An Experimental Study on Effect of Scrap Tyre Crumbed Rubber on Bituminous Concrete Grade 2

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Abstract

In present days the solid waste management is problem like plastic waste tyre waste and also some times of fibres waste is the waste problem disposal problem in a day. The purpose of the research helps both waste management and reuse of tyre waste. The tyre is made up of numerous different rubber compounds much different type of carbon black, fillers like clay and silica and chemical and minerals added to allow or accelerate vulcanisation. Tyres are not made as recycling industry feedstock. Their composition makes them difficult to recycle, the compositions of tyre and their lack of toxicity and likely result of processing for use by shredding and grinding that can be used as aggregates in flexible pavement construction. In present study the scrap tyre crumbed rubber used in bituminous concrete grade 2 at percent of 4%, 6%, 8%, 10%, and 12% by weight of aggregate with 80/100 grade bitumen as binder and the result are discussed.

Keywords: Crumbed rubber, Marshall Stability, Bituminous Concrete

I. INTRODUCTION

It is reported that many country produces around millions of waste tyres per year. However it is also reported that this number is expected to increase due to increase in vehicle fleet numbers, importing of used tyres and the reducing numbers of tyres retreated. Historically the majority of these were landfilled; however landfilling of whole tyres presents problems with tyres tending to 'float' to the top in landfills. Tyres also provide a good source of fuel but it produces toxic gases which creates atmospheric pollution and can act as a breeding habitat for some disease carrying mosquitos. These problems can be addressed by first shredding the tyres however this adds to the cost of their disposal. Crumb-rubber the ideal modifier can prove to be economical as compared to conventional bituminous mix. The use of crumb-rubber for modification of pavements is helpful to get better performance. Modified by using crumbed rubber improved elastic modulus and fatigue strength. So the modification of pavements by using scrap tyre crumbed rubber is logical and economical approach.

II. METHODOLOGY

For this study work aggregate, 80/100 grade bitumen and crumb of scrap tyre was used. Different properties of bitumen and aggregate have been tested. Then prepare different mixes of bitumen and crumb of waste tire rubber with varying proportions by using dry process. The percentage weight of crumb tyre rubber replace for percentage weight of aggregate taken for test. The feasibility of different mixes of bitumen and crumb tire rubber with varying proportions with aggregate has been tested.

III. DISCUSSION

Marshall Stability test has been preparing for bituminous mix design by using job mix formula and also the size of crumbed rubber assuming for better performance. This research project the size of aggregate and crumbed rubber size used for BC grade 2 as follow:

A. Mix Proportion:

Table - 1
Mix Proportion

Material	*Size (mm)*	*Percent*	*Weight in gm.*
Aggregate	*19 mm pass*	*20%*	*240 gm.*
	9 mm pass	*30%*	*360 gm.*
	Grit + Dust (4.75 mm pass)	*48%*	*576 gm.*
	Fillers	*2%*	*24 gm.*
	Total	*100%*	*1200 gm.*

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The sample of scrap tyre rubber was taken from local remoulding agencies which is pass to IS475 and found the cumulative percentage by weight of total aggregate with dust and with rubber.

Table - 2

Mix designation Nominal aggregate size Layer thickness	*Grading 2 13mm 30-45mm*	*Optimize Grading with dust*	*Remark*	*Optimize Grading with CR*	*Remark*
IS sieve (mm)	*Cumulative % by weight of total aggregate and with crumbed rubber*				
19	*100*	*100*	*Pass*	*100*	*Pass*
13.2	*79-100*	*94.40*	*Pass*	*94.4*	*Pass*
9.5	*70-80*	*85.90*	*Pass*	*85.9*	*Pass*
4.75	*53-71*	*62.00*	*Pass*	*62*	*Pass*
2.36	*42-58*	*49.75*	*Pass*	*51.7*	*Pass*
1.18	*34-48*	*41.25*	*Pass*	*42.85*	*Pass*
0.6	*26-38*	*30.45*	*Pass*	*26.85*	*Pass*
0.3	*18-28*	*25.00*	*Pass*	*14.15*	***Fail***
0.15	*12-20*	*13.35*	*Pass*	*5.2*	***Fail***
0.075	*4-10*	*6.75*	*Pass*	*0.45*	***Fail***
Bitumen content, % by weight of total mixture	*5.0-7.0*				

Here we have seen that the 1 kg of crumbed rubber was fail in 0.3, 0.15, and 0.075 cumulative percentage by weight of total aggregate so taking size of crumbed rubber from IS4.75 to IS0.6, to obtain better results, crumbed rubber was replaced with dust in percent of 4%, 6%, 8%, 10%, and 12% by weight of total aggregate.

B. Physical Properties of Aggregate & Filler Used:

Table - 3
Physical properties of aggregate & filler used

Sieved size mm	*19mm pass*	*9mm pass*	*Grit + Dust (4.75 mm pass)*	*Filler (lime)*	*Crumbed Rubber*
Specific gravity	*3.17*	*2.98*	*2.59*	*1.2*	*1.15*

C. The Properties of the Bitumen Without Rubber Content:

Table - 4
The properties of the bitumen without rubber content

Penetration test @270C, 5S,100gm	*Softening point @ ring ball test*	*Ductility (cms) @270C, 5cm/ min*	*Specific gravity Reading (G)*
80/100 grad (88)	*60◦c*	*79*	*1.01*

D. Details of Sample Constitution and Percent Constituent

Table - 5
Details of sample constitution and percent constituent

Sample constitution	*Sample preparation*	*% constituent by wt. of bitumen*	*weight of crumbed rubber*	*weight of dust*
		0%	*0 gm.*	*576 gm.*
80/100 grade bitumen + 2.36-0.6 particle size of crumb rubber+ aggregate	*Dry process*	*4%*	*72 gm.*	*504 gm.*
		6%	*96 gm.*	*480 gm.*
		8%	*120 gm.*	*456 gm.*
		10%	*144 gm.*	*432 gm.*
		12%	*168 gm.*	*408 gm.*

E. Marshall Stability Test:

IRC Recommendation for modified blended bitumen and selected optimum bitumen content for bitumen mix

Table - 6

TYPE OF BITUMEN	*80/100 with plain bitumen*			*With 4% CR as aggregate*	*With 6% CR as aggregate*	*With 8% CR as aggregate*	*With 10%CR as aggregate*	*With 12% CR as aggregate*
Percentage of bitumen	*5%*	*5.5%*	*6%*	*5%*	*5%*	*5%*	*5%*	*5%*
Gb	*2.283*	*2.305*	*2.318*	*2.215*	*2.195*	*2.178*	*2.143*	*2.083*
STABILITY	*9.152*	*9.533*	*9.915*	*11.440*	*10.678*	*10.373*	*8.390*	*7.475*
FLOW	*3.0*	*3.1*	*3.3*	*3.1*	*3.6*	*5.4*	*6.0*	*7.8*
Vv (%)	*5.186*	*3.111*	*1.446*	*3.738*	*2.488*	*1.135*	*0.649*	*1.419*
VMA (%)	*16.488*	*15.662*	*15.216*	*14.703*	*13.354*	*11.917*	*11.258*	*11.371*

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VFB (%)	*68.547*	*80.137*	*90.495*	*74.575*	*81.367*	*90.470*	*94.236*	*87.904*

F. IRC Specifications For Bituminous Concert Grade 2

Table – 7
IRC specifications for bituminous concert grade 2

Test property	*Specified value*
Marshall Stability kg.	*9 kN (minimum)*
Flow value (mm)	*2 – 4*
Air voids in total mix Vv %	*3 to 5*
Voids filled with bitumen VFB %	*65 to 75*

IV. RESULTS

The values of Marshall Stability are consistent for all rubber percentage reading

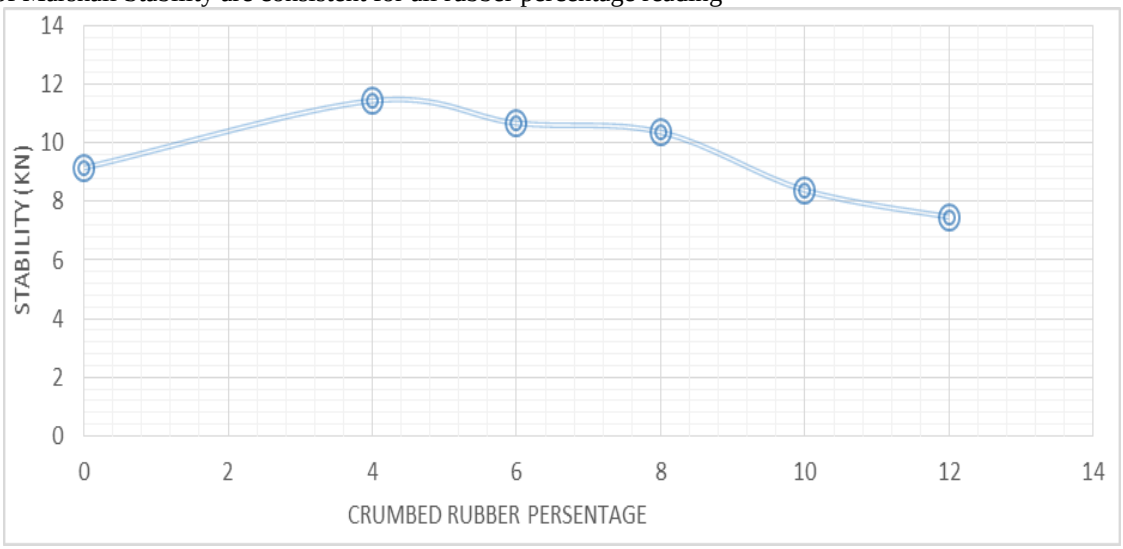

Fig. 1: The values of flow value are consistent for all rubber percentage reading

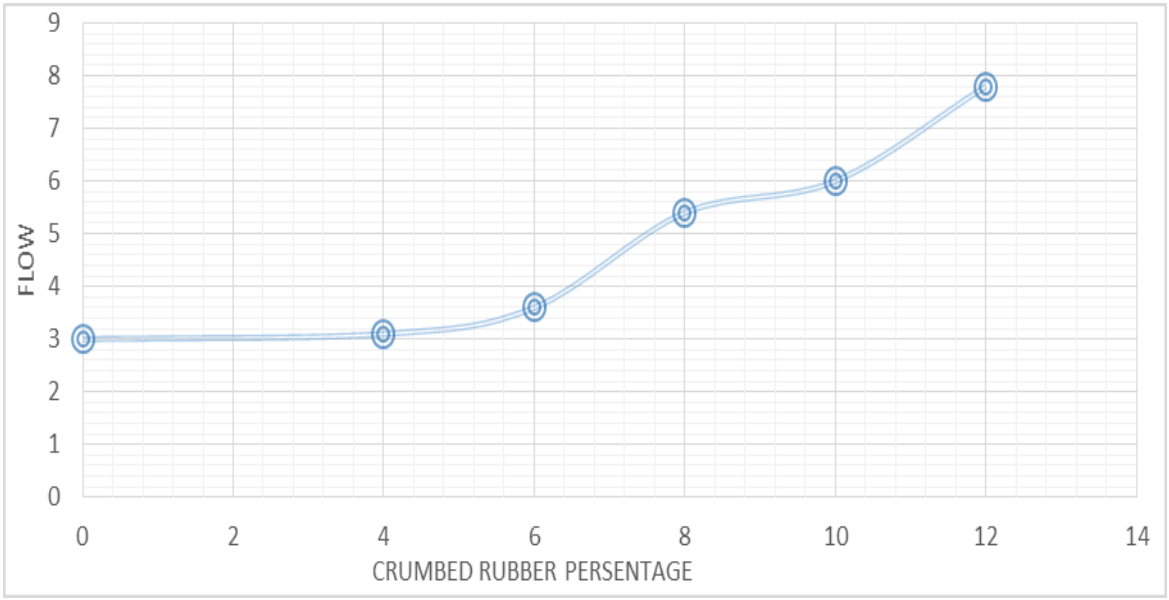

Fig. 2: The values of air voids in total mix are consistent at 4 % of addition of rubber.

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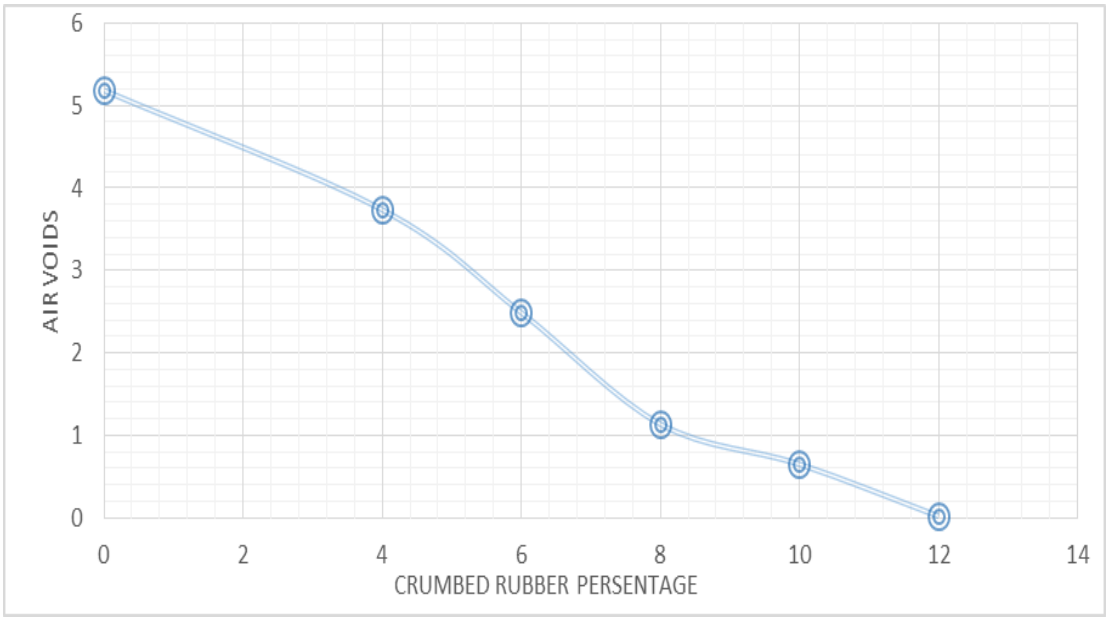

Fig. 3: The values of voids filled with bitumen are consistent up to 4% of addition of rubber

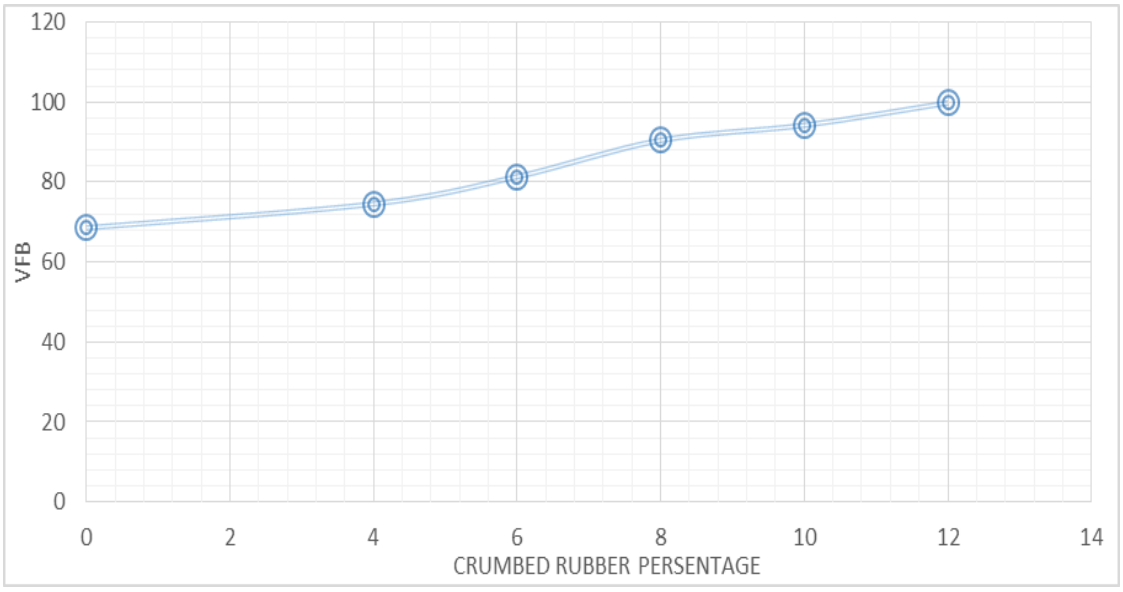

Fig. 4:

V. CONCLUSIONS

After careful assessment of the properties and taking various tests as per standards the results shown by 4% addition of rubber crumbs has best suitability for bituminous concrete. The addition of scrap tyre crumbed rubber will help to dispose the waste tyre rubber in a proper way and solve the problem of disposal, make eco-friendly and reduce the environmental concerns up to a certain extent.

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