Experimental Work on Use of Waste Tyres Rubber In Flexible Road Pavement

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Abstract- *Now-a-days it is necessary to utilize the wastes effectively with technical development in each field. The old abandoned tyres from cars, trucks, farm and construction equipment and off-road vehicles are stockpiled throughout the country. This leads to various environmental problems which include air pollution associated with open burning of tyres and other harmful contaminants like (polycyclic aromatic hydrocarbon, dioxin, furans and oxides of nitrogen) and aesthetic pollution. They are non-biodegradable; the waste tyre rubber has become a problem of disposal. This paper is intended to study the feasibility of waste tyre rubber as binding material in bitumen, the waste tyre rubber is used with aggregate in different layer and also on the top surface layer mixed with bitumen in percentage (5,10,15) and carried out different test result based on it, finding through it the difference in result by forming normal and rubber pavement and calculate the increase in strength of road pavement and also economically achieve. This is not only minimizes the pollution occurred due to waste tyres but also minimizes the use of conventional aggregate which is available in exhaustible quantity.*

Keywords:- Rubber aggregate, Crumb rubber, bitumen, Marshal stability test.

I. INTRODUCTION

Day by day with theincrease in number of automobiles in India during recent years the demand of tyres as original equipment and has replacement also increased. As every new tyre produced is designed to go to waste stream for disposal or recycling or reclamation, despite its passage through re-treading process, the number of used tyres being discarded is going to increase significantly. Timely action regarding recycling of used tyres is necessary in view to solve the problem of disposal of used tyres keeping in view the increasing cost of raw material, resource constraints and environment problem including fire and health hazard associated with the stockpiles of the used tyres. The world generate about 1.5 billon of waste tyre annually, 40% of them in emerging markets such as china, India, south America, southeast Asia, south Africa and Europe. In India, all new vehicles have radial tyres so now there are piles of radial tyres here. Analysis indicates that 0.6 million Tons of tyres scrape is generated in the country annually. It is commonly accepted in the tyre industry that about one tyre one person per year is discarded. Since there is no industry group or industry or governmental agency that monitors tyre disposal in the country, the best estimates that can be made are based on tyre production. So supply situation of scrap tyre is only going to be improving in years to come as result of going vehicle population in India. Mandatory scraping of end of life vehicle, in metros by 2010-11 and across India by 2012-13 is also likely to insure large scale availability of scrap tyre at select locations there by encouraging organized players. The management of scrap tyre has growing problem in recent years, scrap tyres represent one of several special wastes that are difficult to municipalities to handle. Whole tyres are difficult to landfill because they tend to float to the surface. These stockpiles are also direct loss of energy and resources in addition to fire & health hazards and also environmental issues. The main constituent of tyre is rubber and the largest single application of rubber is vehicle tyres. Also the requirement of tyre is directly related to growth of automobile.

II. OBJECTIVE

1) Strength - By replacing rubber in bitumen it increasing its strength which gives better strength as compare to normal road.
2) Environment- There is huge problem of disposal waste tyre by using this waste tyre we protect the environment.
3) Economy – As compare to waste rubber bitumen is costlier by replacing this waste tyre in bitumen we can reduces the cost , hence economy can be achieved.
4) The main property of rubber is reduce noise pollution, friction resistance and also skid resistance
5) It increase drainage properties of road pavement
6) It also decreases maintenance cost of road pavement

III. LITERATURE REVIEW ON WASTE TYRE RUBBERS

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.

3.1) M.O. Hamzah, A.A. Mohamed (2006)

Scrap tire usage in road construction started many years ago and modification of bitumen with crumb rubber in road paving applications has been growing rapidly over the last four decades. This paper examines the properties of base bitumen and crumb rubber modified with antioxidant (CRI1) using a Dynamic Shear Rheometer (DSR). The rheological properties of CRI1 and PMA- D modified bitumen are compared with unmodified 80/100 bitumen. Subsequently, these mixtures are compacted by the gyratory compactor and conditioned for short and long term ageing in accordance with the procedure outlined in AASHTO R30-02. The mixtures are then evaluated for stiffness modulus under standard conditions so as to judge the extent of ageing through the increase in stiffness. This approach enables the establishment of a relationship between complex modulus of the bitumen and the stiffness of the mixture.

3.2) M. Hossain , M. Sadeq (2010)

A set of mixes using different combinations of chunk rubber content, emulsion content and fly ash content were tested. Marshall Stability results of mixes with 10% Type C fly ash showed optimum emulsion contents of 6.8, 7.3 and 7.8% for 2, 4 and 6% rubber, respectively. The Marshall stability values decreased for increasing rubbercontents. The target Marshall stability value of a suitable cold mix at 43ºC was required to be 2225 N. A mix with 10% Type C fly ash, 2% rubber and 7% emulsion showed an average Marshall stability value of 1600 N. Based on the Marshall stability result, some of mix at 43ºC was required to be 2225 N. A mix with 10% Type C fly ash, 2% rubber and 7% emulsion showed an average Marshall stability value of 1600 N. Based on the Marshall stability results, some of these mixes appeared to be suitable as binder courses or stabilized drainable bases for low volume roads. If 9 kg of chunk rubber equivalent is produced per tire, then a one km long and 7.3 m wide low-volume road with a 100 mm thick base built with this mix can incorporate approximately 3350 tires.

3.3) Niraj D. Baraiya (2013)

The possible use of rubber particles from scrap tyres into concrete mix have already given better result in sub-bases for highway pavements, highway medians, sound barriers and other transportation structures. The addition of rubber aggregate in bituminous mix decreases the quantity of stone aggregate by volume and increases the flexibility and flexural strength of the carpet layer of the highways. Aggregate is the granular material used in bitumen concrete mixtures, which makes up 90 to 95 percent of mixture weight and provide most of the load bearing characteristics of the mix. Due to which the quantity of aggregate is gradually decreasing which will need the alternative material as aggregate for the highway construction.

3.4) Prof. Justo et al (2002)

at the Centre for Transportation Engineering of Bangalore University compare the properties of the modified bitumen with ordinary bitumen. It was observed that the penetration and ductility values of the modified bitumen decreased with the increase in proportion of the plastic additive, up to 12 percent by weight. Therefore the life of the pavement surfacing using the modified bitumen is also expected to increase substantially in comparison to the use of ordinary bitumen.

3.5) Shankar (2009)

The crumb rubber modified bitumen (CRMB 55) was blended at specified temperatures. Marshall's mix design was carried out by changing the modified bitumen content at constant optimum rubber content and subsequent tests have been performed to determine the different mix design conventional bitumen (60/70) also. This has resulted in much improved characteristics and for characteristics when compared with straight run bitumen and that too at reduced optimum modified binder content (5.67%).

IV. LIMITATION

The literature which studied I found there was not achieved the addition of rubber in each layer. In present study we are replacing waste tyre rubber with various sizes (80mm to micron) in road construction by using this we are carrying out a experimental study based on it and achiving better results.

V. METHODOLOGY

For this research on , Large no of waste tyre collected. These waste tyre cut to the crushing plant in various sizes (80 mm to micron).The waste rubber use not only in bitumen but also aggregate in percentages of 5, 10, 15 by using wet process. The different test conduct on aggregate (Impact, Crushing, Abrasion, specific Gravity & Water Absorption Test) as well as on bitumen (Penetration Ductility, Softening, Viscosity & Marshall Stability Test)

VI. EXPERIMENTAL WORK

6.1) Impact Value Test

This test is done to determine the aggregate impact value of coarse aggregates as per IS: 2386 (Part IV) – 1963. The apparatus used for determining aggregate impact value of coarse aggregate is Impact testing machine .Toughness is the property of a material to resist impact. The aggregate impact value indicates a relative measure of the resistance of an aggregate to a sudden shock or an impact, which differs from its resistance to a slow gradually increasing compressive load.

6.2) Crushing Valu Test

Satisfactory resistance to crushing under the roller during construction and adequate resistance to surface abrasion under traffic. Also surface under rigid type of heavily loaded drawn vehicles are high enough to consider the crushing strength of road. aggregates as an essential requirement in India. If the aggregates are weak the stability of the pavement structure is likely to be adversely affected. The strength of coarse aggregates is assessed by aggregate crushing test. The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load.

6.3) Abrasion Value Test

Due to the movement of traffic, the road stones are used in the surfacing course are subjected to wearing action. At the top Resistance to wear or hardness is hence an essential property of road aggregate, especially when used in wearing course. Thus road stones should be hard enough to resist the abrasion due the traffic. When fast moving traffic fitted with pneumatic tyres move on the road, the road particles present between the wheel and road surface causes abrasion on the road stone. Steel tyres of the animal drawn vehicles which rub against the stones can cause considerable abrasion of the stones on the road surface Hence in order to tests are carried out in the laboratory.

6.4) Specific Gravity

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. The specific gravity test helps in the identification of stone.

6.5) Water Absorption Test

Water absorption gives an idea of strength of aggregate. Aggregates having more water absorption are more porous in nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

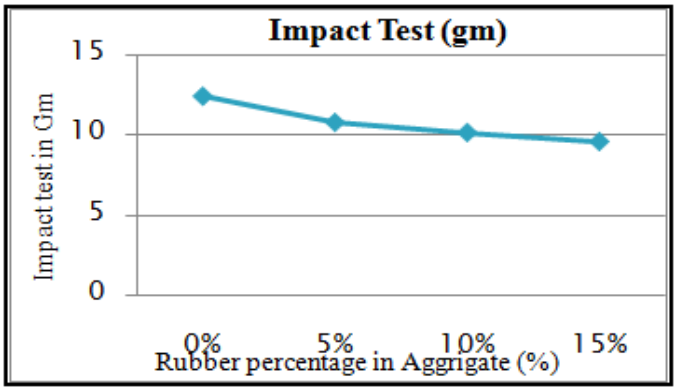
6.6) Result on Aggregate –

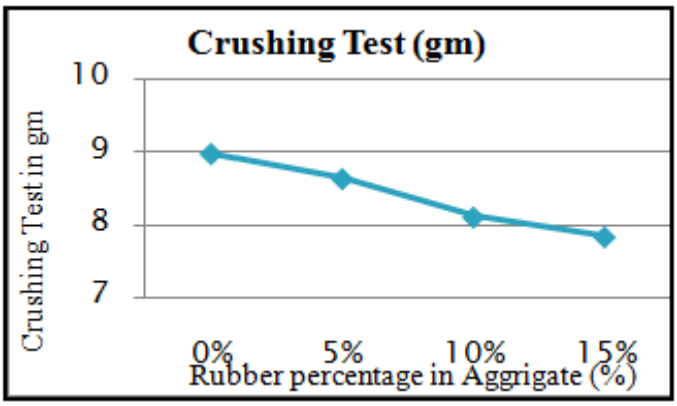
From above the laboratory test on aggregate of replacing rubber in varying percentage. The result shows that with replacing 15% of aggregate gives the better result in above test. All the parameters were also well as per IRC specifications. Hencereplacing 15% of aggregate gives satisfactory result as compare to other.

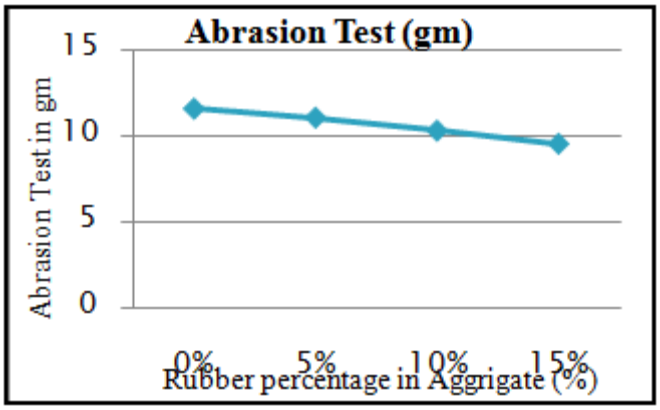
Table 1: Different properties of crumb rubber modified Aggregate

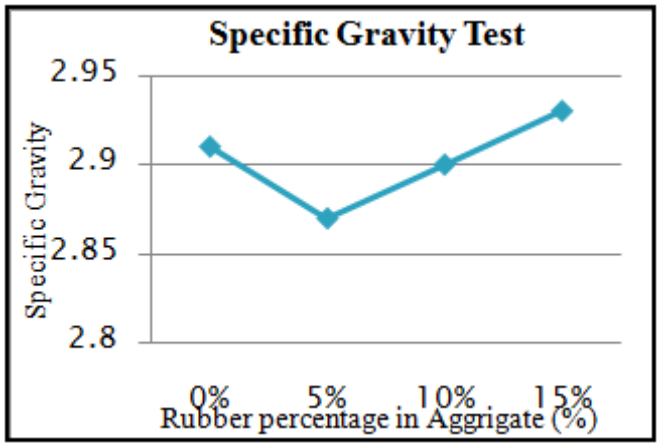
Sr. No	Laboratory Test On Aggregate	Plane Aggregate	Aggregate with rubber content %		
			5	10	15
1	Impact Test (gm)	12.33	10.76	10.13	9.57
2	Crushing Test (gm)	8.97	8.63	8.11	7.84
3	Abrasion Value Test (gm)	11.56	11.05	10.3	9.55
4	Specific Gravity Test	2.91	2.87	2.9	2.93
5	Water Absorption Test (%)	0.34	0.32	0.32	0.33

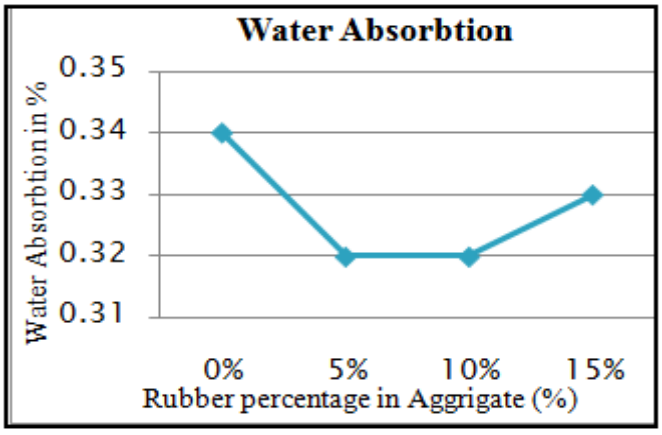
6.7) Graphical Representation











VII. EXPERIMENT – ON BITUMEAN

7.1) Penetration test

Bituminous materials are available in various types and grades. The penetration test determines the hardness of these materials by measuring the depth in tenth of a millimetre to which a standard needle will penetrate vertically under specified conditions of standard load, time and temperature. The sample is maintained at the standard temperature of 25 °C. The total load on needle is l00 gm. test procedure vide IS 1203-1958 Penetration test .

7.2) Ductility Test

In the flexible pavement construction where bitumen binders are used, it is ofsignificant importance that the binders form ductile thin films around the aggregates. This serves as a satisfactory' binder in improving the physical the physical interlocking of the aggregates The binder material which does not possess sufficient ductility would crack and thus provides previous pavement surface. This in turn results in damaging effect to the pavement structure. The test is conducted at 27 + 0.5° C and at a rate of pull of 50 + 2.5 mm per minute The test has been standardized by the IS1208.

7.3) Viscosity Test

Viscosity is defined as inverse of fluidity. It is the property of fluid by virtue of which, it can resist to flow or deformation. Viscosity thus defines the fluid property of bituminous material. The degree of fluidity at the application temperature greatly influences the strength characteristics of the resulting paving mixes. High or low fluidity at mixing and compaction has been observed to result in lower stability values There is an optimum value of fluidity or viscosity for mixing and compacting for each aggregate gradation of the mix and bitumen grade.

7.4) Softening Point Test

Bitumen does not suddenly change from solid to liquid state, but as the temperature increases, it gradually becomes softer until it flows readily. All semi-solid statebitumen grades need sufficient fluidity before they are used for application with the aggregate mix. The softening point is the temperature at which the substance attains particular degree of softening under specified condition of test. For bitumen, it is usually determined by Ring and Ball Test. The apparatus and test procedure are standardized by ISI. It is obvious that harder grade bitumen possesshigher softening point than softer grade bitumen.

7.5) Marshall Stability Test

The Marshall Stability and flow test provides the performance prediction measure for the Marshall mix design method. The stability portion of the test measures the maximum load supported by the test specimen at a loading rate of 50.8 mm/minute. Load is applied to the specimen till failure, and the maximum load is designated as stability. During the loading, an attached dial gauge measures the specimen's plastic flow (deformation) due to the loading. The flow value is recorded in 0.25 mm (0.01 inch) increments at the same time when the maximum loadis recorded. Standard

temperature 600C corresponding load carried by specimen is called Marshal Stability value and the deformation at failure in units of 0.25 mm is recorded as Marshal low value

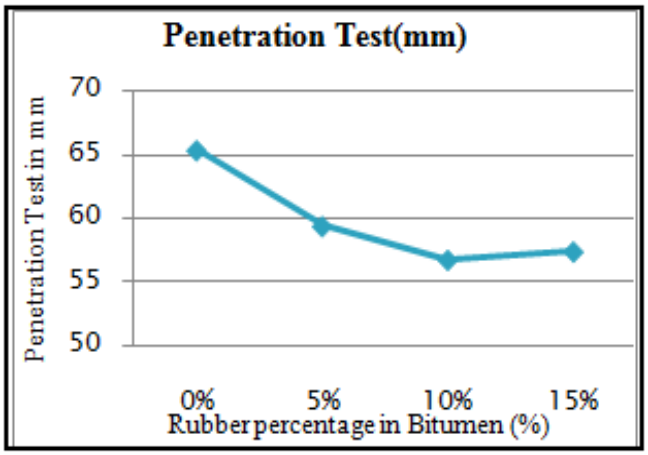
7.6) Result on Bitumen –

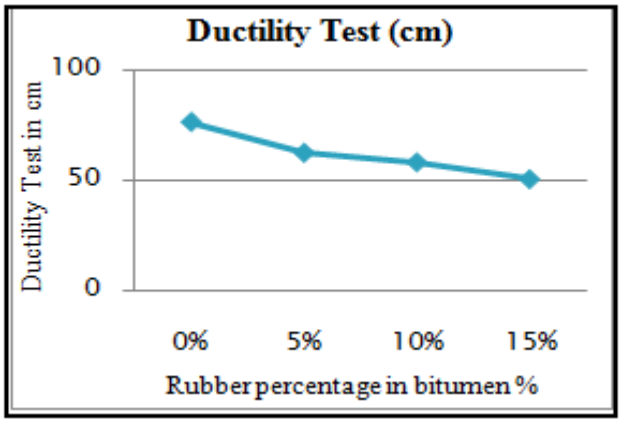
From above the laboratory test on bitumen of replacing rubber in varying percentage. The result shows that with replacing 10% of bitumen gives the better result in above test. All the parameters were also well as per IRC specifications. Hence replacing 10% of bitumen content of 60/70 grade of bitumen gives satisfactory result as compare to other.

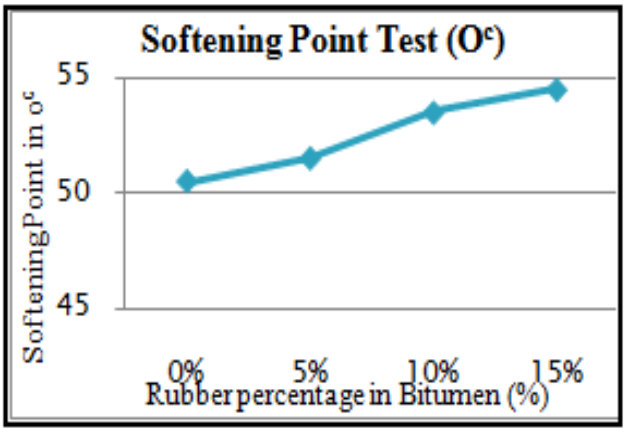
Table 2: Different properties of crumb rubber modified Bitumen

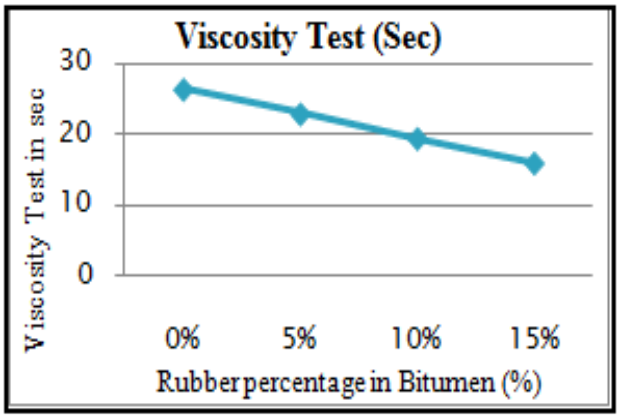
Sr. No	Laboratory Test On Bitumen	60/70 grade bitumen	Bitumen with rubber content %		
			5	10	15
1	Penetration value @ 25 0 C, 5 S, 100 gm (mm)	65.55	59.33	56.67	57.33
2	Softening Point(0 C) @ ring ball test	50.5	51.5	53.5	55.5
3	Ductility test (cms)@ 27 0 C, 5 cm/min	76.6	62.67	58.33	50.67
4	Viscosity test@ 27 0 C(sec)	26.5	23.0	19.5	16.0
5	Marshall stability test (kg)	1195.56	1156.0	1030.0	913.8

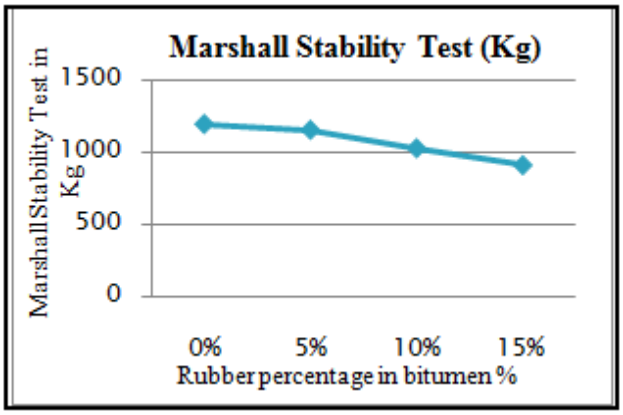
7.7) Graphical Representation











VIII. CONCLUSION

1) After carefully performing the above test on aggregate and bitumen it is concluded that as per IRC specification the results of replacing 10% of rubber has gives a better strength and stability also reduces the problem of disposal of waste tyre and help to make a helthy environment.
2) Addition of waste tyre in rubber aggregate modifies the flexibility of surface layer.
3) The permanent deformation and thermal cracking are reduced in hot temperature region.
4) The main properties of rubber is sound absorbing, so reduced the noise pollution of heavy traffic roads
5) Conventional stone aggregate can be saved to the certain quantities
6) The waste rubber tyre are used in road construction ,so improved the quality of road
7) By replacing the rubber in bitumen the strength will be increased.

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