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Morphological Analysis of VG-30 Bitumen for Short Term Aging Process using *Styrene-Butadiene-Styrene*- SBS and Nano SiO_2

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Abstract - *This paper audits the utilization of different filler materials with bitumen to build the asphalt life. Maturing of cover is the significant disadvantage of black-top asphalt for long administration life perspective. For the most part maturing of cover is caused because of climatic condition which at last prompts splits on asphalt, rutting, weakness breaks, which can't withstand the changing condition and expanded activity loads, at long last the asphalt of disappointment happens. To beat this issue, adjustment in the properties of VG-30 bitumen was finished by including Elastomer Styrene-Butadiene-Styrene (SBS) and Nano Silica Powder (Nano SiO2) in reasonable measurements. The transient maturing properties of bitumen were explored utilizing slight film broiler test (TFOT). The observational tests including infiltration and softening focuses were directed to check for cover consistency.*

Keywords-: **Bitumen, Aging, penetration and softening point, TFOT, SBS, Nano-SiO2**)

1. INTRODUCTION

1.1 BITUMEN

Bitumen is a viscous fluid, or a strong, or, in other words trichloroethylene and is generously non-unpredictable and diminishes continuously when warmed. It is dark or darker in shading and has waterproofing properties. It is gotten by refinery forms from oil, and is likewise found as a characteristic store or as a part of normally happening black-top. Bitumen is accessible in various levels, for example, VG-10, VG-20, VG-30 and VG-40 (IS:73-2013), however its utilization for the most part relies upon the kind of layer to be developed of asphalt and climatic state of the place. Bitumen isn't just an essential designing material yet additionally a crucial material in asphalt building whose properties changes with time.

Here, the attempt is made to overcome from this problem by studying scientifically the performance related characteristics of unmodified bitumen (VG-30) with and without modifiers in the laboratory also simulating the effect of short term aging.

1.2 Modified Bitumen

A. To improve the properties of bitumen.

B. Polymer modified bitumen is used only in wearing course.

C. Better age resistance.

D. Prevention of reflective cracking.

E. Higher resistance to deformation at high pavement temperature.

F. Higher fatigue life.

1.3 AGING OF BITUMEN

The physical properties of bitumen change with time. It might end up harder or less versatile. Bitumen properties change after some time on presentation to high temperature and climate. This procedure is alluded as Aging. In light of solidifying or hardening of bitumen material, two kinds of maturing have been determined:

1. Short term aging
2. Long term aging

Short-term aging:

This occurs when bitumen is mixed with hot aggregates i.e. during production and construction.

Long-term aging:

This occurs due to environmental exposure and loading i.e. during the life of the pavement.

2. MATERIALS

A. Nano SiO2

Nano-silica with the properties presented in Tables 1, 2, and 3 has been used in this study.

1) Physical properties

Silicon dioxide nanoparticles appear in the form of a white powder. The table below provides the physical properties of these nanoparticles.

Table 1. Physical properties of Nano SiO2

Properties Metric	Properties Metric
Density 2.4/cm	Density 2.4/cm
3	3

2) Thermal properties

Table 2. Thermal Properties of Nano SiO2

Properties Metric	**Properties Metric**
Melting Point 1600°C	Melting Point 1600°C
Boiling Point 2230°C	Boiling Point 2230°C

Table 3. Analysis of Nano SiO2

SiO_2	Na	Fe	Ti	Ca
>99%	<50 ppm	<20 ppm	<120 ppm	<70 ppm

3) Chemical composition

Table 4 Chemical composition of Nano SiO2

Element Content (%)	Element Content (%)
Silicon 46.83	Silicon 46.83
Oxygen 53.17	Oxygen 53.17

4) Uses of Nano SiO2

Nano silica or silicon dioxide nanoparticles are a great deal of research due to their:

A. Stability, low toxicity and ability to be functionalized with a range of polymers.

B. Used as an additive in rubber and plastics, strengthening filler for concrete.

B. STYRENE-BUTADIENE-STYRENE (GRADE GP-1)

Molecular Structure of SBS: Radial

Table shows the chemical composition and thermal properties of SBS respectively.

Table 5 Chemical composition of SBS

Element Content (%)	Element Content (%)
Styrene 30	Styrene 30
Butadiene 70	Butadiene 70

Table 6 Thermal Properties of SBS

Properties	Metric
Melting Point	160°C - 200°C

1) SBS indicates versatile conduct at room temperature yet act as plastic at high temperature.

2) Chilly climate adaptability, high flexibility, hence SBS changed bitumen can be utilized at occupied crossing points, connect decks and Roundabouts for expanded existence of asphalt.

C. *Elementary Analysis of Bitumen*

The elementary analysis of the bitumen binder is presented below in Table.

Table 7 : Elementary analysis of bitumen binder

Component Percentage %	Component Percentage %
Carbon 82-88	Carbon 82-88
Hydrogen 8-11	Hydrogen 8-11
Sulphur 0-6	Sulphur 0-6
Oxygen 0-1.5	Oxygen 0-1.5
Nitrogen 0-1	Nitrogen 0-1

3. OBJECTIVE

1. To evaluate scientifically properties of the bitumen VG – 30 with and without modifier styrene-butadiene-styrene (SBS) and Nano Silica (Nano-SiO2) in suitable dosages before and after short term aging using Thin Film Oven Test (TFOT).

2. To examine the impact of SBS and Nano SiO2, as a modifier substitution.

3. To contemplate the cost viability of altered bitumen when contrasted with slick bitumen.

4. To look at the properties of adjusted and unmodified bitumen by directing traditional and non-regular tests.

4. PRACTICAL EVALUATION

Table 8. Result of binder VG-30 with Nano SiO2: before and after short term aging

Binder Type	Polymer Concentration (%)	Softening Point (°c)	Penetration (mm)	Ductility test (cm)	Specific Gravity	Viscosity (sec)	Loss of Weight (%)
BEFORE AGING							
VG-30		47	48	51	0.98	6.65	NIL
Before aging [VG-30 + Nano SiO2]	2	48	41	63	1.01	7.36	NIL
	4	49	47	71	1.01	8.02	NIL
	6	47	58	82	1.02	8.4	NIL
AFTER AGING							
VG-30		48	47	55	0.99	7.05	0.013
AFTER aging [VG-30 + Nano SiO2]	2	51	40	70	1.04	8.21	0.002
	4	56	44	76	1.04	8.45	0.013
	6	49	53	85	1.05	9.39	0.024

Table 9. Result of binder VG-30 with SBS: before short term aging

Binder Type	Polymer Concentration (%)	Softening Point (°c)	Penetration (mm)	Ductility test (cm)	Specific Gravity	Viscosity (sec)	Loss of Weight (%)
BEFORE AGING							
VG-30		47	48	51	0.98	6.65	NIL
Before aging [VG-30 + SBS	2	57	59	64	1.01	7.36	NIL
	4	59	54	71	1.01	7.89	NIL
	6	60	47	79	1.02	8.4	NIL
AFTER AGING							
VG-30		48	47	55	0.99	7.05	0.013
AFTER aging [VG-30 + SBS	2	60	56	70	1.04	9.21	0.002
	4	61	45	76	1.04	9.52	0.013
	6	64	48	82	1.05	9.39	0.024

CONCLUSIONS

It was difficult to blend Nano SiO_2 with bitumen and heating simultaneously. Softening point increased on increasing the % of Nano SiO2 and was maximum for 4% content after aging. This enabled Bitumen to perform well at high temp and resist deformation for the same. Ductility value of modified bitumen increased rapidly before and after aging. Specific gravity also increased when % of additive was increased. Viscosity also increased for increase in amount of Nano SiO_2. Penetration value decreased considerably. Maximum hardness was achieved for 2%Nano SiO_2. TFOT results showed that loss of weight on heating bitumen added with Nano SiO2 kept on increasing, thus it had noticeable effect of heat.

Good reactivity with bitumen and easy blending. Ductility and Specific gravity also showed good results for the same. Penetration value decreased considerably. Maximum hardness was achieved for 7% SBS. Softening point increased on increasing the % of SBS and was maximum for 7% content after aging. This enabled bitumen to Perform well at high temp and resist deformation for the same. Viscosity also increased for increase in amount of SBS after aging. TFOT results showed that loss of weight on heating bitumen added with SBS kept on increasing, thus it had noticeable effect of heat. Thus, 7% SBS came out to be optimum out of selected amount i.e 3%, 5% & 7%. Thus, before and after aging results of SBS modified bitumen proved to be a promising waterproofing agent.

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