Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 3; August, 2014 pp. 5-8

http://www.krishisanskriti.org/jceet.html

Laboratory Study on SBS Modified Bitumen with Titan Copolymer

Ajay Kumar Mandrwalia[1], Arun Gaur[2], Abhishek Mittal[3]

[1]*Department of Civil Engineering, Manipal University Jaipur, Rajasthan*
[2]*Department of Civil Engineering, Malviya National Institute of Technology, Jaipur, Rajasthan*
[3]*Scientist- Pavement Design and Rehabilitation, CSIR-CRRI, Delhi*

Abstract: **The main objective of the study has been to evaluate the laboratory performance of SBS modified bitumen and its comparative performance when Polyethylene polymer "Titan" mixed with the SBS modified bitumen. The addition of small amount of SBS polymer dramatically changes the visco-elastic properties of the binder. SBS modified binder also requires high blending, mixing and placement temperatures. Therefore for better stability, workability and elastic behaviour of bituminous mixes they may be used in conjugation with other additives such as PE wax and PE Co-polymer (7205 and 7686). It has been established that elastic and tensile properties of bituminous mixes increased by the addition of PE Copolymer.**

1. INTRODUCTION

In India for road and runways flexible pavement with bituminous surfacing are widely used. With an accelerated industrialization and urbanization and to meet their needs the volume of traffic, overloading of axel beyond the permissible limit has been increased. Due to which the performance of flexible pavements have been reduced considerably. Reduced serviceability of bituminous pavement burdens the overall maintenance budget. Therefore the longevity and durability of pavements, must, be ensured in order to reduce the cost of maintenance. Flexible pavements with conventional bituminous binder perform below the acceptance level under heavy traffic loads and volumes in extreme weather conditions. Several studies reported that several measures may be adopted to prevent deterioration process of flexible pavements such as use of high performance materials, effective construction technologies and improved design. The use of high performance bitumen such as SBS modified bitumen provide good solution for such traffic and weather conditions as SBS polymer dramatically changes the visco-elastic properties of the conventional binder. But SBS modified binder also requires high blending, mixing and placement temperatures. Therefore for better stability, workability and elastic behaviour of SBS modified bituminous mixes they may be used in conjugation with other additives. Therefore a study has been undertaken to assess the properties of commercial SBS modified bitumen with Polyethylene polymer i.e. Titan (7686). Objective of the study is to understand the rheological behaviour of SBS modified bitumen with Titan and compare the visco-elastic properties of SBS modified with SBS+Titan modified bitumen on the basis of various performance tests.

2. EXPERIMENTAL

Experimental work of study was carried out under laboratory investigation. The description of experimental work is given as under:

2.1 Laboratory Investigations

Materials: SBS modified bitumen (PMB Grade-40) conforming to IS: 15462 and Polyethylene Copolymer Titan (7686) were used in the study. *The Optimum dose of PE copolymer (Titan) determined was 0.5% by weight* of bitumen. Samples were prepared by using melt blending technique.

Table 1 Physical Properties of SBS and SBS+Titan Modified Bitumen

Properties	Test Methods	SBS modified	SBS+Titan modified
Specific Gravity at 27^{O}C	IS: 1202	.98	.99
Softening point, (R&B), ^{O}C	IS: 1205	68	70
Penetration at 25^{O}C, 100g for 5 sec, 0.1 mm	IS: 1203	35	30
Elastic recovery of half thread in ductilometer at 15^{O}C, %	IS: 15462	70	71
Viscosity at 150^{O}C, Poise	ASTM 4404/ASTM D 2983	8.65	8.85

SBS modified bitumen from Total group

For which SBS modified bitumen was heated to a temperature of 160^{O}C and the optimum dose of PE copolymer (Titan) was added. The temperature was maintained at 160^{O}C. The contents were gradually stirred at 1000 rpm for about 1hrs to produce homogenous mixture. The modified bitumen was cooled to room temperature and suitably stored for testing. The physical properties of SBS modified bitumen and SBS+Titan modified bitumen are given in Table 1.

2.2 Dynamic Shear Rheometer (DSR)

The dynamic shear rheometer (DSR) is used to characterize the viscous and elastic behaviour of binders at medium to high temperatures. The DSR measures a specimen's complex shear modulus (G*) and phase angle (δ). The complex shear modulus (G*) can be considered the sample's total resistance to deformation when repeatedly sheared, while the phase angle (δ), is the lag between the applied shear stress and the resulting shear strain. The larger the phase angle (δ), the more viscous the material. Phase angle (δ) limiting values are:

- For Purely elastic material: δ = 0 degrees
- For Purely viscous material: δ = 90 degrees

The various DSR parameters for SBS and SBS+Titan modified bitumen are presented in Table 2 and 3. Rheological properties of SBS and SBS+Titan modified bitumen are given in Table 4. The data of DSR tests for SBS modified and SBS+Titan modified bitumen are plotted in Fig. 1 and 2

Table 2 Various DSR parameters for SBS modified bitumen at 1kPa value of G*·sin (δ)

Strain	Shear Stress	Storage Modulus	Temperature	Phase Angle	|G*|/sin(δ)	|G*|·sin(δ)
[%]	[Pa]	[Pa]	[°C]	[°]	[kPa]	[kPa]
12.4	160	375	97.6	73.1	1.35	1.24
12.3	131	290	100	74.1	1.1	1.02
12.3	110	235	102	74.9	0.934	0.87

Table 3 Various DSR parameters for SBS+Titan modified bitumen at 1kPa value of G*·sin (δ)

Strain	Shear Stress	Storage Modulus	Phase Angle	Temperature	|G*|/sin(δ)	|G*|·sin(δ)
[%]	**[Pa]**	**[Pa]**	**[°]**	**[°C]**	**[kPa]**	**[kPa]**
12.2	149	397	70.9	106	1.28	1.15
12.2	130	337	71.5	108	1.12	1.01
12.2	113	283	72.2	110	0.971	0.88

Table 4 Rheological Properties of SBS and SBS+Titan Bitumen

Binder Type	Failing Temperature (^{O}C)	G*·sin δ (kPa)
SBS	101	1.0
SBS+Titan	109	0.9

Titan from Honeywell Group

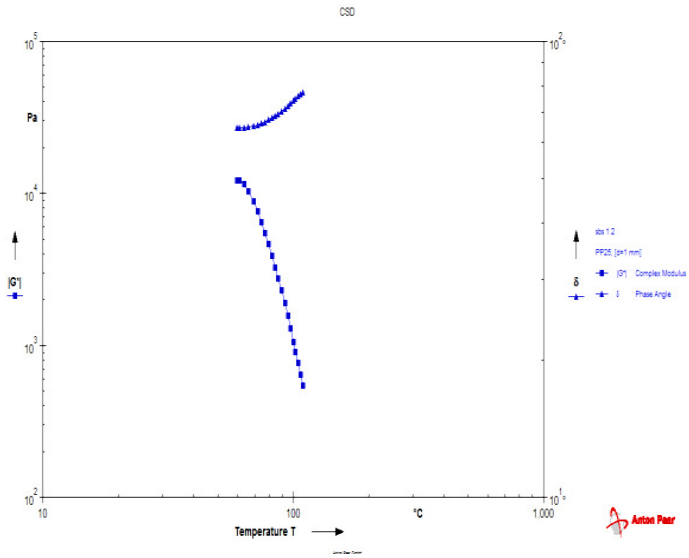

Fig. 1 DSR Graph (G* vs T and δ vs T) for SBS Modified Bitumen

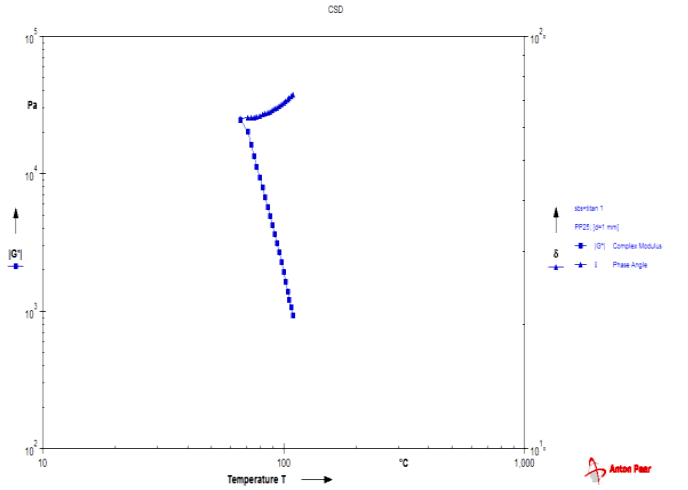

Fig. 2 DSR Graph (G* vs T and δ vs T) for SBS+Titan Modified Bitumen

3. DISCUSSION OF RESULTS

Data of Table 1 indicate the enhanced properties of SBS modified bitumen. It can be seen from the data, titan increases the viscosity and decreases the penetration thus better stiffness at service temperature. Complex shear modulus G*/sinδ is an important parameter and it should be more in order to resist rutting and it can been seen in Table 2 and 3 the value of G*/sinδ for SBS+Titan is more than the value of G*/sinδ for SBS modified bitumen. Similarly the higher value of failing temperature has been observed for SBS+Titan modified bitumen.

4. CONCLUSIONS

a) PE Copolymer (Titan) can be used in conjugation with the SBS modified bitumen as it enhances the elastic properties of binder.

b) As there was no phase separation in SBS+Titan Modified bitumen, it shows PE copolymer (Titan) is compatible with base bitumen and gives a stable homogenous blend and blending of PE copolymer (Titan) with base binder is simple and easy. Blending is done by melt blending technique.

c) Other properties of base bitumen were also found to be improving with the addition of PE Copolymer (Titan) such as increased viscosity.

d) In the present study, the value of G* (complex modulus), G*/sin δ (shear modulus) and failing temperature for SBS+Titan binders are found to be higher than SBS modified binders.

e) The phase angle values clearly illustrate the improved elastic response (reduced δ) of the SBS+Titan modified binders compared to their respective base bitumen.

f) SBS modified bitumen lost their elasticity at 101^{O}C. However, SBS+Titan modified bitumen still display considerable elastic at this temperature.

5. ACKNOWLEDGEMENTS

Author is thankful to Dr. P.N. Sharma, Professor (Manipal University Jaipur) for his invaluable guidance and meticulous attention. Thanks are due to Mr. Shivnaath Mehra for his support and help in collecting data.

REFERENCES

[1] Mandrawalia. Ajay kumar, Laboratory study on SBS modified Bitumen with Titan Copolymer, M.Tech., Thesis, Transportation Engineering, Department of Civil Engineering, MNIT (2013), pp 1-32.

[2] Airey, G.D., Rheological Properties of Styrene Butadiene Styrene Polymer Modified Road Bitumen's, Fuel, Vol 82, (2003), pp 1709-1719.

[3] Gonzalez, O., Munoz, M.E., Santamaria, A., Garcia, M.G, Navarro, F.J. and Partal, P., Rheology and Stability of Bitumen/EVA Blends, European Polymer Journal, Vol. 40, (2004), pp 2365-2372.

[4] IS: 1203-1978 Penetration Tests, IS: 1205-1978 Softening Point Test IS: 1202-1978 Specific Gravity Test.

[5] IS: 15462-2004, polymer and Rubber Modified Bitumen-Specification.

[6] IRC: SP-53-2010. Guidelines on Use of Polymer and Rubber Modified Bitumen in Road construction, Indian road Congress, New Delhi.

[7] Jain, P.K, Sangita, Bose, Sunil and Arya, I.R., Characterization of Polymer Modified Asphalt Binder for Road and Airfields", ASTM STP 1108 (1192), pp.341-355.

[8] Mehndiratta H.C. and Chandra S., Investigation on Bituminous Mixes with Blended Modifiers, Journal of Institution of Engineers, India, Vol 81, (2000), pp 115-119.

[9] Panda M. and Mazumdar M. Development and Evaluation of a Bituminous Paving Binder Containing Reclaimed Polyethylene, Indian Highways, IRC, Vol 25, (1997), pp 11-21.

[10] Singh K. L., Rheological Behaviour of Bituminous Binders for Indian Conditions, Ph.D. Thesis, Transportation Engineering Section, Department of Civil Engineering, Roorkee, (2006), pp 21-230.