation of crude oil. It has a unique combination of excellent water-proofing and adhesive properties which have been used effectively for more than 5000 years.

It is widely used in roofing, road and pavement applications. However, it is brittle in cold environments and softens readily in warm environments. One of the many methods employed to toughen bitumen is to blend it with polymers, either virgin or scrap, to produce Polymer modified bitumen.

2. LITERATURE REVIEW

In the last thirty years many researchers and development chemists have experimented with modified bitumen mainly for industrial uses, adding asbestos, special filler, mineral fibers and rubber. Their studies are concluded below: -

- **Panda and Mazumdar (2016):** Studied the stability value using 80/100 penetration grade bitumen and Ethylene Vinyl Acetate (EVA) copolymer. The study that there was an increase in stability value in case of polymer modified bitumen. Stability value was high as 14kN in case of polymer modified bitumen. Tensile strength was also increased and stripping properties were improved.

- **Sharma et al. (2014):** studied using 60/70 penetration grade bitumen. Here waste plastic/polymer was used as modifiers. The waste plastic/polymer was added on the aggregate before mixing Optimum Binder Content (OBC) in dry process at 150-160o C temperature. This type of mixing increases the bonding between aggregates coated with plastic/polymer which increases the strength of the bituminous concrete mixes.
- **Gupta and Veeraragavan (2013):** experimented using 60/70 penetration grade bitumen and Styrene Butadiene Styrene (SBS) modified binder. Here tests were conducted by marshal stability test. The test results showed that strength parameters like tensile strength, Marshall stability values of SBS modified mixes were higher than 21% to 25% than that of conventional mixes. Fatigue life of SBS modified binder mix was 2.1% to 2.4% higher than the conventional mix.
- **Kanchan Gowthami and P Gopal (2017):** studied the effects of use of a naturally & locally available fibre called SISAL fibre as an additive in BC. In this study, it was found that OBC for BC turned out to be 5% & addition of SISAL fibre improve the mix properties like Marshall stability & tensile strength of bitumen.
- **Praveen Kumar et al. (2013):** Performed tests using EVA with 60/70 grade bitumen & found that EVA modified bitumen gives higher softening point as well as higher viscosity
- **Sakunthala and Kumara (2014):** studied the feasibility of using PMB in making pavements and recommended that the highway sector in Sri Lanka should move to perform fundamental tests rather than empirical methods.
- **Mohammed Sadique and K.A Patil (2014):** studied the performance of EVA modified bitumen with respect to the bitumen modified by waste low density polyethylene (LDPE) & it is found that the

waste plastic could be better alternative to use for modification of bitumen.

- **Sawant P.A and Kulkarni S.S(2014):** experimented using 60/70 grade bitumen with EVA polymer and crumb rubber to find solutions on potholes and crack formations & found that the addition of EVA & crumb rubber obtained from waste tyres increases the stiffness and improves temperature susceptibility of bitumen.

The primary objective of polymer modified bitumen is to provide extra life to pavement, roads and construction designs. The polymer that is added is styrene butadiene styrene (SBS) and Ethylene vinyl acetate (EVA) both of these acts as a binder modification agent and the qualities exhibited by these polymers are:

Higher rigidity, resistance to deformations, Increased resistance to cracks and stripping, Better water resistance properties, High durability.

3. MATERIALS REQUIRED

- **BASE BITUMEN-** Bitumen (grade 80/100) is used to perform multiple test on bitumen.
- **Aggregate -** Aggregates used for the Marshall stability test according to the calibration chart available with the machinery to perform the Marshall stability test.
- **Ethylene Vinyl Acetate (EVA) -** Ethylene vinyl acetate (EVA) is the copolymer of ethylene and vinyl acetate. Which exhibits low temperature toughness and water proofing properties. The chemical structure of the EVA is

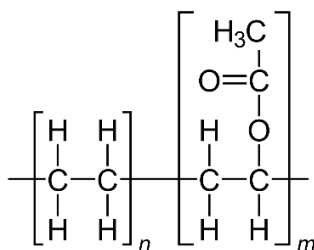


Fig-1: EVA

- **Styrene butadiene styrene (SBS) -** Styrene butadiene styrene is a copolymer of polystyrene as well as of polybutadiene provides increase in stiffness as well as great temperature susceptibility. The chemical structure of SBS is

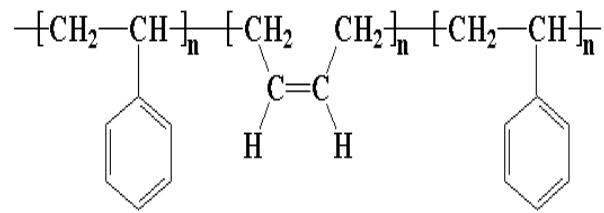


Fig-2: SBS

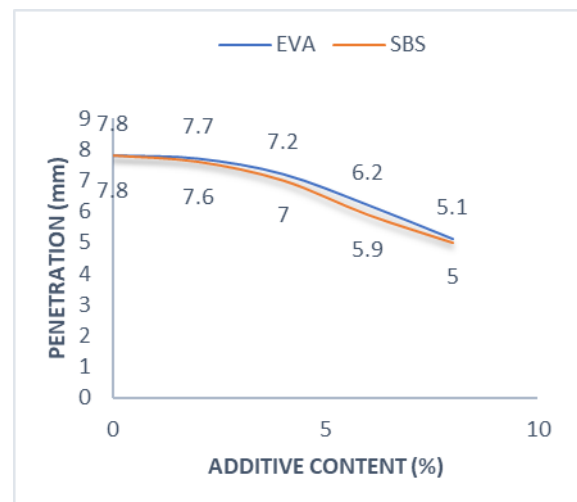
4. EXPERIMENTATIONS

- The behaviour of Bitumen (grade 80/100) is studied by varying the percentage of SBS and EVA polymer (2 ,4,6 & 8 %) then we performed these tests on the bitumen sample -
- Penetration Test
- Softening Point Test
- Ductility Test
- Marshall Stability Test

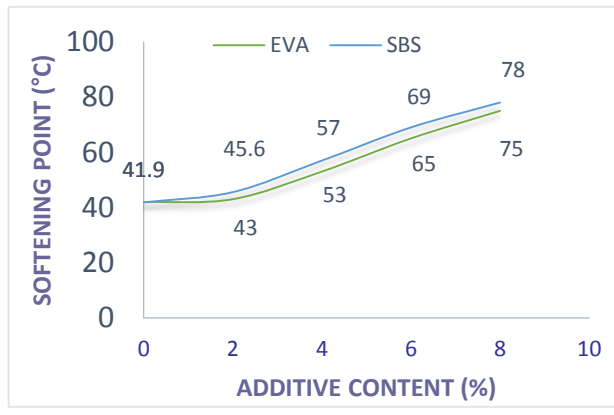
3. RESULTS AND DISCUSSIONS

- The effect of polymers are studied through various experimentations on the bitumen sample.
- The graph in the figure no. 1 shows the penetration value decreases that shows increase in stiffness.
- The graph in the figure no. 2 shows the softening point of bitumen increases with the increase in the polymer content.
- The graph in the figure no. 3 shows ductility value of bitumen is improved in comparison to conventional bitumen.
- The graph shows that the optimum content of bitumen is found at 6 percent for both EVA and SBS polymer.

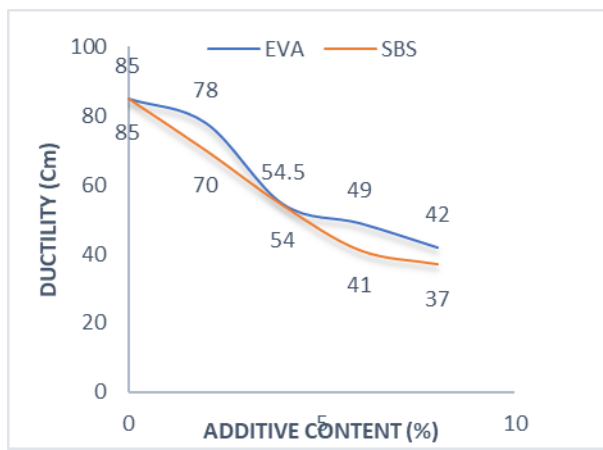
PENETRATION TEST RESULTS



SOFTENING POINT RESULTS

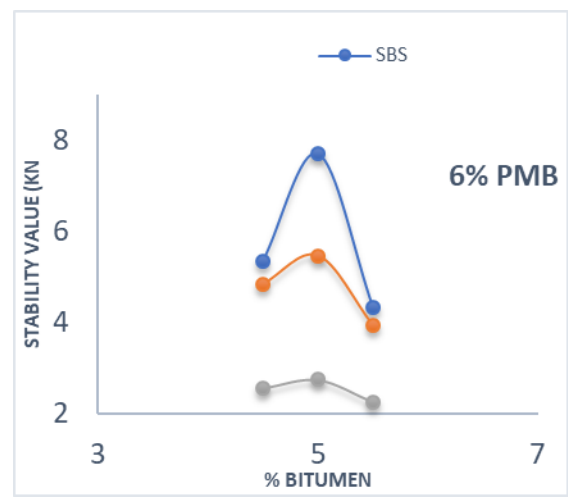
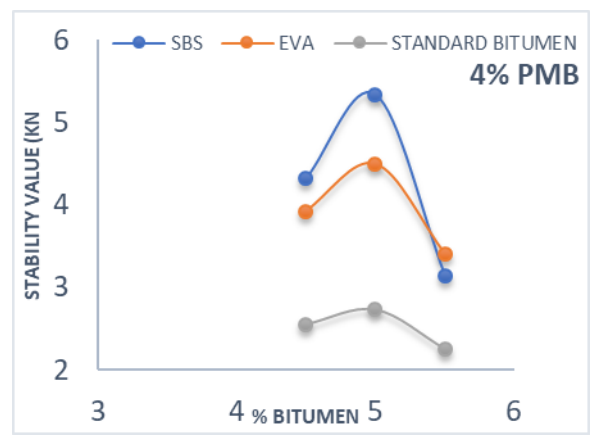
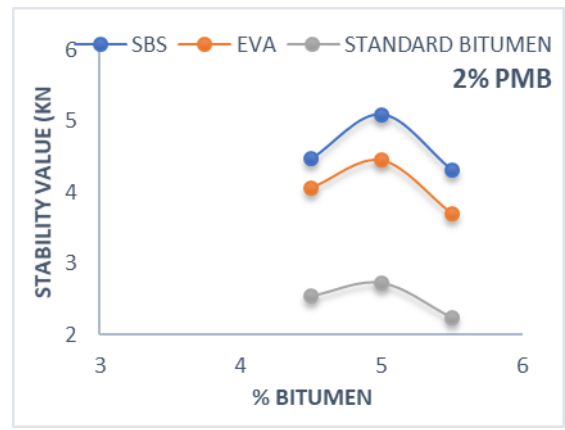


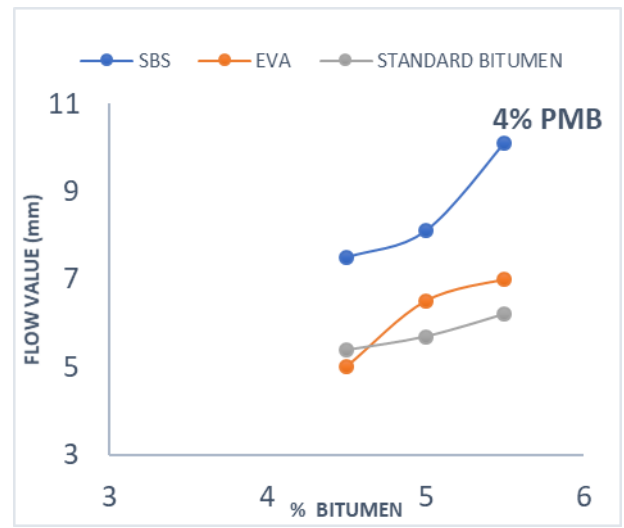
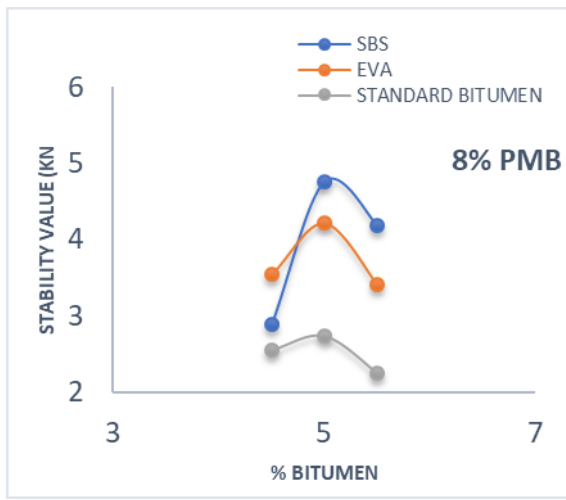
DUCTILITY TEST RESULTS



MARSHALL STABILITY VALUES(KN)

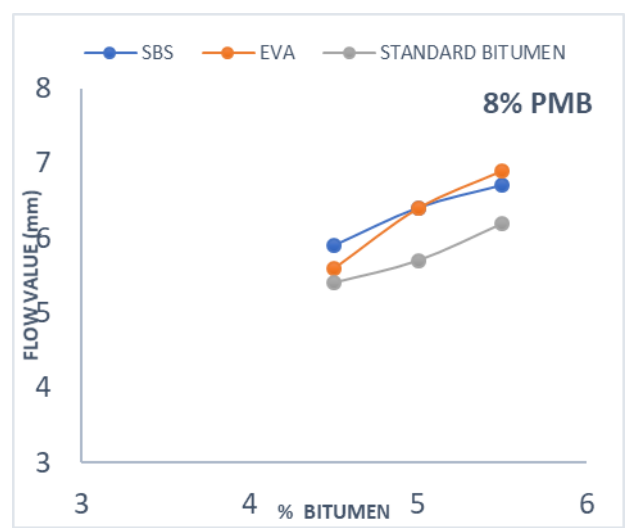
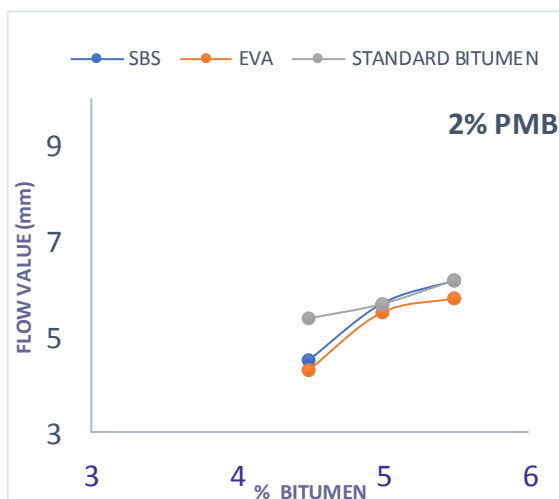
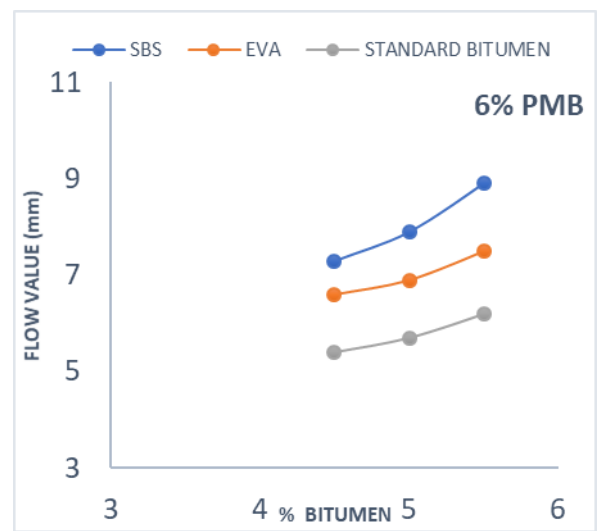
%Bitumen in the sample	4.5	5	5.5
Polymer modified bitumen			
2% SBS	4.472	5.092	4.316
2% EVA	4.056	4.446	3.691
4% SBS	4.316	5.340	3.145
4% EVA	3.925	4.498	3.405
6% SBS	5.340	7.694	4.316
6% EVA	4.836	5.436	3.925
8% SBS	2.885	4.758	4.186
8% EVA	3.535	4.212	3.405





FLOW VALUE RESULTS

%Bitumen in the sample	Polymer modified bitumen		
	4.5	5	5.5
2% SBS	4.5	5.7	6.2
2% EVA	4.3	5.7	5.8
4% SBS	7.5	8.1	10.1
4% EVA	5	6.5	7
6% SBS	7.3	7.9	8.9
6% EVA	6.6	6.9	7.5
8% SBS	5.9	6.7	7.5
8% EVA	5.6	6.4	6.9



4. CONCLUSIONS

- The Sample of EVA and SBS at 2,4,6,8 % with respect to the bitumen, showed only little variation in the readings of Ductility, softening point and penetration test.
- The Flow value of SBS modified bitumen sample at 5.4 % unexpectedly increased, in Marshall Stability Test.
- The Optimum value of Marshall Stability is found to be at 6 percent for both EVA and SBS.
- As the cost of EVA polymer is 160 Rs/kg with respect to the SBS polymer which costs at the rate of 220 Rs/KG according to the Indian market, we found out that EVA polymer is way more economical than SBS polymer to enhance the properties of bitumen .
- This study also reveals that the polymer modified bitumen offer better engineering properties there by increasing the durability of the road to a certain extent and their usage will also serve as a means of managing the waste menace properly.

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