Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 07, July-2016

Lab Scale Evaluation of Waste Tyre Rubber Blended with Bitumen on Asphalt Road

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***Abstract*:- For a country like India an efficient road network is necessary for national integration and as well as for socio-economic development. India has an extensive road network of 3.3 million km, one of the largest in the world. Roadways are directly related to the industrial development and population growth. Infrastructure is very important for the industrial development in a country like India. Due to improvement in living standards of the people, the use of vehicles has increased over the last few years, giving rise in the vehicular density on roads. As vehicles are used increasingly the wear and tear of their tires are occurs. Due to this, the life of tire goes down and finally becomes waste. The disposal of these tires is troublesome, which then disposed of by either burning or dumping on somewhere on surface land. These leads to air pollution and land to be wasted for stacking up the tires. So it is necessary to find some other measures of disposal. An attempt was made to use waste tire rubber to blend with bitumen, hence, the properties of bitumen enhanced and economy also achieved in bitumen.**

Keywords: Bitumen, Asphalt, Marshall Stability test, Crumb rubber, Crumb rubber modifier (CRM).

1. INTRODUCTION

1.1 General Information

Emerging economies need a proper transportation system, of which roadways are a crucial fragment. The construction and maintenance of road pavements should be long enduring due to their extensive influence on the economy of a nation. The increase in overall traffic, poor material quality and climatic effects are Prime reasons of the damaged conditions of roads. Recycled tyre rubber constitutes Vulcanized natural and synthetic rubber which is highly valuable. Therefore, beyond the conventional components of the bituminous pavement layers, the use of crumb rubber recycled from used tires should be studied as a form of environmental stewardship and as a pavement performance enhancer. It will be substitute way of solid waste disposal.

Over the years, road structures have deteriorated more promptly due to increasing in service traffic density, axle loading, and poor maintenance services. To minimize the damage of pavement surface and increase the durability of flexible pavement, the conventional bitumen needs to be improved with regards to performance related properties, such as resistance to permanent deformation (rutting) and fatigue cracking. The modification of bituminous binder has been explored over the past years in order to improve road pavement performance properties. There are many modification processes and additives that are currently used in bitumen modifications, such as styrene butadiene styrene (SBS), styrene-butadiene rubber (SBR), ethylene vinyl acetate (EVA) and crumb rubber modifier (CRM). The use of commercial polymers, such as SBS and SBR in road and pavement construction will increase the construction cost as they are highly expensive materials. However, with the use of alternative materials, such as CRM, will definitely be environmentally beneficial, and not only it can improve the bitumen binder properties and durability, but it also has a potential to be cost effective.

1.1.1 Aim & Objectives of Study

A planned disposal of waste tyre rubber is quite essential for attaining sustainability and economy.

Objectives of study:-

1. To check the feasibility of the waste tire rubber blended with bitumen.
2. To study the properties of bitumen after blended with waste tyre rubber.
3. To check the safe disposal of waste tyre rubber.

1.2 Bitumen

Crude petroleum obtained from different places has quite a different composition. It varies place to place. Crude petroleum is not pure at the first place. Hence, the petroleum should be dehydrated first before carrying out the distillation. General types of distillation processes are a fractional distillation and destructive distillation. In fractional distillation, the various volatile constituents are separated at successively higher temperatures without substantial chemical change. The successive fractions obtained yield gasoline. Naphtha, kerosene, and lubricating oil; the residue would be petroleum bitumen.

1.3 Crumb rubber

Crumb rubber is a term usually applied to recycled rubber from vehicle waste tires. During the recycled process

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 07, July-2016

steel and blub is removed leaving tyre with a granular consistency. The particles are sized and classified based on various certain including colour. The CRM shall be 100% passing 1 mm sieve. The amount of CRM by weight of terminal blend RAC shall be between 10 to 15%.

1.4 Asphalt

Asphalt is a mixture of a bituminous binder with mineral aggregate (stone), sand and filler, typically containing approximately 4-7% bitumen. Asphalt is primarily used for road construction, the properties being dependent upon the type, size and amount of aggregate used in the mixture, all of which are adjusted to provide the required properties for the desired application.

1.5 Marshall stability test

This test covers the measurement of resistance to plastic flow of 102 mm cylindrical specimens of bituminous paving mixture loaded in a direction perpendicular to the cylindrical axis by means of the Marshall apparatus. This test is for use with dense graded bituminous mixtures prepared with asphalt cement (modified and unmodified), cutback asphalt, tar, and tar-rubber with maximum size aggregate up to 25 mm in size (passing 25 mm sieve).

2. METHODOLOGY

For this research work aggregate, bitumen and crumb of scrap tyre were used. Different properties of bitumen and aggregate have been tested. Then prepared different mixes of bitumen and crumb of waste tire rubber with varying proportions by using the wet process. The percentage weight of crumb tyre rubber replaces for percentage weight of bitumen taken for the test. The feasibility of different mixes of bitumen and crumb tire rubber with varying proportions with aggregate has tested[5].

2.1 Mix proportion

Material	Sieve size mm	Weight in kg.
Aggregate	40 - 19	74.10 gm.
	19 - 13	347.1 gm.
	13 - 6	260.00 gm.
	6 - 0	559.00 gm.
Bitumen		59.8 gm.
	Total	1300 gm.

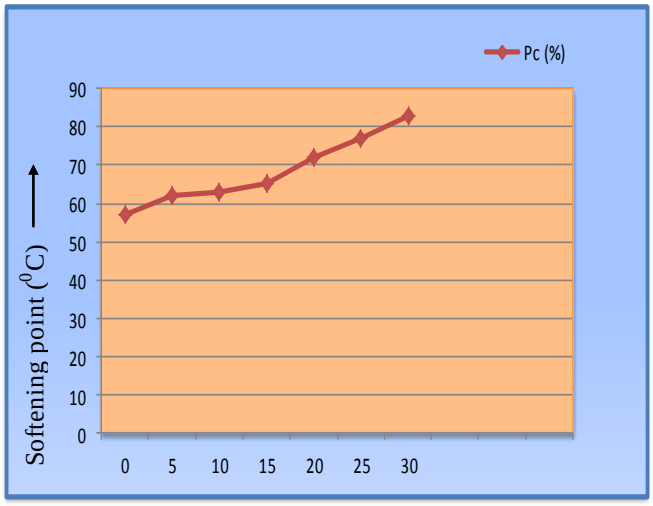
2.2 Physical properties of aggregate & filler used

Sr. no.	Tests on Aggregate	Test result obtained			
1	Crushing value (%)	24			
2	Impact value	20.7			
3	Los Angeles abrasion value	31.8			
	Sieve size in mm	40-19	19-13	13-6	6-0
4	Specific gravity	2.67	2.64	2.62	2.64
5	Water Absorption	0.92	0.76	0.65	-

3. RESULT AND DISCUSSION

(A). Softening point test

The values of softening point of bitumen are consistent for all rubber percentage reading

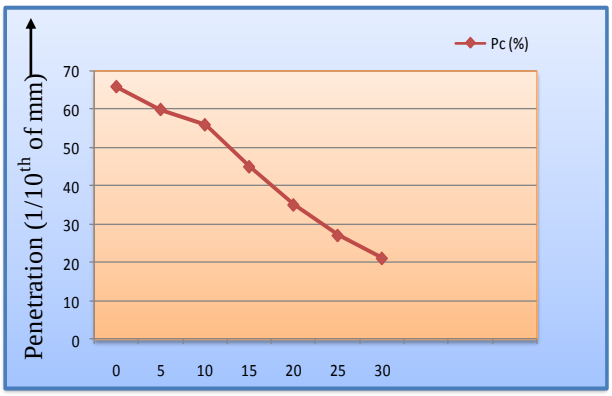


Rubber percentage in Bitumen (%) →

Graph No.1: Softening point

(B). Penetration test

The values of penetration of bitumen are consistent up to 10% of addition of rubber.



Rubber percentage in Bitumen (%) →

Graph No.2: Penetration

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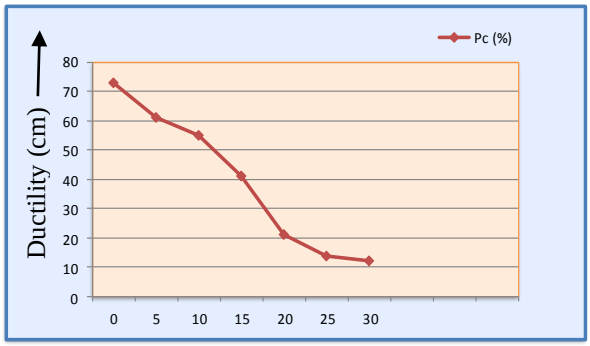
Vol. 5 Issue 07, July-2016

C) Ductility test

The values of ductility of bitumen are consistent up to 10% of addition of rubber.

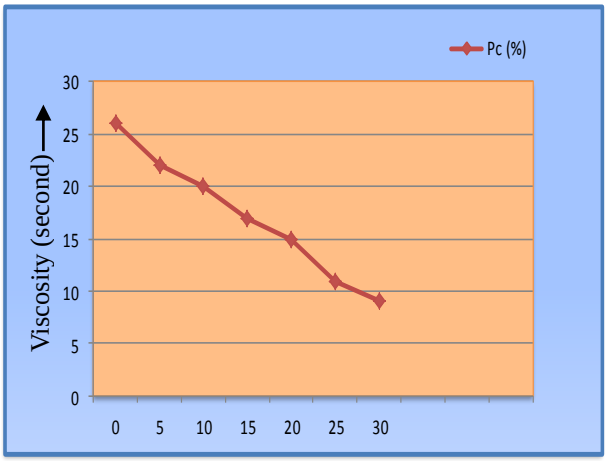


Rubber percentage in Bitumen (%) →

Graph No.3: Ductility

D) Viscosity test

The values of viscosity of bitumen are consistent up to 10% of addition of rubber.



Rubber percentage in Bitumen (%) →

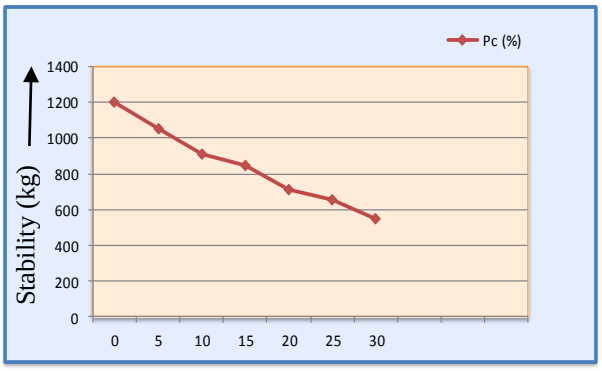
Graph No 4: Viscosity

E) Marshall stability test

IRC Recommendation for modified blended bitumen Grade – 60/70

Test property	Specified value
Marshall Stability kg.	340 (minimum)
Flow value (mm)	2.5 – 4
Air voids in total mix Vv %	3 to 5
Voids filled with bitumen VFB %	65 to 85

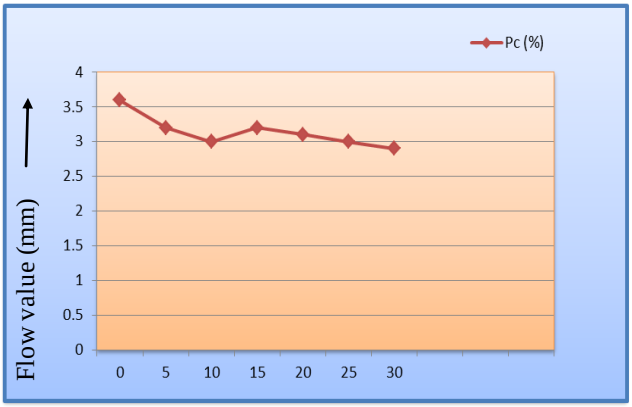
1) The values of Marshall Stability are consistent for all rubber percentage reading.



Rubber percentage in Bitumen (%) →

Graph No.5: Marshall Stability (A)

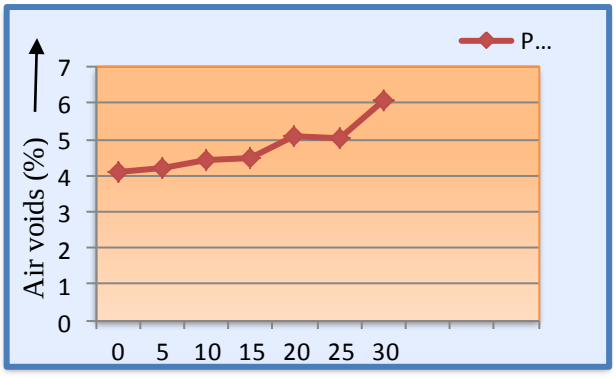
2) The values of flow value are consistent for all rubber percentage reading.



Rubber percentage in Bitumen (%)

Graph No.6: Marshall Stability (B)

3) The values of air voids in total mix are consistent up to 15% of addition of rubber.

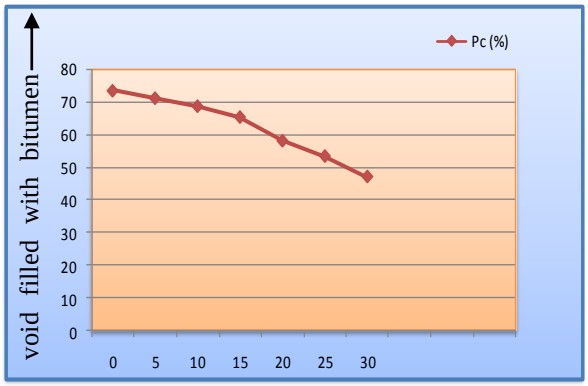


Rubber percentage in Bitumen (%) →

Graph No.7: Marshall Stability (C)

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 5 Issue 07, July-2016

4) The values of voids filled with bitumen are consistent up to 10 % of addition of rubber.



Rubber percentage in Bitumen (%) ⟶

Graph No.8: Marshall Stability (D)

4. CONCLUSION

The addition of crumb rubber to 60/70 grade bitumen significantly reduced the penetration, ductility, and viscosity values. There is increase in softening point values with the addition of crumb rubber. The laboratory results obtained shows that 10% addition of the crumb rubber will give the optimum results; hence, finally it will be economical as it saves 10% of bitumen cost. The use of rubber in bituminous binder increases the properties of the binder so that it can be efficiently used. Disposal of tires by burning is of great nuisance and hazardous to environment as it causes air pollution and is non-biodegradable thus causing land pollution. This can be overcome by using tyre crumb in bituminous road construction.

ACKNOWLEDGEMENT

This technical report was researched and principally authored by Professor S.R. Khot from the Savitribai Phule. The author also acknowledges the guidance and support from all the members of the RMD Sinhgad Institute

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