Study of Using Waste Rubber Tyres in Construction of Bituminous Road

Nitish Kumar k, Dr. H N Rajakumara

Abstract— India is a rapid urbanizing country. Due to overall development new roads are being constructed for ever increasing population. Density of vehicular traffic increases day by day. The wear and tear of tires from these vehicles is undoubted. So a large number of scrap tires are being generated. A large number of waste and worn out tires are 15-20% each year. These tires are discarded indiscriminately or stockpiled. The used tires cause a great threat to human health and environment, the waste tire rubber has become a problem of disposal. This paper is intended to study the feasibility of the waste tire rubber as a blending material in bitumen and its mix which is used for road construction. The present study has been carried out in two stages. In the first stage basic property of bitumen is modified by adding the crumb rubber in 1-4%. In the second stages strength property of bituminous mix is determined by adding crumb rubber up to1-4% with bitumen and replacing aggregate from 5-15% with waste rubber aggregate. The grade of bitumen used in this study is VG-30. The test result of basic property of VG-30 bitumen is within the permissible limit. By Adding 0-4% rubber in bitumen the values of specific gravity, softening point, flash & fire point are increases and ductility, penetration values are decreases but up to 1% addition of crumb rubber. Stability and flow of bitumen mix are within the limit up to 1% of crumb rubber. By replacing 5% aggregate by rubber aggregate, the Marshall Stability and flow values are within optimum limit.

Index Terms— Crumb rubber, Waste tyres, Marshal Stability test, Flow, stability, OBC optimum bituminous content, VMA, VFB & V_a.

1 INTRODUCTION

Now-a-days disposal of different wastes produced from different Industries is a great problem. Naturally available materials becoming less and cost of materials also high. In road construction there is a huge scarcity of aggregate. Due to this conventional bituminous mix includes stone aggregate and 3 to 5 percent bitumen by weight of the aggregate has to be modified. The use of bitumen as a binder material for stone and sand in construction of road. This material can be altered by using different waste materials such as plastic and rubber lead to good improvement in waste disposal problem.

By modifying the material we can achieve different satisfactory results. Niraj D Baraiya[1] suggested addition of waste tyres reduce thermal cracking and permanent deformation in hot temperature region and also decreases the sound pollution. R Vasudevan et al [2] stated rubber coated aggregate bitumen makes better material for pavement construction as mix shows higher Marshall stability value.

In the present study we use tyre & crumb rubber as additive's in bitumen and bituminous aggregate mix. Basic properties of bitumen are modified by adding the crumb rubber. Marshal stability test are conducted by taking 1200gm aggregate (coarse & fine) for a mix design. Obtained optimum bitumen content is mixed with crumb rubber 1-4% with replacing aggregate 5-15% with waste rubber aggregate.

2 MATERIAL

Material used in the work is Bitumen (VG-30), Filler passing 0.075mm IS sieve cement, lime and Stone dust are used, Course aggregate retained on 4.75 mm. IS sieve size, Fine aggregate passing 4.75 mm and retained on 0.075 mm IS sieve and Crumb rubber is used in 2mm size and *Waste* rubber tyre used is of 22.4 mm passing and 5.6 mm retained size.

3 METHODOLOGY

Basic properties of VG-30 grade bitumen are compared with the addition of 0-4% rubber waste of 2mm size. Marshall Stability test are conducted to get the optimum bitumen content (OBC). By adding 0-4% of 2mm rubber waste Marshall stability test were conducted and similarly by replacing rubber waste of 22.4mm passing and 5.6mm retaining with aggregate mix.

4 TEST RESULT AND DISCUSSION

All representative samples collected and various tests were conducted in laboratory. The Result obtain from test are tabulated and discussed as follows.

TABLE -1
Test results of Bitumen

Property Tested	Test Methods	Permissible limit as per IS 73:2013	Results
Specific gravity of bitumen	IS:1202	0.99(min)	1.02
Softening point	IS:1205	40-55^{0}C	46^{0}C
Ductility	IS:1208	75cm	97cm
Penetration	IS:1203	40mm	67mm
Flash & Fire point	IS:1209	220^{0}C	210 & 260^{0}C

TABLE -2
Test results of Aggregate

Property Tested	Test Methods	Results	MORTH Specification
Aggregate Impact Value	IS:2386(4)	18%	24% max
Los Angeles Abrasion Value	IS:2386(4)	30%	30%max
Water Absorption Value	IS:2386(3)	0.25%	2%max
Specific Gravity	IS:2386(3)	2.5	2.5-3.0
Combined Flakiness and Elongation Index	IS:2386(1)	28%	30%max
Crushing test	IS:2386(4)	20%	45%

The variation of Bitumen properties with the addition of waste rubber is shown in the following graphs. With addition of different percentage of rubber the basic bitumen value varies based on rubber properties.

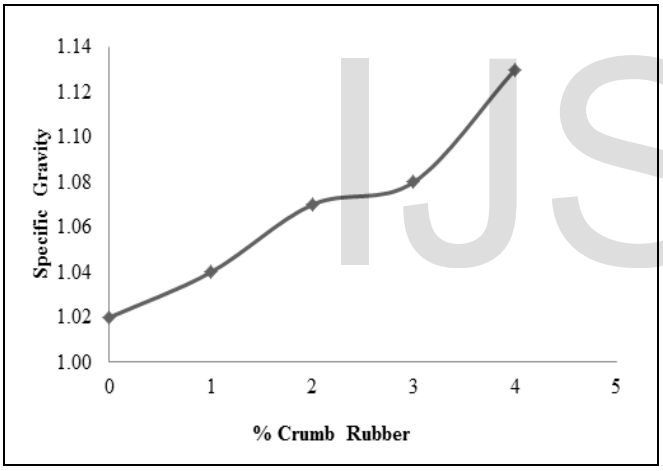


Fig.1: Shows variation of specific gravity with addition of rubber waste

Specific gravity of tyre waste is 1.25 and bitumen is 1.02 but with the addition of rubber the specific gravity of bitumen increases as shown in above fig.1, it is due to the reason that the specific gravity of tyre waste causes the improvement in specific gravirt.

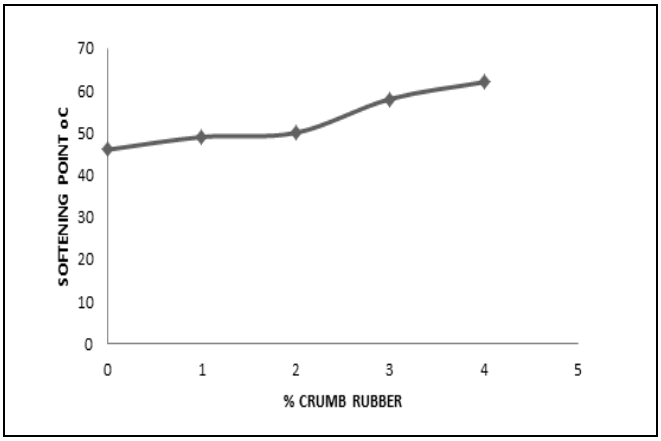


Fig.2: Shows variation of Softening point with addition of rubber waste

Softening point increased by addition of crumb rubber to the bitumen. Higher the % of rubber added higher is the softening point as shown in above fig.2

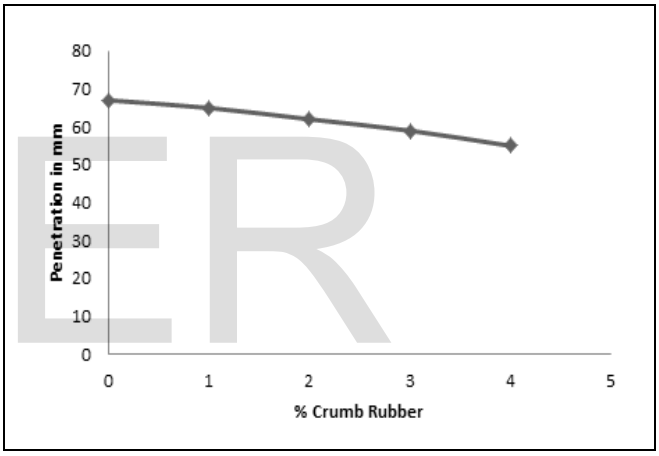


Fig.3: Shows variation of Penetration with addition of rubber waste

From the above figure it was observed that with increasing % of rubber, penetration value decrease. It is due to the reason that addition of rubber increases the hardness of bitumen.

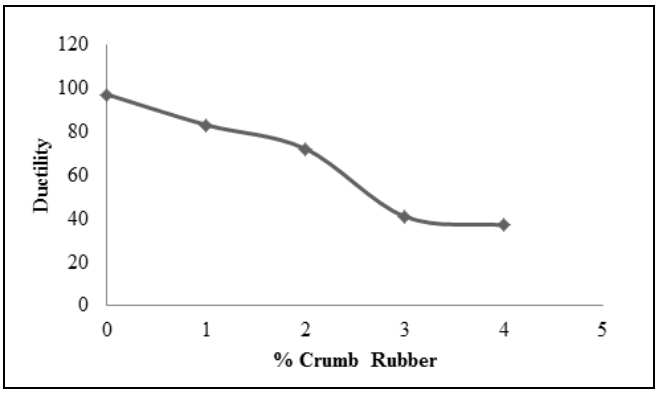
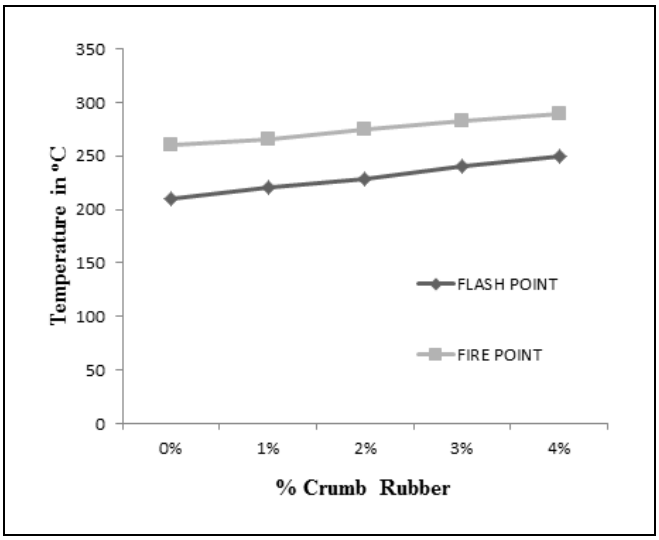


Fig.4: Shows variation of Ductility with addition of rubber waste

The ductility value is decreasing by addition of crumb rubber

to the bitumen the decrease of value is due to interlocking of rubber with bitumen as shown in fig.4



Sl. No.	B.C	Weight in gms	G_{mb}	% V_a	%VMA	%VFB	Stability	Flow (mm)
1	5.5 + 0	1256	2.35	4.76	15.51	69.75	1564.7	3.9
2	5.5+1	1246	2.33	5.08	17.76	70.72	1150.56	2.3
3	5.5+2	1256	2.35	5.28	17.82	71.3	826.86	3.5
4	5.5+3	1260	2.4	5.28	17.82	71.3	635.36	4.6

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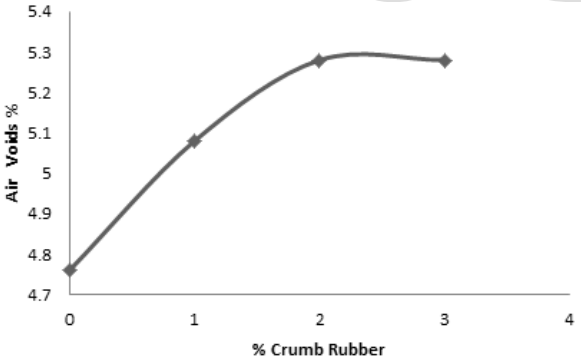

Fig.6: % Crumb rubber v/s Air Voids

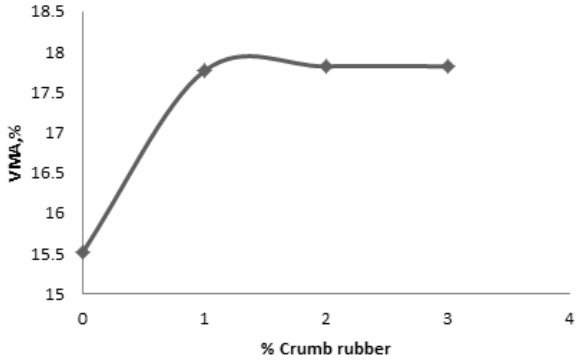

Fig.7: % Crumb rubber v/s VMA

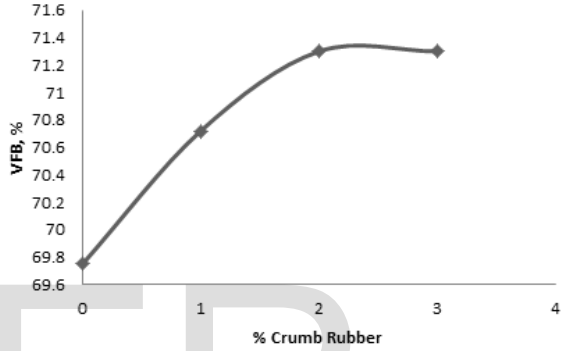

Fig.8: % Crumb rubber v/s VFB

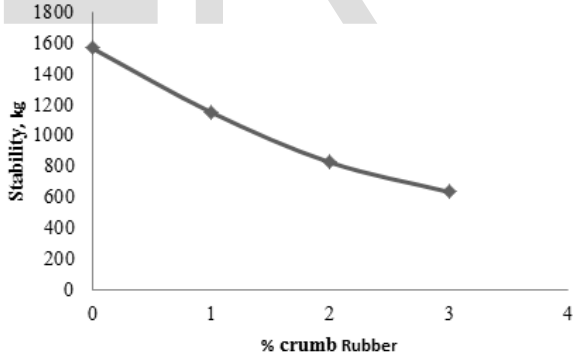

Fig.9: % Crumb rubber v/s Stability

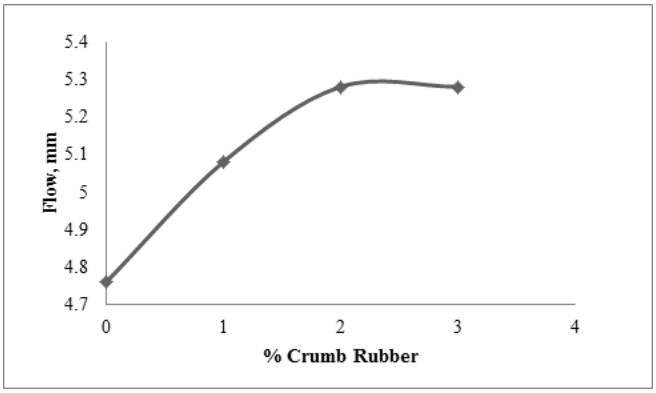

Fig.10: % Crumb rubber v/s Flow

From the above figures, it can be observed that with the addition of crumb rubber air voids increases, %VMA, %VFB and flow increases but stability decreases, up to 2% of crumb rubber. The value obtained is satisfactory.

5 MARSHALL PROPERTIES

5.1 At Different Percentage of Waste Rubber Tyre used by Replacing Aggregate

TABLE: 4

Property for Waste Rubber Tyre Replacing Aggregate in marshal mix

Sl. No.	B.C	Weight in gms	G_{mb}	% V_a	%VMA	%VFB	Stability	Flow (mm)
1	5.5 + 0	1256	2.35	4.76	15.51	69.75	1564.7	3.9
2	5.5+5	1246	2.32	6.6	19	65.26	1030.6	4.3
3	5.5+10	1258	2.372	7.78	20.26	61.99	815.82	4.75
4	5.5+15	1263	2.31	9.6	22	56.36	530.24	5.2

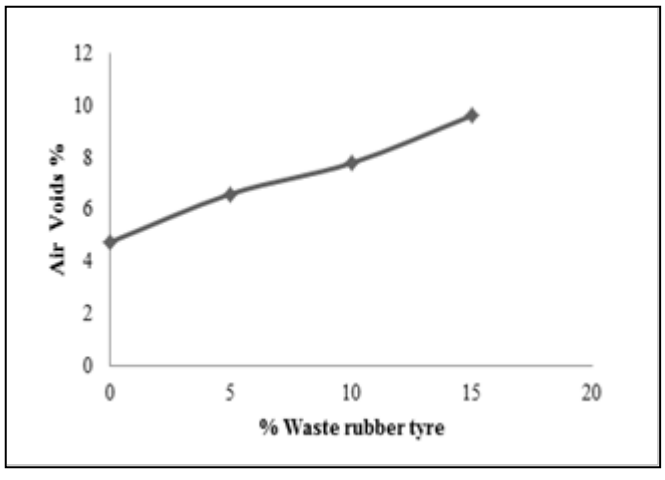

Fig.11: % Waste rubber tyre v/s Air Voids

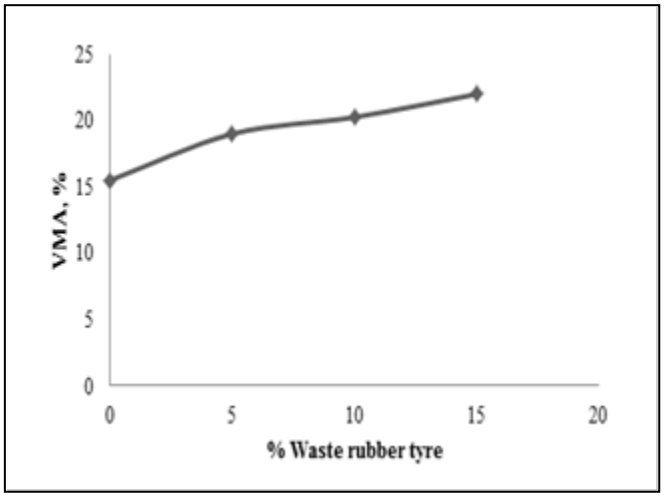

Fig.12: % Waste rubber tyre v/s VMA

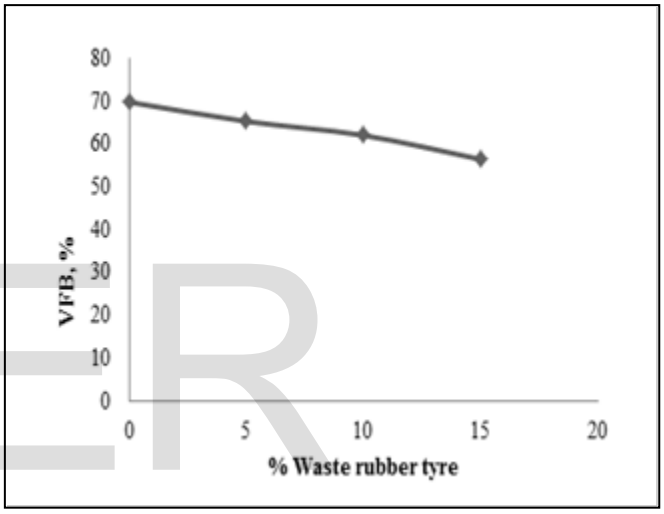

Fig.13: % Waste rubber tyre v/s VFB

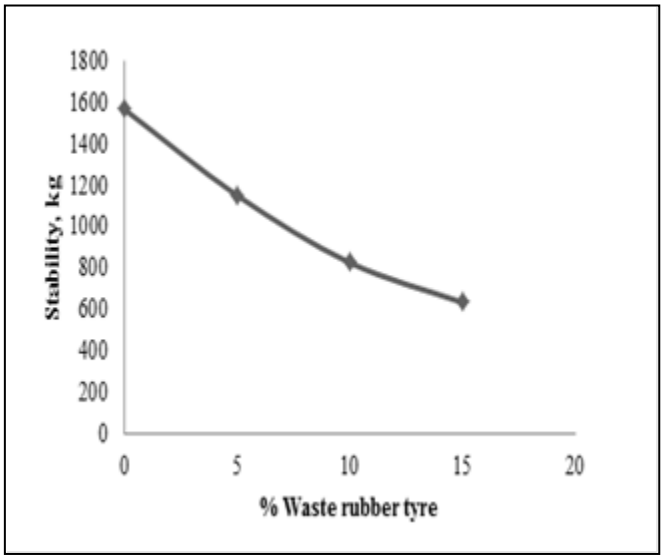

Fig.15: % Waste rubber tyre v/s Flow

From the above figures, it can be observed that with the addition of waste rubber upto 0 to 15% Air voids increases, %VMA, %VFB and flow increases but stability decreases, up to 5% of waste rubber the value obtained is satisfactory.

1 CONCLUSIONS

The basic property that we tested for VG-30 bitumen is in permissible limit. By Adding 0-4% Crumb rubber in bitumen specific gravity, softening point, flash & fire point are increasing and ductility, penetration are decreasing. But up to 1% addition of crumb rubber obtain value are within the limit. Stability and flow of bitumen mix are within the limit up to 1% of crumb rubber. By replacing 5% aggregate of size passing 19mm & retained on 13.2mm by rubber aggregate obtained Marshall Stability and flow value are within optimum limit.

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