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Experimental Investigation on Structural Stability of Conventional Bitumen Using Rubber and Glass Powder

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ABSTRACT
Bitumen is a binding material and is mostly used various purpose like road pavement and roofing, etc., which has been used for thousands of year in various ways, E.g. as adhesive, sealant, preservative, waterproofing agent and pavement binder. Ancient inhabitants directly used the conventional bitumen which is usually in the earth's surface. The world consumption of bitumen has increased rapidly, most of which was used in road construction. The growth in various types of industries together with population growth has resulted in an increase in production of various types of waste material world over. The creation and disposal of non-biodegradable waste materials such as Rubber, Blast Furnace Slag, Fly ash, Steel Slag, etc. have been posing problems in the developed as well as developing countries. Rubber is everywhere in today's lifestyle. Use this non-biodegradable product is growing rapidly and creating the problem of its disposal. Modified bitumen obtained through mixing of elastomeric as well as plastomeric substances possesses better quality than conventional bitumen. Therefore, these waste Rubber are used to alternate the bituminous mix, to improve the physical properties and structural stability.

Keyword: Bitumen, Rubber, Glass Powder, Stability

I. INTRODUCTION

Bitumen is a black or dark brown non-crystalline solid or viscous material, composed principally of high molecular weight hydrocarbons, having adhesive properties, derived from petroleum either by natural or refinery processes and substantially soluble in carbon disulphide[4]. The modified binder are more stable under heavy loads, braking and accelerating forces and shows increased resistance to permanent deformation in hot weather. It resists fatigue loads and having better adhesion between aggregates and binders. This produces a product with good flexibility, elasticity and adhesion while maintaining high temperature properties that are better than conventional Bitumen[2]. And the rubber that is high in natural rubber content is vulcanized to ensure a greater degree of reaction between the rubber and bitumen at high temperatures. The natural rubber also provides better elasticity and adhesion than synthetic rubber[3]. For this reason a minimum of 30% by mass of the rubber component of the blend must be natural rubber. Non-uniform dispersion requires high temperatures and long mixing times andcan yield a heterogeneous binder, with the rubber acting mainly as flexible filler however crumb rubber is essentially a combination of natural rubber, which improves elasticity, carbon black, and synthetic rubber, both of which improve thermal stability[1]. In addition, crumb rubber has been found to increase rutting resistance and decrease reflective cracking Nevertheless, it was found that natural rubber showed superior reactivity as compared to crumb rubber and that the reacted particles became tacky, which improved adhesion The strong cohesion between aggregates is one of the benefits of using natural rubber to modify asphalt. Natural rubber increases the stiffness of the binder at high temperatures, thereby enhancing the latter's performance,

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Remarkably, natural rubber displays high mechanical strength, outstanding resilience, and excellent elasticity[5]. Bitumen is brittle at low temperatures and turns into liquid at high temperatures, which is called temperature susceptibility. Base bitumen should be modified to reduce its temperature susceptibility. Different materials such as polymers or rubber could be used to improve bitumen quality and reduce its temperature susceptibility[6]. The aim of this study was to evaluate effects of adding RGP on properties of NR modified bitumen. Nowadays, as a result of growth in the production of industrial materials all over the world, generation of different waste materials has been also increased. Therefore, it is essential to develop methods for recycling waste materials. The main objective of this research was to investigate the influences of micro size crushed glass on the physical and mechanical properties of NR modified asphalt binders and mixtures.

II. MATERIALS USED

2.1 Bitumen

Bitumen composed primarily of highly condensed polycyclic aromatic hydrocarbons, containing 95% carbon and hydrogen (±87% carbon and ±8% hydrogen),up to 5% sulfur,1% nitrogen,1% oxygen and 2000ppm metals. Also bitumen is mixture of about 300-2000 chemical components, with an average of around 500-700. It is the heaviest fraction of crude oil, the one with highestboiling point (525°C)[7].

Figure 1 Bitumen Material

2.2 Natural Rubber

A tough elastic polymeric substance made from the latex of a tropical plant or synthetically. Natural rubber, also called India rubber or caoutchouc, is an elastomer (an elastic hydrocarbon polymer) that was originally derived from latex, a milky colloid produced by some plants.

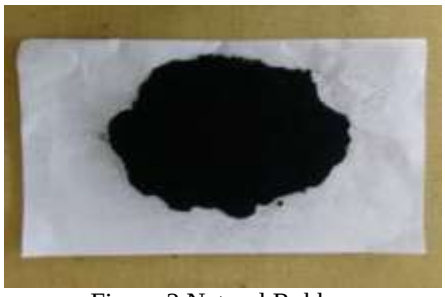

Figure 2 Natural Rubber

2.3 Recycled Glass Powder

Glass powder is finely ground glass. These fine glass particles remind you of talcum powder. Use extreme care when handling this dry powder pigment to prevent breathing the dust particles.

Figure 3 Recycled Glass Powder

III. TEST RESULT

3.1 Ductility Test

The ductility of bituminous material is the distance in centimeters to which it will elongate before breaking when a briquette specimen of the materials is pulled at a specified speed and at specified temperature. The ductility values of bitumen generally vary from 5 to 100cm for different bitumen grade.

Figure 4 Ductility test of Bitumen

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Table 1: Ductility Test Results

Description	Conventional Bitumen	% Of Rubber added	Ductility in (cm)	% Of Glass Powder added	Ductility in (cm)	% of Modified Binder		Ductility in (cm)
						% ofNR	% of RGP	
Initial Reading	0cm	0.1	62.7	0.1	42.7	0.1	0.1	37.2
		0.2	55.4	0.2	43.2	0.1	0.2	35.8
		0.3	47.8	0.3	43.8	0.1	0.3	34.5
Final reading	83.5cm	0.4	35	0.4	44.5	0.1	0.4	36.0
		0.5	30.2	0.5	45.1	0.1	0.5	36.8
	83.8cm	0.6	26.5	0.6	42.3	0.1	0.6	37.3
		0.7	22.3	0.7	41.2	0.1	0.7	37.8
Average	83.65cm	0.8	27.5	0.8	41.8	0.1	0.8	38.2
		0.9	28.2	0.9	42.5	0.1	0.9	38.9
		1	35.7	1	44.2	0.1	1.0	40.3

Table 1 shows the ductility test of conventional and modified bitumen. Rubber and glass powder is added at 0.1 to 1% of Bitumen.

3.2 Viscosity

The viscosity of a liquid is the property that retards flow so that when a force is applied to a liquid; the slower the movement of the liquid, the higher the viscosity in this sense viscosity is the pure measure of consistency.

Figure 5 Viscosity test for Bitumen

Table 2: Viscosity Test Results

Conventional Bitumen	% Of Rubber added	Viscosity in (sec)	% Of Glass Powder added	Viscosity in(sec)	% of ModifiedBinder		Viscosity in (sec)
					% of NR	% of RGP	
Viscosity flowof sample	0.1	29.7	0.1	75.62	0.1	0.1	72.45
	0.2	31.31	0.2	79.84	0.1	0.2	75.24
	0.3	42.28	0.3	81.76	0.1	0.3	76.65
	0.4	47.15	0.4	83.91	0.1	0.4	74.35

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is 28.4 sec Viscosity at 60 degree,poises: 2000 ± =500 135 degree min:300	0.5	60.01	0.5	85.65	0.1	0.5	72.41
	0.6	84.32	0.6	67.97	0.1	0.6	70.64
	0.7	97.25	0.7	52.5	0.1	0.7	67.50
	0.8	77.69	0.8	46.50	0.1	0.8	66.91
	0.9	71.75	0.9	49.75	0.1	0.9	64.76
	1	65.25	1	53.74	0.1	1	63.97

Table 2 shows the viscosity test of conventional and modified bitumen. Rubber and glass powder is added at 0.1 to 1% of Bitumen.

3.3 Softening Point

Softening point is the temperature at which the substance attains a particular. Degree of softening under specified conditions of test. The softening point of bitumen ranges 30°C to 80°C. Here we taken the bitumen softening point value is 41.35°C

Figure 6 Softening test for Bitumen

Table 3: Softening Test Results

Description	Conventional Bitumen	% Of Rubber added	Softening point in (°C)	% Of Glass Powder added	Softening point in (°C)	% of Modified Binder		Softening point in (°C)
						% of	% of	
When the first ball touch the bottom	40.2	0.1	43.5	0.1	52.2	0.1	0.1	58.15
		0.2	47.2	0.2	56.1	0.1	0.2	58.49
		0.3	48.3	0.3	59.3	0.1	0.3	60.25
When the second ball touch the bottom	42.5	0.4	50.1	0.4	62.5	0.1	0.4	59.35
		0.5	52.5	0.5	65.2	0.1	0.5	57.4
		0.6	53.5	0.6	42.7	0.1	0.6	56.8
		0.7	57.1	0.7	41.4	0.1	0.7	54.42
Average	41.35	0.8	54.15	0.8	40.5	0.1	0.8	54.2
		0.9	49.9	0.9	43.4	0.1	0.9	54.45
		1	44.3	1	45.7	0.1	1	55.3

Table 3 shows the softening test results of conventional and modified bitumen.

3.4 Penetration Test

Penetration value is a measure of hardness or consistency of bituminous material. It is the vertical distance traversed or penetrated by the point of a standard needle in to the bituminous material under specific conditions of load, time and temperature. This distance is measured in one tenths of a millimeter. This test is used for

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evaluating consistency of bitumen. It is not regarded as suitable for use in connection with the testing of road tar because of the high surface tension exhibited by these materials.Table 4 shows the penetration test results of conventional and modified bitumen.

Figure 7 Penetration test for Bitumen

Table 4: Penetration Test Results

Description	Conventio nal Bitumen	% Of Rubber added	Penetration in (cm)	% Of Glass Powder added	Penetration in (cm)	% of Modified Binder		Penetration (cm)
						% ofNR	% of RGP	
Initial Reading	0	0.1	22.5	0.1	33.15	0.1	0.1	27.82
		0.2	23.67	0.2	33.47	0.1	0.2	28.48
	0	0.3	26.07	0.3	33.64	0.1	0.3	31.50
	0	0.4	28	0.4	33.97	0.1	0.4	30.25
		0.5	29.67	0.5	34.2	0.1	0.5	28.87
Final reading	21.2	0.6	32	0.6	30.73	0.1	0.6	28.05
		0.7	33.63	0.7	29.12	0.1	0.7	26.94
	23.8	0.8	31.25	0.8	28.73	0.1	0.8	25.65
	19.7	0.9	29.75	0.9	32.84	0.1	0.9	27.52
		1	30.15	1	34.07	0.1	1	28.95

3.5 Marshall Stability Test

Marshall Stability test, the resistance to plastic deformation of cylindrical specimen of bituminous mixture is measured when the same is loaded at the periphery at a rate of 5 cm per minute.The test procedure is usedin the design and evaluation of bituminous paving mixes. Marshall Test gives Stability, Flow, Density, Voids in Total Mix (VTM), Voids in the Mineral Aggregate (VMA), Voids Filled with Binder (VFB)

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Table 5: Results of Conventional Bitumen, Rubber Binder & Glass Powder Mix Design

Results of Conventional Bitumen, Rubber Binder & Glass Powder Mix Design								
Sl.No	**% Bitumen**	**Marshall Stability Value (kN)**	**Flow Value (mm)**	**Bulk Density (Gm)**	**Air Void % (Vv)**	**% of Bitumen (Vb)**	**VMA**	**VFB**
1	4	932.8	3.68	2.087	1.556	8.108	9.664	83.895
2	4.5	966.72	3.98	2.052	2.659	8.927	11.586	77.050
3	5	953.25	3.82	2.055	1.988	9.887	11.875	83.259

Table 5 gives the Marshall Stability value of Conventional Bitumen, Rubber Binder & Glass Powder.

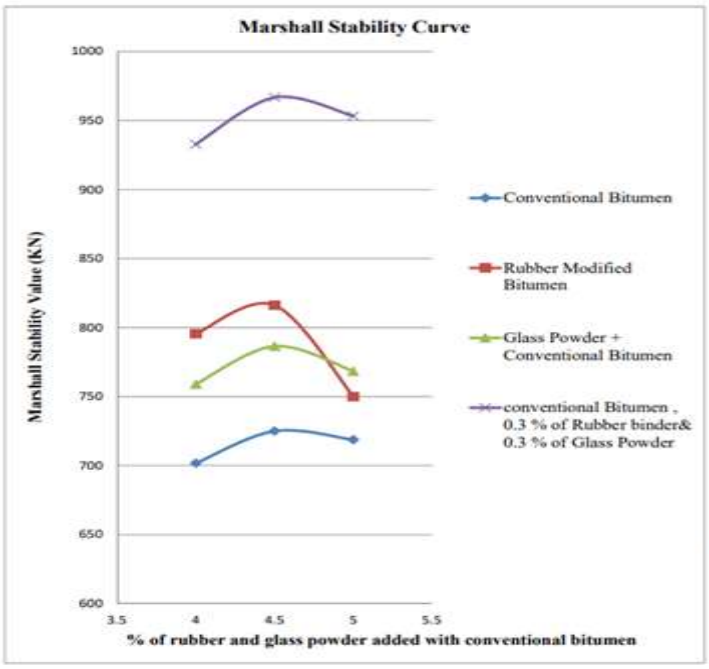

Figure 8 Marshall Stability Curve

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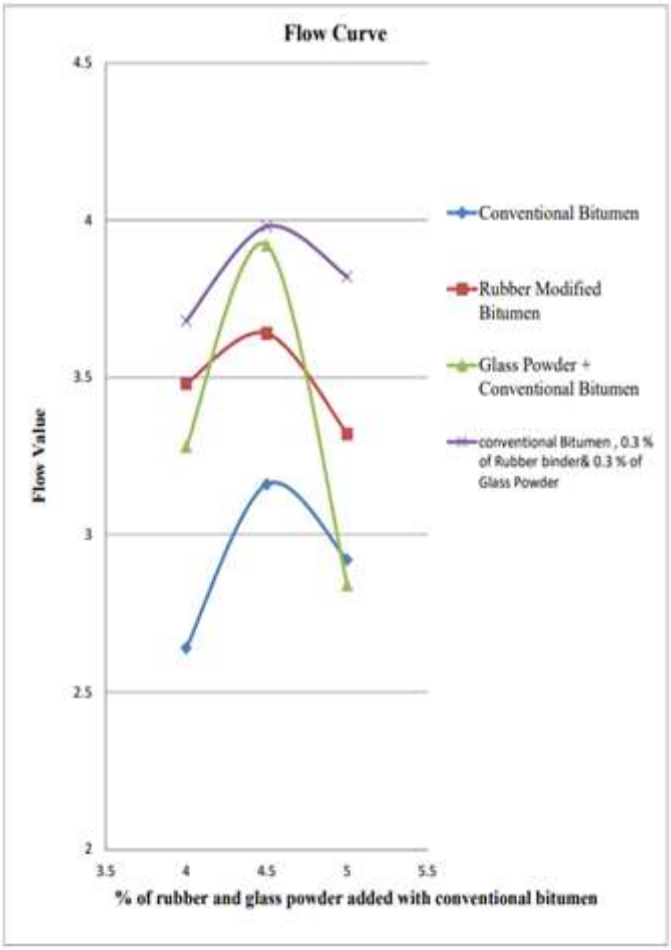

Figure 9 Flow Curve

IV. CONCLUSION

- From this study we have inferred that the properties of ModifiedBinders.
- Viscosity, ductility, penetration, softening point, Marshall Stability and flow test of the various bituminous mixes was carried out using of different admixtures such as rubber and glass powder. The modified bitumen binder has proved to be higher stability than that of the conventional bitumen.
- When compared to conventional bitumen the stability value ofbitumen is increased by
- 12.5% by adding Natural Rubber with Bitumen mix
- 8.4% by adding Glass Powder with Bitumen mix
- 33.3% by adding Natural Rubber and Glass Powder withBitumen mix

Therefore from this above study we concluded that addition of Natural Rubber and Glass Powder increases the structural stability ofBitumen.

REFERENCE

[1]. A.Ananthakumar, K.Anisha, M.Aishwarya, R.Indhumathi, S.Malathi, "Performance of Asphalt Mixture using Waste Materials" International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249-8958 (Online), Volume-9 Issue-3, February 2020.

[2]. Teerthananda Sagar C , Kavitha , Sultan Fayaz , Ashwini C Goudathi "Experimental Investigation on Partially Replacement Of Bitumen With Waste Materials For Flexible Pavement Construction", Research Gate, Volume-6, Issue-6, 2019.

[3]. Farag Khodary, "Experimental Study of using Waste Glass as additives in Asphalt Concrete Mixtures", International Journal of Advances in Scientific Research and Engineering (ijasre), Volume 4, Issue 12 December – 2018.

[4]. Murryam Hafeez, Naveed Ahmad, Mumtaz Ahmed Kamal "Experimental

Investigation into the Structural and Functional Performance of Graphene Nano-Platelet (GNP)-Doped Asphalt" 17 February 2019, https://doi.org/10.3390/app9040686.

[5]. Rafi, J.; Kamal, M.A.; Ahmad, N.; Hafeez, M.; Faizan, M.; Asif, S.A.; Shabbir, F.; Bilal, S.; Zaidi, A. Performance Evaluation of Carbon Black Nano-Particle Reinforced Asphalt Mixture. Appl. Sci. 2018, 8, 1114.

[6]. Li, J.; Han, M.; Muhammad, Y.; Liu, Y.; Yang, S.; Duan, S. Comparative analysis, road performance and mechanism of modification of polystyrene graphene nanoplatelets (PS-GNPs) and octadecyl amine graphene nanoplatelets (ODA-GNPs) modified SBS incorporated asphalt binders. Constr. Build. Mater. 2018, 193, 501–517.

[7]. Aditya Dapurkar, Akshay Gunjal, Omkar Lokhande"Comparative Study On Effects Of Crushed Waste Glass In Bituminous Mix", International Research Journal of Modernization in Engineering Technology and Science, Volume:04/Issue:07/July-2022.