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STUDY ON SHREDDED TYRE RUBBER MIXED WITH BITUMENS MIX FOR ROAD ASPHALT MIXTURES

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Abstract

Now a day's construction cost of road materials are quit increasing day by day so its necessity of time is to use the low cost materials or wastage to optimize the cost of road construction. Rate of increase of Tyre waste of automobiles is a big issue, so the tyre waste of automobile vehicles are easily available and shredding of rubber is also done in a very low cost to obtained the shredded crumb rubber. Now the aim of this study is to reduce the scrap tyre waste by using it in bituminous mix for flexible pavement, somehow it may also reduce the today's cost of road construction. The idea behind this study is that the shredded crumb rubber is added in different proportions (10%, 15% & 20%) in a bituminous mix to prepare a Crumb Rubber Bituminous mix (CRBM). Further the strength and stability characteristics (Marshal Stability test) of this Crumb Rubber Bituminous mix is determined and anlysed. Mixing temperatures of 155°C and 150°C were adopted for modified binders (CRBM) and 80/100 neat binder respectively. Five different binder contents were chosen for testing, they are 4.5, 5.0, 5.5, 6.0 & 6.5% by weight of aggregate.

Keywords: *Shredded crumb rubber, Crumb Rubber Bituminous mix (CRBM), Marshal Stability test.*

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1. INTRODUCTION

Roads are considered one of the most important aspects of infrastructure and play an important role in our daily lives. In road masonry construction, the use of latex rubber for bituminous binder conversion is recognized as a viable sustainable development solution for waste recycling. In addition, the amount and increase in landfill disposal of waste tires is a major problem that leads to environmental pollution. Rubber debris found in discarded tire disposals has been shown to improve the performance of 1840s transparent bitumen. It can be used as an inexpensive and environmentally friendly conversion system to reduce road damage caused by increased numbers of service vehicles, stress on axles, and low-end maintenance services that quickly brought road construction to a halt. Using waste rubber results in better road conditions, a better ride, and less maintenance.

A major problem with crumb rubber mix mixtures made by both dry and wet processes is the lack of cohesion. This is mainly due to poor interaction between crumb rubber and bitumen. This reduces moisture resistance, causes spalling of the aggregate, and reduces the pavement's load-bearing capacity. A major drawback of incorporating rubber crumbs into bitumen mixtures is that becomes unstable when mixed with bitumen. particle size of the granules, method of obtaining the rubber granules, percentage of the rubber granules added to the mixture, composition of the rubber granules, degree of penetration, etc.). bitumen softening point, bitumen composition, etc.) and mixture properties (mixing time and type, temperature, etc.). As a result, there are a great many variables in manufacturing crumb rubber mix mixtures, which also means that the results are highly sensitive when the process is applied.

Regarding wet processes, there are many studies and experiments showing the influence of the aforementioned variables, resulting in a set of reference values for the optimum properties (size, composition, etc.) of crumb rubber. , type, etc.), mixing temperature and time, bitumen properties [31–33]. Research studies have also been conducted in recent years to determine the effect of such variables on the properties of dry process asphalt mixtures, with the aim of promoting the use of dry process. As a result, studies on the effect of decay time (the time required for crumb rubber to interact with bitumen to obtain optimal properties) are currently underway.

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Bitumen is often used as a raw material for flexible road construction. Different bitumen brands such as 30/40, 60/70, 80/100 are available depending on the starting price. The ever-increasing service life of vehicles in the commercial vehicle sector, with their large daily and seasonal variations, necessitates improved traffic signage. Improved binder materials are a prerequisite. The preferred range of bitumen permeability in this study was 60/70, which is commonly used as a paving grade bitumen suitable for the construction of flexible corridors with high-rise structures.

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Imports waste rubber from tire factories. It has the shape of a black mouse and is also used by used tiers.Crum rubber is reclaimed rubber obtained by mechanically crushing or pulverizing small cracked rubber tires. Tires are made from a variety of rubber chemicals. The main variations are rubber content, natural rubber content, total rubber hydrocarbon content, and acetone extraction. Ash and carbon content are generally similar for various rubber tire compounds.

In addition to the potential uses, approximately 300 million tons of tires are produced annually in the United States alone, of which approximately 13% end up in landfills in Europe, and 355 million tires are produced annually, with hundreds of Thousands of used tires are discarded. illegally disposed of or maintained; Proper disposal of tires can be very dangerous to human health and increase environmental hazards. Fortunately, tire waste is used for many technical purposes these days.

In 2010, around 200,000 tonnes of end-of-life tires (EOL) were collected across Spain for reuse, recycling and energy recovery. In this study, the crumb rubber modified binder (CRUMB RUBBER MIXB) used in the bituminous mixture uses scrap tires, so this type of wear course could be a viable application for these wastes. The use of rubber powder on roads is justified as it provides advantages in bituminous mixtures. The addition of crumb rubber improves temperature sensitivity and permanent set resistance as it increases the compound's elasticity at operating temperatures.

Advantages of crumb rubber bituminous mix modified bitumen can include following for road works:

1. Lower susceptibility to daily & seasonal temperature variations.
2. Higher resistance to deformation at elevated pavement temperature.
3. Better age resistance properties.
4. Higher fatigue life of mixes.
5. Better adhesion between aggregates & binder.
6. Prevention of cracking & reflective cracking.
7. Overall improved performance in extreme climatic conditions & under heavy traffic conditions.

2. MATERIAL USED

Aggregates

The coarse aggregates of varying size are sieved by passing through 26.5 mm and retained on a 2.36 mm sieve while fine aggregate should comprise 100% of fine crushed sand passing the 2.36 mm sieve and retained on 0.075mm sieve.

Mineral fillers

Mineral fillers have substantial influence over the properties mix design. Filler should comprise of finally divided mineral such as rock dust or hydrated lime. The utilization of hydrated lime is encouraged because of its very good anti-stripping and anti-oxidant properties. Fillers used are lime and sand in bituminous mix specimen.

Bitumen

Bitumen is the by-product of petroleum and its grading depends upon its penetration value and viscosity grade for different climatic factor and nature of duty. It is utilized to build additional heavy duty bitumen pavement that need to persevere through considerable substantial traffic loads.

Figure 1. Bitumen VG30

Crumb rubber

Crumb rubber is actually small pieces of waste tire scrapped from light motor vehicles and whose disposal is a serious menace. The annual available capacity for procured tires retreading is 4.8 million for bus and truck tires and 4.5 million for car and jeep tires. The crumb rubber is made by shredding scrap tire, which is a particular material free of fibre and steel. The rubber particle is graded and found in many sizes and shapes. The crumb rubber is described or measured by the mesh screen or sieve size through which it passes during the production process. To produce crumb rubber, generally, it is important to reduce the size of the tyres.

Figure 2. Crumb Rubber

3. EXPERIMENTAL PROGRAM

The Following tests were performed as per IRC Recommendation to find the various properties of mix are as follows:

- Specific gravity test
- Penetration index test
- Softening point test
- Ductility index test
- Ductility index test
- Marshall Stability test
- Modification of Bitumen is done by two ways, they are;
  - Wet mix process
  - Dry mix process

4. RESULTS

Table 1. Physical Properties of Unmodified and Modified Samples

S. No.	Experiment Name	(80/100) Unmodified Bitumen sample	Crumb Rubber type	% Crumb Rubber		
				10	15	20
1.	Penetration (1/10 mm)	91	Clean	61	56	54
			Unclean	62	55	54.5
2.	Softening Point (0 C)	42	Clean	47	48	49
			Unclean	47	49	50.5
3.	Ductility Value (cm)	98	Clean	67	61	58
			Unclean	59	55	46
4.	Elastic Recovery (%)	30.5	Clean	46.5	56	58
			Unclean	48.6	53.5	55
5.	Flash Point (0 C)	330	Clean	336	336	335
6.	Specific gravity	1.03	Clean	1.027	1.032	1.032

Table 2. Marshall Properties of 80/100 Bitumen, Clean & Uncleaned Crumb Rubber

Binder	Binder/aggregate in mix	Density (gm/cc)	Stability (kN)	Flow (mm)
Clean				
	4.5	2.62	11.83	3.53
	5.0	2.63	11.96	3.36
	5.5	2.61	11.86	3.95
	6.0	2.60	9.23	5.31
	6.5	2.60	8.70	5.73
Unclean				
	4.5	2.59	11.32	4.43
	5.0	2.60	10.80	4.48
	5.5	2.60	10.15	5.25
	6.0	2.61	9.35	5.45
	6.5	2.60	9.22	5.70
80/100				

	4.5	2.60	12.17	3.30
	5.0	2.60	12.65	3.47
	5.5	2.61	9.47	2.92
	6.0	2.63	9.77	4.37
	6.5	2.59	8.85	6.18

Table: Marshall Properties of 80/100 Bitumen, Clean & Uncleaned Crumb Rubber

Binder	Binder %	VMA %	VA %	VFB %
Clean				
	4.5	14.91	7.45	50.31
	5.0	14.52	6.26	57
	5.5	14.38	5.40	62.65
	6.0	14.99	5.35	64.50
	6.5	14.60	4.23	70.99
Unclean				
	4.5	14.90	7.47	50.17
	5.0	14.80	6.60	55.60
	5.5	14.50	5.57	61.67
	6.0	14.40	4.73	67.17
	6.5	14.57	4.27	70.83
80/100				
	4.5	15	7.27	50.63
	5.0	14.57	6.27	56.80
	5.5	15.27	5.83	60.57
	6.0	14.60	4.87	66.57
	6.5	14.97	4.43	69.70

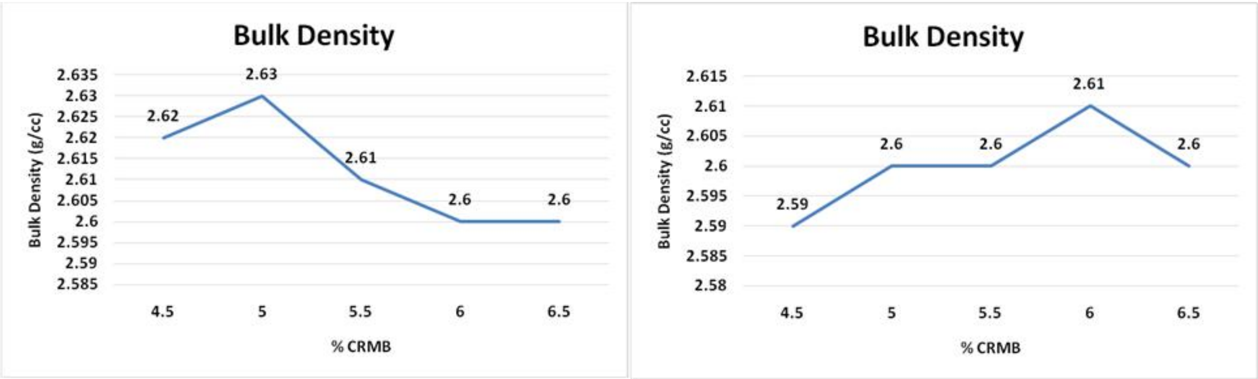

Figure 3. Bulk Density of the samples with different proportion of clean crumb rubber bitumen and unclean crumb rubber bitumen

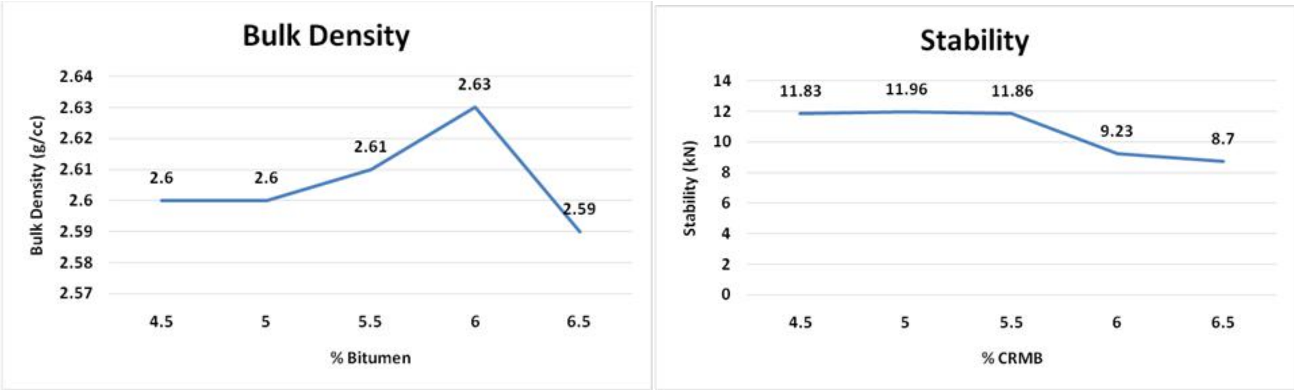

Figure 4. Bulk Density of the samples with different proportion of bitumen clean crumb rubber bitumen

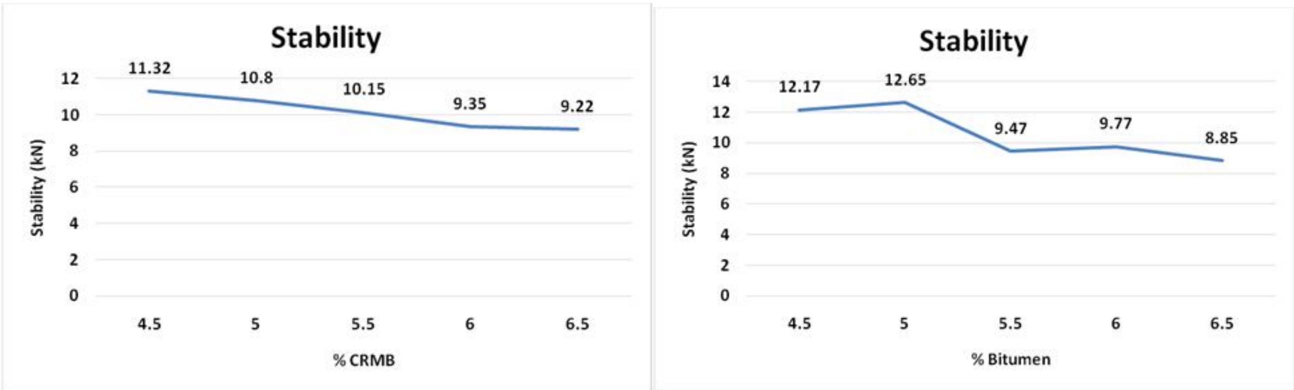

Figure 5. Stability of the samples with different proportion of unclean crumb rubber bitumen and Bulk Density of the samples with different proportion of bitumen

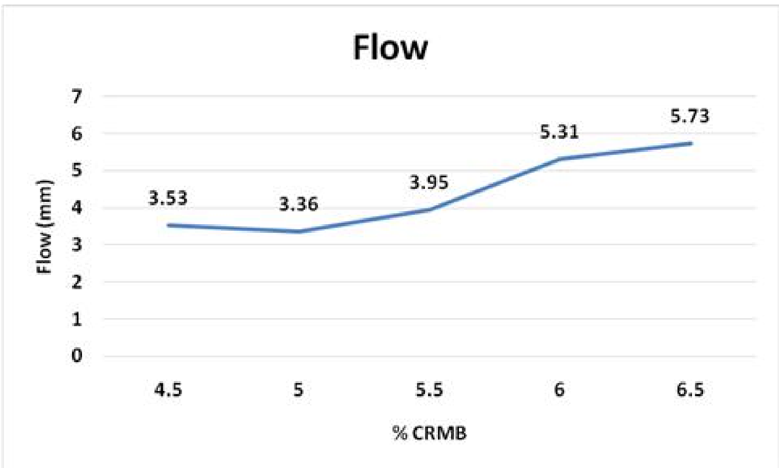

Figure 7. Flow value of the samples with different proportion of clean crumb rubber bitumen

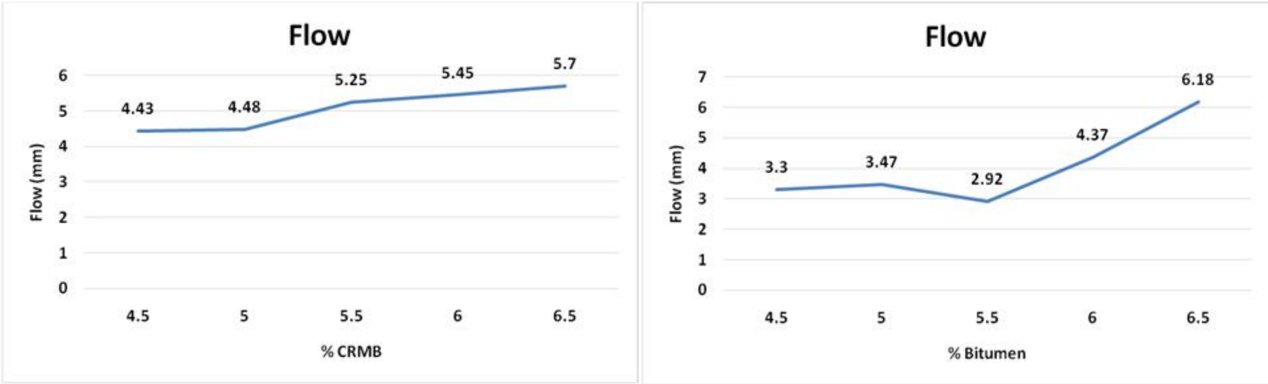

Figure 8. Flow value of the samples with different proportion of unclean crumb rubber bitumen and only bitumen

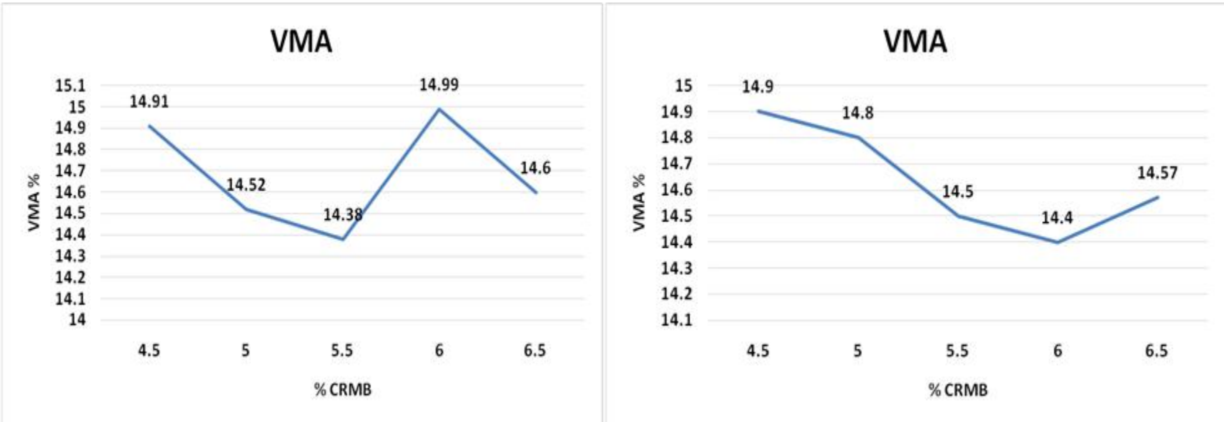

Figure 9. VMA of the samples with different proportion of clean crumb rubber bitumen and unclean crumb rubber bitumen

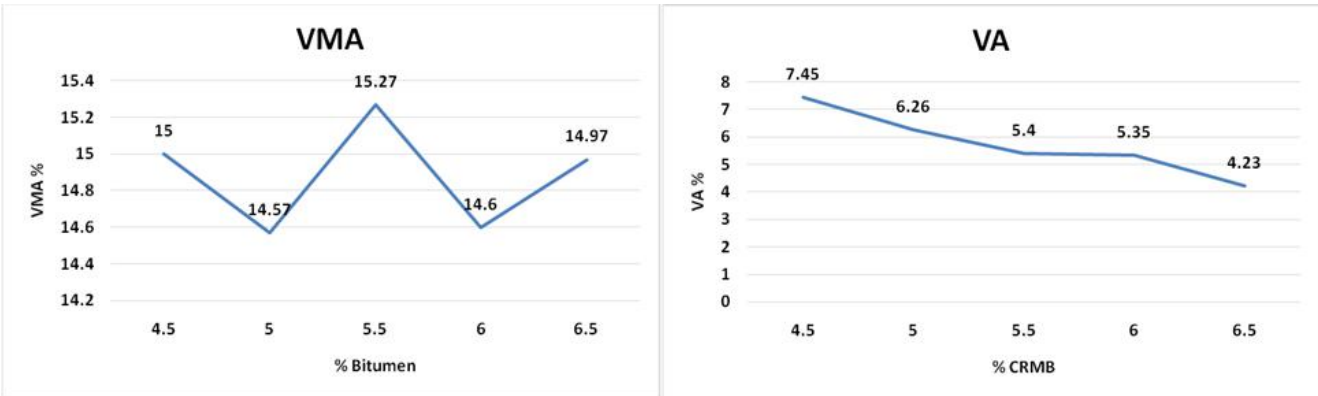

Figure 10. VMA of the samples with different proportion of bitumen and clean crumb rubber bitumen

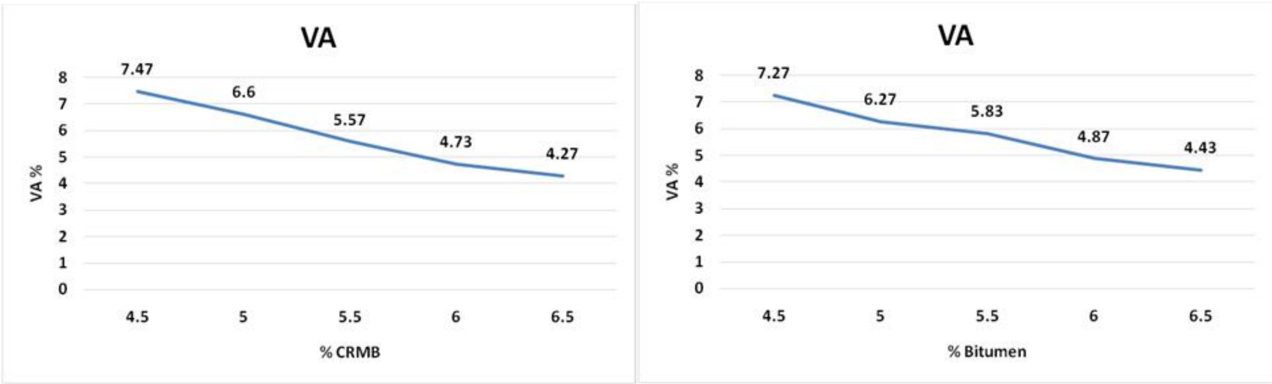

Figure 11. VA of the samples with different proportion of unclean crumb rubber bitumen

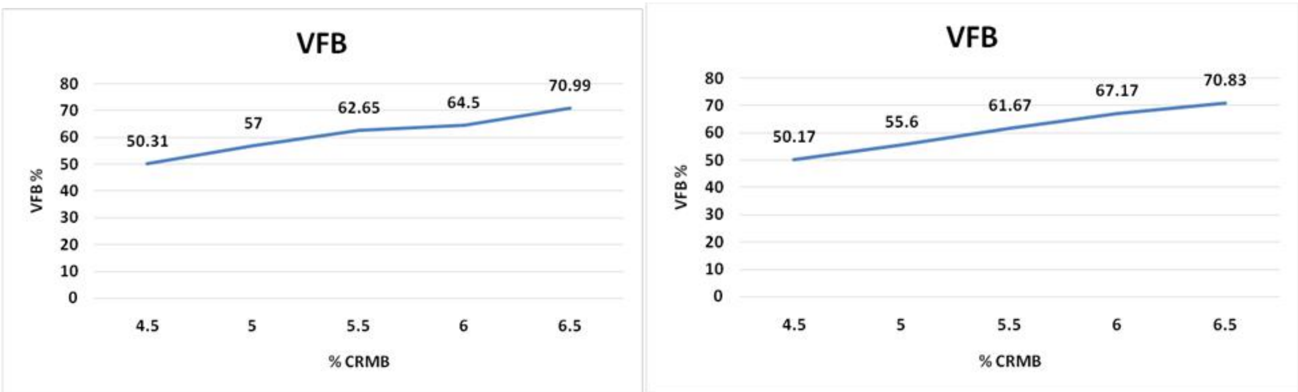

Figure 12. VFB of the samples with different proportion of clean crumb rubber bitumen and unclean crumb rubber bitumen

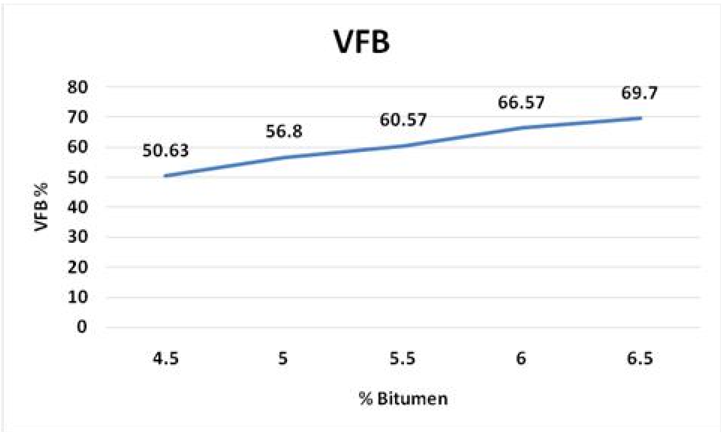

Figure 13. VFB of the samples with different proportion of bitumen

5. CONCLUSION

- There is little improvement in the flash point and specific gravity values of the modified binder, compared to the neat bitumen

- Marshall stability values of mixes with clean modified binder are slightly greater than those of mixes with 80/100 bitumen, even though the flow values decreased for mixes with clean modified binder compared to 80/100 binder no fixed trend was observed.
- Optimum blending time was found to be ¼ hr. mixing + 1 hr. reaction + ½ hr. mixing , for mixing temperature of 165 °C, tire shred size of 1cm X 1cm (and tire shred concentration of 15%).
- 15% tire shred concentration was found to be optimum, as the improvement in the binder properties beyond this (15%) is not significant for mixing temperature of 165 °C and blending time of ¼ hr. mixing + 1 hr. reaction + ½ hr. mixing

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