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Mix Design of Bituminous Road Using Crumb Rubber

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***Abstract*— The growth rate of vehicles is the backbone of economic development of any country. India is the second fast growing automobile industry in the world. In today's era, solid waste management is the thrust area. On the other side, the traffic intensity is also increasing. As a result amount of waste tyres is also increasing. Today these are generally disposed by burning and landfilling. The main objective of this study is to determine the effects of crumb rubber on bituminous mix. An attempt has been made to use Crumb Rubber; blended using wet process .Marshall method of bituminous mix design was carried out for varying percentages of Crumb Rubber to determine the different mix design characteristics. Marshall's was carried out by changing the crumb rubber content at constant optimum binder content and subsequent tests have been performed to determine the different mix design characteristics. This has resulted in much improved characteristics when compared with straight run bitumen. Crumb rubber modification has shown the ability to improve the rutting resistance, resilience modulus, and fatigue cracking resistance of asphaltic mixes. This is due to the alteration to the property of the bituminous binder in terms of the viscosity, softening point, loss modulus, and storage modulus. Use of crumb rubber also leads to excellent pavement life, driving comfort and low maintenance**.

***Index Terms*— bitumen, Crumbrubber ,marshallstability ,mixdesign.**

I. INTRODUCTION

As it is estimated that about 60% of waste tyres causes land pollution in both urban and rural areas and per capita land is decreasing in India due to this hazardous waste, it is either land filled or incinerated which cause land and air pollution if this waste is mixed in to bitumen to improve the quality of road it would prove itself as an eco-friendly characteristics. By using the waste Crumb Rubber as a modifier the properties of bitumen will be change and this change in physical properties like softening point, penetration value, elastic recovery and Marshall stability was checked by different test. In this project the comparative study of stability of bituminous road with and without Crumb rubber is done. In this study we used modifier in proportion 4%,8%, 12%, 16% and 20% by the weight of VG-30 as bitumen.

II. LITERATURE REVIEW

Many researches were carried out by many scholars and professors of civil engineering in this field, to find the ways and crumb rubber mix in conventional bitumen to improve in engineering properties of bitumen.

Nabin Rana Magar (2014) investigates the performance of crumb rubber modified bitumen by varying the sizes of crumb rubber. the test results of common laboratory tests on plain bitumen and crumb rubber modified bitumen shows that the penetration values and softening points of plain bitumen can be improved significantly by modifying it with addition of crumb rubber which is a major environment pollutant. The best size to be used for crumb rubber modification is suggested as (0.3-0.15mm) size for commercial production of CRMB.

Siddharth Rokade (2012), The Crumb Rubber was added to 60/70 grade bitumen in varying percentage of 8%, 10% and 12%. The mix was prepared with 5 % bitumen and the varying percentages of Crumb Rubber. The bitumen when mixed with Crumb Rubber is termed as Crumb Rubber Modified Bitumen (CRMB). The results observed that the Marshal Stability Value are increased from 8% to 10% Crumb Rubber and then it is decreased 12% of Crumb Rubber of the weight of bitumen is the optimum dose for getting enhanced strength characteristics of mix.

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- ***Nuha S.Mashaan(2012)***,In their study presented the application of crumb rubber modifier in the asphalt modification of flexible pavement. From the results of previous study, it aspires to consider crumb rubber modifier in hot mix asphalt to improve resistance to rutting and produce pavement with better durability by minimizing the distresses caused in hot mix asphalt pavement. Hence, road user would be ensured of safer and smoother roads. R.Vasudevan et.al. (2007), Has studied that the crumb rubber

modified bitumen and they construct different stretches and perform field study with the help of National Transport Planning and Research Centre, Trivandrum. From this field study they concluded that the entire road having a good skid resistance value and from bump instigator study a good surface evenness.

III. EXPERIMENTAL WORKS

The objective of bituminous mix design is to determine the combination of bituminous binder and aggregates that will give durability to the pavement structure .Correct mix design involves adhering to certain laboratory test procedures and design criteria. These are based on scientific research and years of experience in observing the performance of the bituminous mix pavements.

Table 1: Tests on Aggregates

TEST	VALUE	SPECIFICATION
specific gravity 12 m 6mm M sand filler	 2.67 2.7 2.58 2.6	2.5-3.2
Impact test	21.76	30
Los Angeles abrasion test	30.7	30-40
Shape test • flakiness index • Elongation index • Combinedflakines & elongation	 23.57 13.25 36.82	30-40

Table 2: Tests on Bitumen

TESTS	VALUE OBTAINED	MORTH SPECIFICATIONS
Specific Gravity	1	**Max 1**
Ductility	38	**Max 40**
Penetration	30	**30 –For VG30**

IV. MARSHALL METHOD OF MIX DESIGN

The concept of Marshall Method of designing paving mixes was formulated by Bruce Marshall, formal bituminous engineer with the Mississippi State Highway Department. The US Army Corps of Engineers further developed this method.

The original Marshall method is applicable only to hot bituminous paving mixes, with a maximum aggregate size of 25 mm. Subsequently modified Marshall Method has been developed for aggregates with maximum size up to 38 mm. The Marshall method uses standard test specimens of 64 mm height and 102 mm diameter. They are prepared using a specified procedure for proportioning materials, heating, mixing and compacting the aggregate bitumen mixture. The two principal features of this method are a density void analysis and a stability flow test. The stability is the maximum load taken by a specimen when tested after keeping in 60°C water bath for 30 to 40 minutes. The flow value is the deformation of the specimen in units of 0.25 mm or 1.0 mm at the maximum load condition. Marshall Stability test is empirical in nature. Hence no modifications can be effected to the standard procedure, likely reheating of mix for preparing specimens.

Table 3: ordinary bitumen

No:	Bitumen Content	Stability value	Corrected Stability	Average Stability Value	Flow Value	Average Flow Value
1	5.0	15	15.33	14.22	3.79	3.79
2		17.00	16.58		3.11	
3		11	10.75		3.42	
4	5.5	22.60	23.10	17.84	2.34	3.11
5		16.30	16.20		4.61	
6		14.20	14.23		3.50	
7	6.0	22.70	23.29	18.35	2.60	3.08
8		15.50	15.81		3.54	
9		15.40	15.94		3.10	
10	6.5	14.90	15.27	12.90	2.56	2.87
11		9.70	11.03		3.08	
12		12.70	12.41		2.98	
13	7	9.5	9.75	11.02	2.47	3.38
14		12	12.00		3.83	
15		11.3	11.30		3.84	

Table 4: crumb rubber 475µ-75µ

No:	Crumb rubber Content	Stability value	Corrected Stability	Average Stability Value	Flow Value	Average Flow Value
1	4.0	13.4	13.13	14.49	2.00	3.79
2		16.30	16.37		3.25	
3		13.9	13.98		1.81	
4	8.0	8.00	9.60	7.43	3.31	3.11
5		10.30	9.17		2.76	
6		3.70	3.52		2.86	
7	12.0	6.00	6.12	7.13	2.09	2.38
8		8.00	8.40		1.95	
9		8.80	6.86		3.11	
10	16.0	9.60	9.60	9.63	2.32	2.86
11		11.50	9.66		3.41	
12			0.00			
13	20	9.6	8.54	8.50	2.24	2.30
14		9	8.46		2.36	
15						

Table 5;crumb rubber 4.75mm-425µ

No:	Crumb rubber content Content	Stability value	Corrected Stability	Average Stability Value	Flow Value	Average Flow Value
1	4.0	4.2	4.20	1.40	1.11	0.00
2	8.0	8.84	8.66	2.89	1.83	0.00
3	12.0	14.20	13.77	13.83	2.85	0.00
4	16.0	16.70	16.63	5.54	2.50	0.00
13	20	15.8	15.04	0.00	1.75	0.00

V. ANALYSIS AND RESULTS

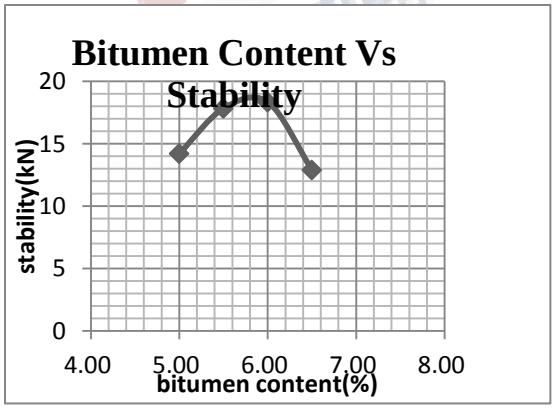

Fig 1 :variation in stability with bitumen content

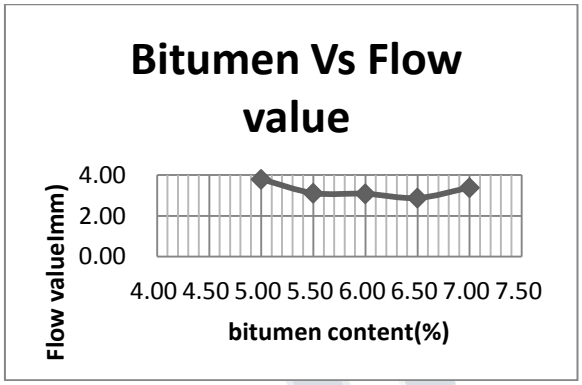

Fig 2 :variation in flowvalue with bitumen content

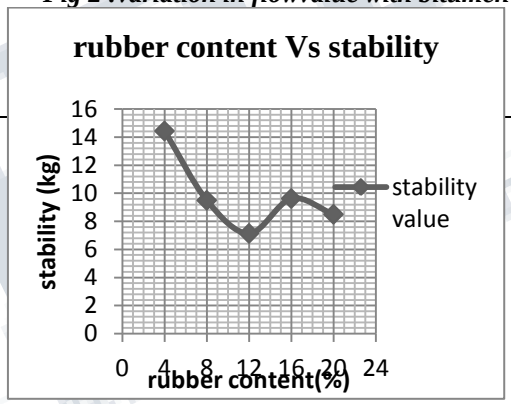

Fig 3: variation in stability with crumb rubber(425µ-75µ)

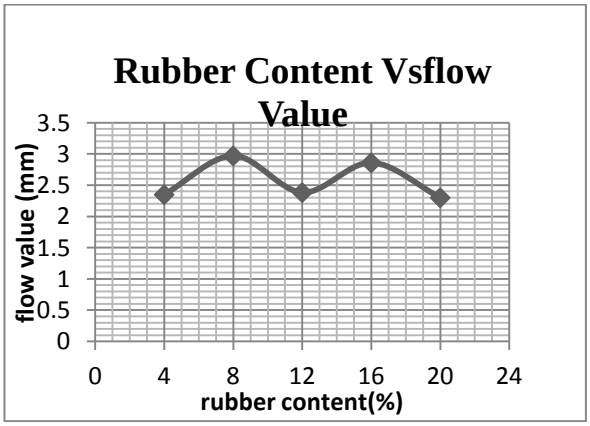

Fig 4: variation in flowvaluewith crumb rubber(425µ-75µ

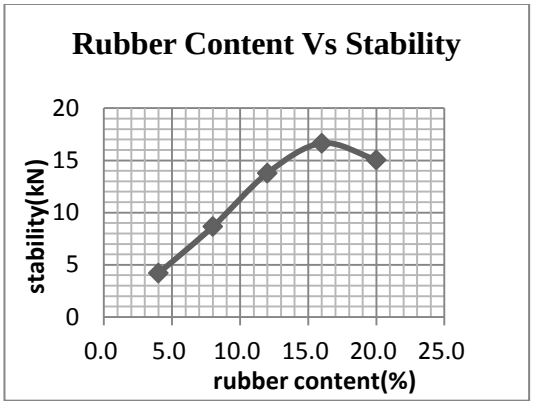

Fig 5: variation in stability with crumb rubber(4.75mm-425µ)

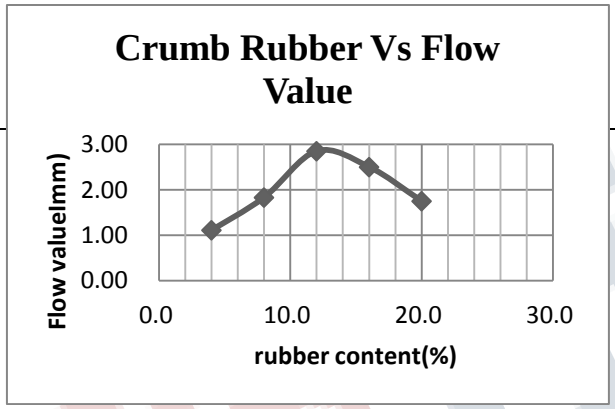

Fig 6: variation inflow value with crumb rubber(4.75mm-425µ)

VI. CONCLUSION

This experiment study presented the application of crumb rubber modifier in the modification of bituminous pavement. From the Marshall test results, it is concluded that the Marshall stability value increases with an increase in bitumen content from 5 to 6 then it decreases. The optimum binder content was found to be 5.8% .

Since our project concentrates on the stability factor, the result shows that the bituminous pavement mixed with crumb rubber of size ranging 4.75cm-425µ shows similar strength characteristics as ordinary mix pavement. But higher value of Marshall stability was found for a unmodified mix as compared to an modified one.

Even though the stability value of the modified mix was declining ,the value remained almost same as unmodified mix for crumb modifier of size ranging 4.75cm-425µ when compared with crumb rubber size ranging 425µ-75µ.

However, from the results of previous studies, it aspires to consider crumb rubber modifier in hot mix bitumen to improve resistance to rutting and produce pavements with better durability by minimizing the distresses caused in hot mix bitumen pavement. Hence, road users would been sured of safer and smoother roads. Furthermore, the use of crumb rubber modifier as an additive in bitumen modified binder would reduce pollution problems and protect our environment as well.

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